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MOVE2CCAM

Methods and tools for comprehensive impact assessment of the CCAM solutions for passengers and goods

HORIZON-CL5-2021-D6-01

D3.4 - Satellites' needs, impact analysis and mapping

Impact of self-driving vehicles on
citizens and organisations in Europe

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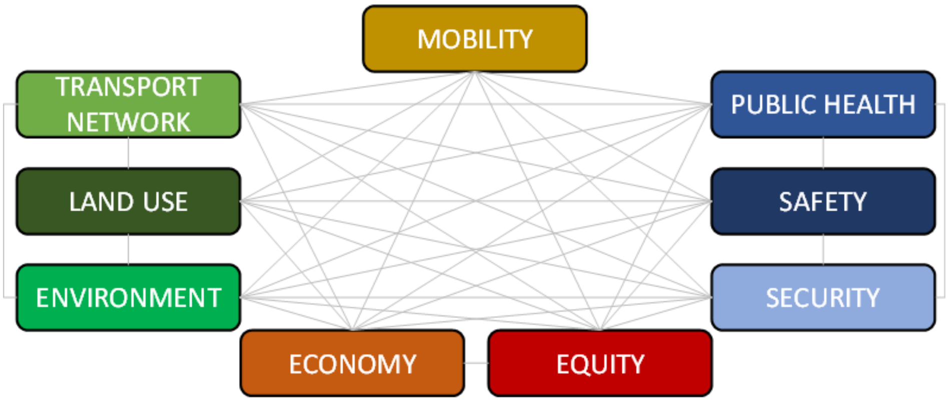
Executive summary

This report analyses the perceptions of citizens and organisations in Europe about the impacts of self-driving vehicles, based on a series of activities implemented by Move2CCAM, a research project funded by the European Union. In these activities, citizens and organisations expressed their views about the impacts of self-driving passenger and freight vehicles on eight inter-related domains, as below. Some activities were conducted in all eight Move2CCAM countries: Cyprus, France, Germany, Greece, the Netherlands, Poland, Spain, and the United Kingdom. Others were conducted only in the three "prototypical regions" of the project: North Aegean region (Greece), Helmond (Netherlands), and Metropolis GZM (Poland).



Part 1 – Impact of self-driving vehicles on citizens

Chapter 2 - Qualitative assessment of impact - citizens

This chapter reports the results of online and face-to-face discussions and other group activities involving 232 citizens across the eight countries.

Citizens believed that self-driving vehicles could improve the mobility of those underserved by existing transport services, while also improving safety. Human assistants would still be needed, in case of emergencies, to help passengers with additional needs, and to solve situations such as anti-social behaviour (in public transport) and theft (in freight transport). Citizens were also cautious about technical issues such as lack of connectivity in rural areas, driving in bad weather or on uneven terrain, hardware or software failure, hacking, and handling of private data.

Congestion may decrease due to more efficient driving or increase due to a higher number of vehicles on the road. Shared services are unlikely to reduce private car ownership, due to their convenience. Congestion may also move elsewhere (e.g., the pavement for delivery bots, or the air for drones). Self-driving vehicles being electric could reduce air and noise pollution but could also create new environmental problems related to the manufacturing and disposal of batteries. There is also fear of job losses for delivery and public transport drivers, but also hope that more jobs and industries will be created. The net effect on jobs is uncertain. There were concerns about the exclusion of already marginalised groups.

Chapter 3 - Demonstration of self-driving vehicles - citizens

This chapter reports the results of a demonstration of three self-driving vehicles (a bus, a mini-shuttle, and a delivery robot) in Helmond (Netherlands), involving 35 citizens.

Participants reported mostly positive feelings about using the vehicles. Most said they felt safe and believed that the vehicles will also be safe for pedestrians and cyclists. Participants also liked that the self-driving vehicles were quiet, and that the ride was smooth. Self-driving vehicles are expected to be cheaper, less stressful, and more comfortable than human-driven ones. Participating in the demonstration increased intentions to use self-driving vehicles.

The main negative aspects were the perception that self-driving vehicles can be insecure in terms of exposure to crime and anti-social behaviour from other passengers, vandalism, and, in the case of the delivery robot, stolen goods. Participants who thought the mini-shuttle was less secure were also less likely to say they intend to use it. While safety perceptions improved after the demonstration, there were some remaining doubts about what happens in emergency situations or if the technology fails. The general view was that the vehicles were slow, although this was related to the design of the experiment, as the vehicles were programmed to travel at slow speeds. While the bus felt familiar, the mini-shuttle was thought to be too narrow, with not enough seating.

Chapter 4 - Virtual reality experiments

This chapter reports the results of virtual reality experiments with 92 citizens in Helmond (Netherlands), Katowice (Poland), and Mytilene (Greece). Participants played a game where they chose between using a virtual self-driving car or bus. Electroencephalography (EGG) data was recorded. Participants also answered questionnaires and joined group discussions.

Participants had positive views about both vehicles and the experience of using them in virtual reality raised the intention of using them in the real world. The most common opinion was that self-driving vehicles will be cheaper, more comfortable, and safer than human-driven ones. The possibility to see the view was identified as a key element of trip quality in self-driving vehicles.

Personal security issues related to bus passenger number or behaviour were a concern, both in the participants’ stated opinions and in reactions to specific situations inside the self-driving bus, as measured by EEG data. Participants noted that the lack of a human assistant in buses could reduce the accessibility of individuals with mobility restrictions. Women and older participants had more situations where EEG data indicated stress/arousal. Older participants were more likely to think that self-driving buses will be more insecure and less likely to think they will be safer than human-driven ones. There were also concerns about congestion, lack of space, and seat arrangement.

The experiment was successful as a method to study user reactions to self-driving vehicles. The scenarios were perceived to be realistic, and participants noticed most changes in the car and bus scenarios.

Chapter 5 - Pan-European survey

This chapter reports the results of an online survey answered by 7,941 participants in the eight countries.

Around one fifth of the individuals interviewed were not aware of self-driving vehicles. One fifth also thinks that these vehicles will never be implemented in their regions. Intentions to buy or use one are not very strong. Willingness to pay to use a self-driving vehicle is lower than what individuals currently spend on travel. The groups more likely to use self-driving vehicles are the 18-34 group, individuals without children, living in city centres, and who currently make more and longer trips, as well as those with high levels of technology adoption and awareness of self-driving vehicles.

Citizens expect that self-driving vehicles will increase their mobility (i.e. more and longer trips) but on average do not think that delivery orders, parking needs, or residence location will change much. Private car use may increase. Self-driving freight vehicles are expected to have a weaker impact on people's lives than passenger vehicles.

For their region as a whole, citizens expect some improvements in mobility without increasing congestion. However, self-driving vehicles could increase travel costs and will require the use of more resources such as electricity, parking space, and redesigned infrastructure. Most other perceived impacts are positive: increase in accessibility and economic activity and reduction in environmental harms and safety problems. Possible detrimental impacts are the increase in cyber attacks, vehicle breakdown, obesity, dependence on technology, and legal issues. Opinions about impacts on jobs or travel stress are split.

Chapter 6 - Survey on impact of self-driving freight vehicles

This chapter reports the results of a survey on the impact of self-driving freight vehicles in the United Kingdom, involving 700 participants.

The survey found that while there is interest towards deliveries made with self-driving vehicles, conventional vans remain the preferred choice, as citizens are familiar with them and value human interaction. Citizens prefer conventional vans to self-driving freight vehicles, after accounting for differences in cost, time, and other delivery characteristics. This preference increases with age. Citizens would only use self-driving freight vehicles if they were cheaper or faster. Some participants were also concerned with the reliability of these vehicles in face of unexpected situations or security issues. Others thought that deliveries with self-driving vehicles can be faster, reliable (in terms of punctuality), and more convenient.

Road users also expressed a variety of concerns about sharing roads with self-driving delivery vehicles, related to road safety, congestion, and privacy.

Chapter 7 - Conclusions of Part 1 – Impact on citizens

A common conclusion of all chapters in Part 1 is that self-driving vehicles can enhance people's mobility. Some of the project activities with citizens concluded that travel will be cheaper, others that travel will be more expensive. However, there was consensus that travel will be more comfortable and allow for productive or leisure uses of time. The number of trips that people make will probably increase, especially by private modes, which will increase road traffic levels but not necessarily congestion, as self-driving vehicles will be more reliable in dealing with unexpected events and bottlenecks. The effect on parking is uncertain. The perceived impacts on safety were consistent across activities: travel will be safer, but there are remaining concerns about emergency situations that self-driving vehicles may not be able to handle.

The main concern about self-driving vehicles is security. Travelling in public transport without a human driver or assistant increases fear of crime and harassment. Freight deliveries will also be vulnerable to theft. Vehicles can be hacked, and citizen data can be misused.

Emissions and noise will probably decrease. However, citizens expressed concern in some activities about the implications of relying on electric vehicles, as demand for electricity will increase, and battery disposal may become a problem.

The impacts on public health were consistent across activities: air quality will improve but the impact on travel stress is uncertain. Perceived effects on jobs were also consistent: there will be both job creation and destruction, with an uncertain net effect. Finally, the perceived effects on equity were also consistent. Accessibility may increase in areas currently not served by public transport, but self-driving vehicles may not meet the needs of people with disabilities and may create price-related exclusion.

Part 2 – Impact of self-driving vehicles on organisations

Chapter 8 - Qualitative assessment of impacts - organisations

This chapter reports the results of online and face-to-face discussions and other group activities with 87 individuals representing organisations in the eight countries.

Organisations thought that self-driving vehicles can improve travel reliability and increase the accessibility of people with mobility issues or living in isolated areas, while also facilitating night-time trips and deliveries. However, security was a core concern, including theft of goods from driverless vehicles, dangerous or hazardous cargo being unsupervised, and issues around cybersecurity. Multiple safeguards and regulations are needed.

Other concerns were the ability to drive in bad weather, uneven terrains, and areas of poor connectivity, and the environmental impacts of battery manufacturing and particulate pollution, as well as increased noise and visual pollution. Infrastructure also needs to be adapted. This would have high costs that could be passed onto users. There are also risks to businesses if the technology were to malfunction and lose public trust.

There are also several uncertainties, such as whether there would be more vehicles on the road, which could increase congestion, collisions, pollution, and urban space use. Organisations are also undecided about the impact on jobs. Potential job losses for delivery and public transport drivers are a concern, but at the same time, more jobs, industries, and investment will be created.

Chapter 9 - Demonstration of self-driving vehicles - organisations

This chapter reports the results of a demonstration of a self-driving mini-bus in Katowice (Poland), an event joined by 20 representatives of organisations related to the transport sector.

On average, organisations thought that self-driving mini-buses are a useful innovation and are safe both for their users and for pedestrians and cyclists, although not necessarily safer than human-driven ones. Safety remained a concern even after the demonstration. Organisations also thought that self-driving mini-buses will be worse than human-driven vehicles in aspects such as speed, security in terms of crime, and travel stress. There was also some concern about the cost of using these vehicles.

Overall, organisations showed slightly less enthusiasm for self-driving vehicles than citizens did in the demonstration in the Netherlands reported in Chapter 3. However, organisations expressed a positive intention to use the self-driving mini-bus in the future.

Chapter 10 - Case studies of organisations

Detailed case studies were conducted with representatives from 11 organisations in all countries except France, including transport providers, large institutions using transport, and the self-driving vehicle industry. The case studies were based on semi-structured interviews.

The organisations expressed their views on the costs and benefits of different types of self-driving vehicles. Self-driving buses were seen to have a large potential for providing additional bus services, covering unmet demand in rural areas or at night-time. Drones could also provide useful services. Both are safe and reliable and can reduce costs but require large investments. Organisations expressed their intention to use self-driving vehicles. Passenger transport providers may even be forced to use them, due to increased problems in recruiting drivers. However, many technical, financial, regulatory, infrastructural, safety, and labour issues need to be addressed before the organisations start using self-driving vehicles in their daily operations

Organisations thought that self-driving vehicles are expensive but may increase revenue and decrease costs, albeit only in the long term. They will also improve operational aspects but will require changes in the workforce.

Organisations also gave their views of the broader impact of self-driving vehicles in their regions. Mobility will increase but this will cost. Travel will be more reliable but may fail to meet the needs of people with disabilities. Some large facilities may be moved away from the centre, but parking spaces will not. Jobs will be created and destroyed. Travel will be safer, but less secure, due to increased risk of crime in public transport and freight vehicles, and hacking of vehicles.

Chapter 11 - Conclusions of Part 2 – Impact on Organisations

A common conclusion of all chapters in Part 2 was that travel will be more reliable. Road traffic levels, especially of private vehicles, will increase but this will not necessarily increase congestion. Extensive changes to the infrastructure are needed.

The strongest concern, expressed in all activities, was personal security. Fear of crime may increase in public transport. Freight deliveries will also be vulnerable to theft. Vehicles can be hacked, and citizen data can be abused or stolen with malicious intent.

Organisations were consistent across activities that there will be both job creation and job destruction, with uncertainty on the net effect. There was also concern about customer resistance to new solutions, especially when they fail. Costs will also probably increase and be passed on to customers. There will also be a new industry developing self-driving vehicles and software. To adjust the economy to the new realities, large investments are needed.

Self-driving vehicles can improve accessibility of rural and suburban residents and night-shift workers, but there are also concerns about whether the new solutions can meet the needs of people with disabilities. They can also create digital and price exclusion. The self-driving vehicle industry is also dominated by younger males. Across all industries, older workers may feel excluded.

The impacts on safety were consistent across activities: travel will be safer, with fewer collisions, but there is a concern about emergency situations. Emissions will decrease, but new problems with be created such as battery disposal and visual pollution (due to increased number of vehicles). The impacts on public health are also mixed. Self-driving vehicles can solve emergency situations, but the impact on travel stress is uncertain.

Part 3 – Further analysis, synthesis, and conclusions

Chapter 12 - Joint qualitative assessment of impacts - citizens and organisations

This chapter reports the results of workshops where 44 citizens and 10 representatives of organisations exchanged views on the impacts of self-driving vehicles.

Participants found it difficult to judge whether people would be travelling more or less, if self-driving vehicles were available. Participants wanted the convenience of private cars to be preserved, especially for regional and leisure travel, but they were open to using shared vehicles. Participants believed that safety issues would be mostly resolved by 2050, which will cause public acceptance to automatically increase. Hacking was seen as a risk, but counter-measures were expected to keep up with more sophisticated attacks. Job losses could be absorbed, so as not to result in a net loss of jobs overall.

Participants believed in a mostly automated network by 2050. The more widespread the roll-out, the safer and more efficient the system would be. For self-driving vehicle services to gain public trust, they would need to be safer, more punctual, convenient in terms of frequency and routes, low cost, not increasing congestion, accessible to disabled people, and comfortable. Implementation depends Fon interventions from government and transport system operators and relies on investment and development of security provisions, the public transport system, and job transitions being managed well.

Chapter 13 - Synthesis - comparison of impacts on citizens and organisations

This final chapter compares the conclusions derived from the activities with citizens and organisations.

Opinions of citizens and organisations were mostly consistent. Self-driving vehicles can enhance mobility and improve travel reliability, but this may come at the expense of increased costs. Traffic levels will increase but congestion may not. Parking needs may not decrease. Current environmental problems will be reduced, but new ones will be created. There will be both job creation and job destruction and the net effect is uncertain. Large investments are needed to adapt the economy. Customers may dislike freight delivery solutions based on self-driving vehicles. Accessibility of some groups may increase but self-driving vehicles may not meet the needs of people with disabilities and create price and digital exclusion. The impact on travel stress is uncertain. Safety will improve but collisions will not be eliminated. The strongest concern for both among citizens and organisations is the security of both passengers and freight.

Table of contents

Concepts

	Definitions
Move2CCAM	An EU-funded project analysing the potential impacts of self-driving vehicles in Europe (https://move2ccam.eu). This report is one of the deliverables of this project.
CCAM	Cooperative, Connected, and Automated Mobility. Concept used in European research projects to denote technologies, products, or services to transport passenger and/or freight using self-driving vehicles.
Self-driving vehicles	Also known as autonomous vehicles. Vehicles for passenger or freight transport that are partially or fully operated by computer systems, without the need of a human driver. The vehicles are connected with other vehicles and with physical and digital infrastructure. This report focuses on fully self-driving vehicles only.
Use case	How a technology, product, or service could potentially be used. In this report, the concept applies to self-driving vehicles for passenger or freight transport.
"Satellites"	Group of citizens and organisations associated with the Move2CCAM project and invited to a sequence of project activities, including co-creation activities and activities where they express their views on potential impact of self-driving vehicles.

1. Introduction

Cooperative, Connected, and Automated Mobility (CCAM) is a new frontier for mobility. It allows vehicles to communicate with each other, the infrastructure, and other users of the transport network. Self-driving vehicles open new possibilities for both passenger and freight transport and could contribute to more efficient, equitable, and sustainable mobility systems. However, the potential impacts of this radical change are still not well understood. There is little knowledge on the many possible inter-relationships between the impacts of self-driving vehicles in different economic, social, and environmental domains.

The MOVE2CCAM project (https://move2ccam.eu) is exploring these inter-related impacts, aiming at delivering methods and tools for systems-wide assessments of self-driving vehicles. This exploration is done with input from the project "satellites", i.e., citizens and organisations in eight European countries (Cyprus, France, Germany, Greece, the Netherlands, Poland, Spain, and United Kingdom), who were invited to participate in a series of activities throughout the project.

Citizens represent diverse groups in society, while organisations represent a range of stakeholders with interest in self-driving vehicles. The engagement with the "satellites" ensures that the methods and tools developed in the project acknowledge the wide diversity of perceptions, needs, objectives across and within the eight countries in this project and are potentially transferable to the rest of Europe. Figure 1 is the structure of the "satellite" network, showing citizens and the range of different types of organisations in that network.

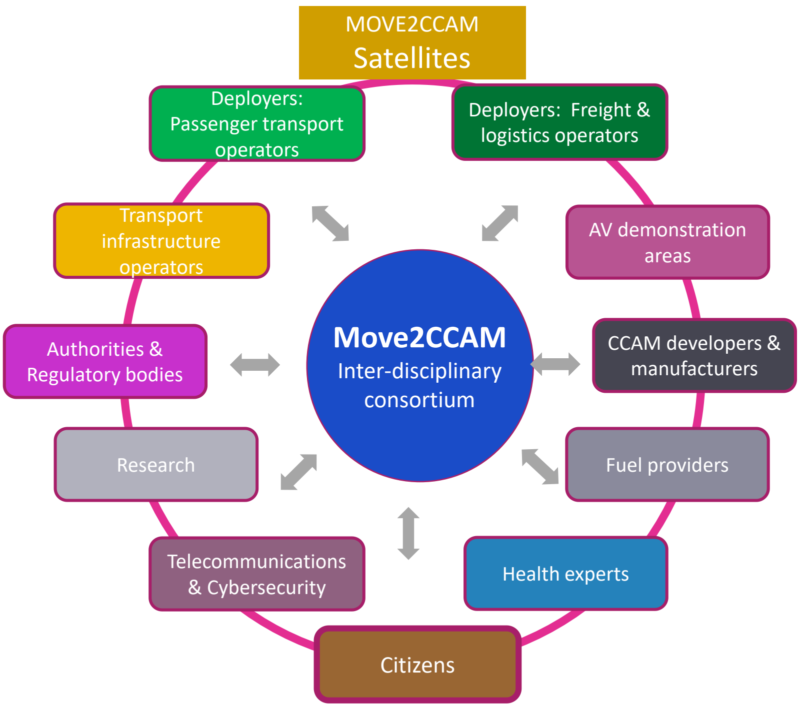


Figure 1. The Move2CCAM project network of "satellites" (citizens and organisations)

In the first part of the project (**Co-Creation**), citizens and organisations participated in activities to co-create use cases, scenarios, and business models for self-driving vehicles. The results of this part of the project were reported in Deliverable 1.2 (*CCAM use cases, business model, scenarios and Key Performance Indicators*).

In the second part of the project (**Impact**), reported in the present deliverable, citizens and organisations participated in activities where they expressed their views about the possible impact of self-driving vehicles on eight inter-related domains (Figure 2): mobility, transport network, land use, environment, economy, equity, public health, safety, and security.

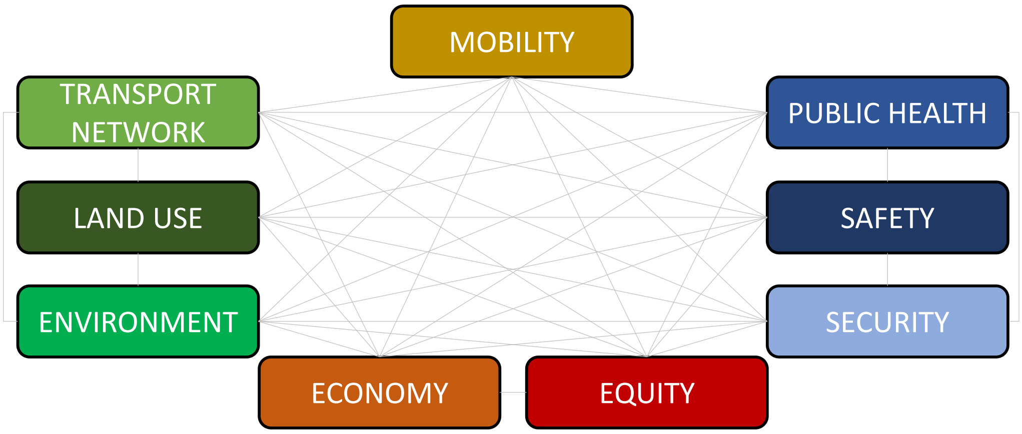


Figure 2. The Move2CCAM self-driving vehicle impact dimensions

This second part of the project used as input some of the outputs produced in the first part of the project, namely:

- Results from questionnaires answered by citizens and organisations when they were recruited to join the project's "satellite" network, i.e., before they joined the co-creation activities.
- A selection of use cases of self-driving passenger and freight transport vehicles, co-created by citizens and organisations. The concept of "**use case**" in this project is understood as a description of how a technology, product, or service could potentially be used – in this case how self-driving vehicles could be used to transport passengers and vehicles. A self-driving vehicle use case is characterised by several aspects: type of vehicles, possible origin and destinations of trips made by these vehicles, modes (private or public), and, in the case of public transport modes, characteristics of the service (e.g. frequency).

Previous project deliverables set the scene for the analysis of impact of self-driving vehicles reported in this deliverable:

- Deliverable 1.3 (*CCAM impact analysis roadmap*) presented a roadmap for assessing the impact of the self-driving vehicle use cases, including data to be collected, data collection methods, analysis methods, expected outcomes, participant recruitment strategy, and ethics consideration.
- Deliverable 3.3 (*Primary and secondary data and the MOVE2CCAM data warehouse*) presented the materials used to collect primary data during the activities to assess impact of self-driving vehicles. This included questionnaires, discussion guides, stimuli shown to activity participants, and documents related to research ethics, such as information sheets and consent forms.

The present deliverable (3.4) presents the results of all activities where citizens and organisations provided input about the impact of passenger and freight self-driving vehicles. The deliverable is organised into three parts, and a total of 13 chapters.

All chapters can be accessed directly through hyperlinks from this introduction. There are also hyperlinks throughout the document to facilitate navigation within the document, given its length.

Part 1 reports the results of activities involving citizens. Table 1 lists these activities, their location and timing, number of participants targeted (across all countries) as specified in the project's Grant Agreement (Part B, Table 10), achieved number of participants (i.e. individuals who actually participated in the activities, across all countries), and activity number (as defined in the Grant Agreement).

Chapters 2-6 report the results of each activity. This includes a qualitative assessment of impact, through online and face-to-face discussions (Chapter 2), citizens' feedback on a demonstration of passenger and freight self-driving vehicles in Helmond (Netherlands) (Chapter 3), results of virtual reality experiments in Helmond (Netherlands), Katowice (Poland), and Mytilene (Greece) (Chapter 4), results of an online pan-European survey, implemented in all regions of the eight Move2CCAM countries (Chapter 5), and results of a survey on the impact of self-driving freight vehicles, implemented in all regions of the United Kingdom (Chapter 6).

Chapter 7 then brings all these results together, providing an overview of citizens' opinions about the impact of self-driving vehicles.

Table 1. Overview of activities - citizens

Chapter	Activity	Location	Timing	Number of participants		Project activity number
				Target	Achieved	
2	Qualitative assessment of impact of use cases	Netherlands, Poland, Greece	October 2023	400	232	5
3	Demonstration of self-driving vehicles	Netherlands	January 2024	30	35	5
4	Virtual reality experiments for self-driving vehicle use	Netherlands, Poland, Greece	December 2023-January 2024	96	91	5
5	Pan-European survey of impact of use cases	Cyprus, France, Germany, Greece Netherlands, Poland, Spain, United Kingdom	January-May 2024	32	7,941	6
6	Survey of impact of self-driving freight vehicles	United Kingdom	June 2024	N/A	700	N/A

Part 2 of the deliverable reports the results of activities involving organisations. Table 2 lists these activities. Chapters 8-10 report the results of each activity. This includes a qualitative assessment of impact, through online and face-to-face discussions (Chapter 8), organisations' feedback on a demonstration of a self-driving passenger vehicles in Katowice (Poland) (Chapter 9), and detailed case studies, based on in-depth interviews, of the impact of self-driving vehicles on 11 organisations (Chapter 10).

Chapter 11 is an overview of organisations' opinions about the impact of self-driving vehicles.

Table 2. Overview of activities – organisations

Chapter	Activity	Location	Timing	Number of participants		Project activity number
				Target	Achieved	
8	Qualitative assessment of impact of use cases	Netherlands, Poland, Greece	October-November 2023	240	87	4
9	Demonstration of self-driving vehicle	Poland	June 2024	N/A	20	N/A
10	Case studies (in-depth discussion of impact of use cases on selected organisations)	All Move2CCAM countries except France	March-April 2024	10	11	Task 3.5 – point 2

Part 3 of the deliverable provides the results of further analysis of impact from activities mixing citizens and organisations (Chapter 12). Table 3 gives the characteristics of these activities, which involved discussions and other group of activities. Chapter 13 then synthesises the results presented in all previous chapters, by comparing the impacts of self-driving vehicles on citizens and organisations.

Table 3. Overview of activities mixing citizens and organisations

Chapter	Activity	Location	Timing	Number of participants		Project activity number
				Target	Achieved	
12	Further qualitative assessment of impact of use cases (citizens and organisation)	Netherlands, Poland, Greece	April-May 2024	240	59	7

A series of appendices collect further information. As mentioned, Deliverable 3.3 of this project compiled data collection materials and related ethics documents. However, the project organised extra activities that collected data, using new materials. In addition, some of the other materials were further refined since the submission of Deliverable 1.3 (e.g. the pan-European survey) or were customised to specific participants (e.g. the case study interview guides). As such, the present deliverable collects the new or revised materials used to collect the data analysed, as well as the unmodified materials, so that the deliverable is self-contained. These materials are collected in Appendices 1-11. Ethics documents are not included, but can be consulted in Deliverable 3.3

A final Appendix 12 includes the statistical models used in some of the analyses of the pan-European survey (since Chapter 5 describes only the main results of these models).

The table below lists all appendices and the chapters they are related to.

Table 4. Overview of appendices

Appendix	Contents	Related chapters
1	Questionnaire to collect citizens' demographic data	2, 3, and 4
2	Pre-events questionnaire - citizens	2, 3, and 4
3	Qualitative assessment of impact – activity guide	2 and 8
4	Self-driving vehicle demonstration – post-event questionnaire	3 and 9
5	Virtual reality experiments - post-event questionnaire	4
6	Virtual reality experiments - post-activity discussion guide	4
7	Pan-European survey on impact on impact on citizens – questionnaire	5
8	Impact of self-driving freight vehicles – questionnaire	6
9	Pre-events questionnaire – organisations	8
10	Organisation case studies – topic guides	10
11	Further qualitative assessment of impact – activity guide	12
12	Statistical models of impacts	5

PART 1

IMPACT OF SELF-DRIVING VEHICLES ON CITIZENS

Part 1 - IMPACT OF SELF-DRIVING VEHICLES ON CITIZENS

Part 1 reports the results of analyses of European citizens' perceived impacts of passenger and freight transport self-driving vehicles on their lives and on their regions where they live.

Chapter 2: Qualitative assessment of impact, through discussions and other group activities involving citizens.

Chapter 3: Citizens' feedback on a demonstration of passenger and freight self-driving vehicles in Helmond, the Netherlands.

Chapter 4: Results of virtual reality experiments in Helmond (Netherlands), Katowice (Poland) and Mytilene (Greece).

Chapter 5: Results of the online pan-European survey applied in eight European countries (Cyprus, France, Germany, Greece, The Netherlands, Poland, Spain, and United Kingdom).

Chapter 6: Results of a survey on the impact of self-driving freight vehicles in all regions of the United Kingdom.

Chapter 7: Conclusions of the analyses above.

2. Qualitative assessment of impact - citizens

2.1 Overview

The qualitative impact assessment explored citizens' perceptions of the potential impacts of the self-driving vehicle use cases co-created with citizens and organisations in earlier project activities.

In all eight countries (Cyprus, France, Germany, Greece, the Netherlands, Poland, Spain, United Kingdom), participants joined a week-long online engagement platform, followed by an online or in-person workshop. In-person workshops were held in Greece, Netherlands, and Poland, focusing on the project's three "prototypical regions" (North Aegean Region, Helmond, and Metropolis GZM).

In each region, four self-driving use cases were examined in detail, aiming to understand perceptions of impact across the eight MOVE2CCAM domains: mobility, transport network, land use, environment, economy, public health, safety, and security. Use cases in each region were selected according to relevance, based on the results of earlier activities with the same participants.

The objectives of the online platform and workshop discussions were to understand:

- How citizens view the potential role of the selected use cases in their everyday lives and under what circumstances they might benefit from these use cases (or not)
- What positive and negative impacts citizens imagine might arise from the proposed use cases and which impacts are most important to them
- How certain they are about the range of impacts discussed, when they think use cases might be rolled out, and where they agree and disagree with one another.

A main output from these sessions was a set of causal effect diagrams, co-created with citizens for each use case. These diagrams have formed the basis of causal-loop diagrams used in another work package of the project to develop an impact assessment tool.

This chapter is organised as follows:

- Section 2.2 describes the methods used to assess perceived impacts of use cases across domains
- Section 2.3 describes the sample make-up and characteristics
- Section 2.4 reports the results of the engagement activities
- Section 2.5 draws conclusions.

2.2 Methods

2.2.1 Research design

The research was carried out in two stages: an online platform (Recollective), where citizens across all regions joined a week-long online engagement with tasks designed to familiarise them with the use cases and domains, followed by the workshop sessions, where most of the time was dedicated to developing the causal effect diagrams.

For most of the engagement of the platform, citizens were asked to imagine that it is the year 2035, before commenting on a number of scenarios related to the use cases they had helped to co-create in earlier project activities.

For each use case, citizens answered questions on three of the eight MOVE2CCAM domains, giving in-depth data across the whole sample, while keeping the online engagement activity short enough to retain participant interest.

For each domain, participants were asked whether they thought the use case scenario would improve or worsen conditions. For example, if they thought the use case would have a positive or negative impact on the environment (e.g., in terms of air quality, pollution, climate change, or noise). Different domains were allocated across the sample to achieve coverage without overwhelming participants:

- All participants answered questions on mobility – as it is the domain where individual behaviour is most influential.
- All participants answered questions on one of these three domains: safety; economy; and environment – as previous sessions suggested citizens had the most developed views with regards to these domains.
- All participants answered questions on one of these four domains: public health, transport network, land use, and equity.

Figure 3 and Figure 4 show two aspects of the online platform.

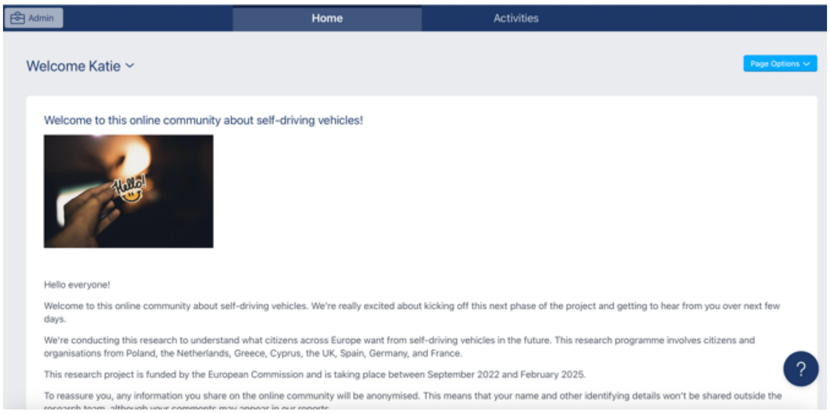


Figure 3: Online citizens engagement platform – welcome page

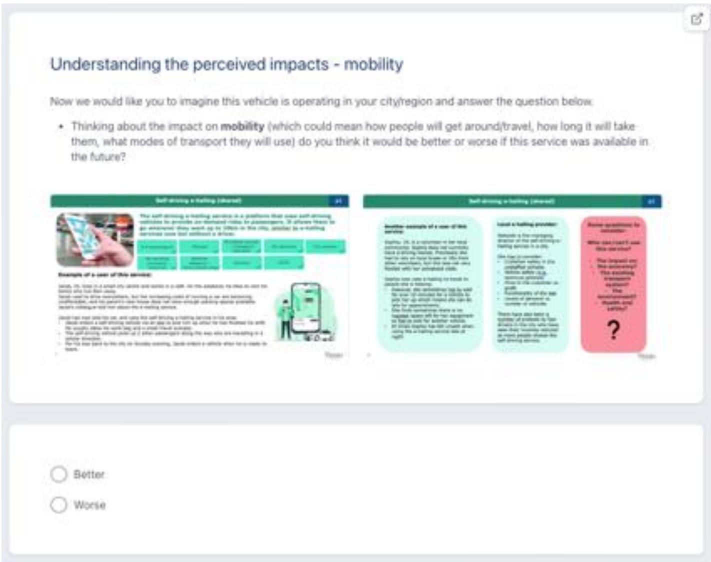


Figure 4: Online citizens engagement platform – example of exercise

After the online engagement was completed, citizens in the UK, Spain, Germany, France, and Cyprus participated in 2-hour online workshops, using the Zoom platform.

The workshops were designed to understand:

- What positive and negative impacts citizens imagine will arise from the use cases proposed, and which impacts are the most important to them.
- What they see as the potential effects or consequences of identified impacts.
- Citizens' views on the timeline for deployment of each use case in the next few years (see example in Figure 5).

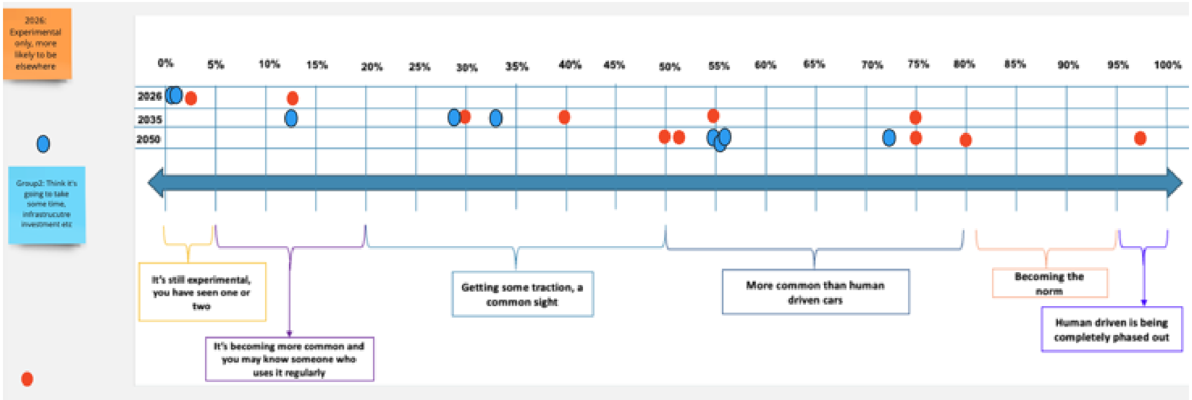


Figure 5: Online citizen workshop exercises – timeline exercise

Citizens were split into smaller groups within each workshop. Each group focused on two to three use cases in detail and worked together with the moderator to develop causal effect diagrams (see definition below) for each use case (including findings from the online engagement platform).

A causal effect diagram is a way of visualising how one thing (the introduction of a particular type of self-driving vehicle) affects another (the amount of traffic congestion in a city). There may be many steps between the two things, and each step involves a positive or negative change (more trips, or less, for example) at a given scale (e.g. 10 more, or 100 more). Figure 6 is an example.

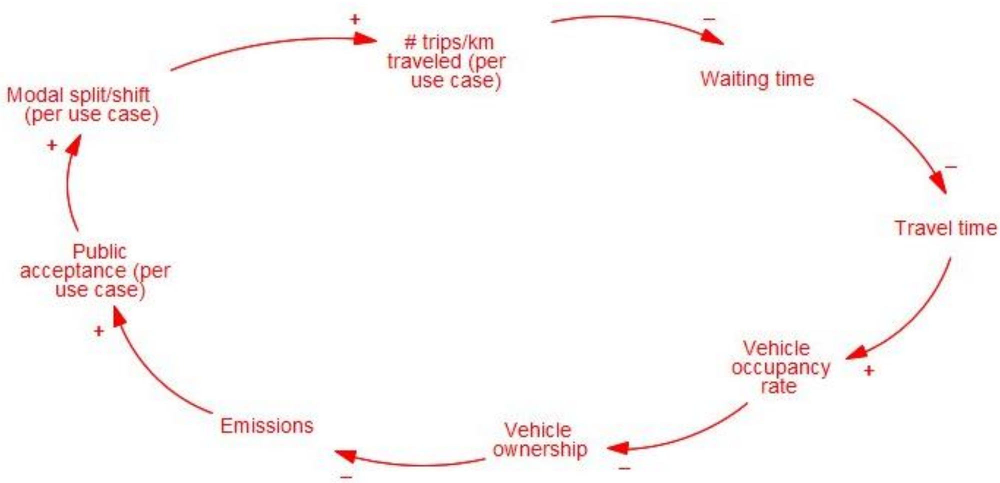


Figure 6: Example of causal feedback diagram

Examples of the types of causal effect chains that make up the diagrams include:

- Self-driving long-distance trucks could lead to reduced air pollution (compared to conventional trucks), which could lead to improved public health, leading to a more positive perception of self-driving vehicles overall.
- Self-driving long-distance trucks are at risk of data or connection interruptions, leaving them stranded or going the wrong way, leading to reduced uptake of the vehicles and reduced public trust in self-driving vehicles overall.

In order to make the idea of the causal feedback diagram more accessible to citizens, we developed a simpler diagram, with the eight domains as quadrants of a circle. For each domain the research team identified a few impacts, from the literature, to illustrate the concept. Citizens first discussed these impacts, adding or changing impacts based on their perceptions. Facilitators then asked participants to consider what the secondary or knock-on impacts might be for each domain, these were captured in the next layer of the circle, as shown in figure 6 below. Where participants described connections between impacts these were captured with arrows, and where they felt impacts were circular (e.g. that once a particular impact increased there would be a feedback loop) these were marked with a star. In this way citizens were able to generate their own causal feedback loops in a simplified way, based on their perceptions.

Each group's draft diagram was then presented to another group, allowing a higher number of participants to review and input into each causal effect diagram. This process highlighted a number of areas of uncertainty where citizens within or between groups were usure about how impacts would interrelate. These uncertainties were explored further in other activities of the project (see Chapter 12). Figure 7 shows an example of a diagram.

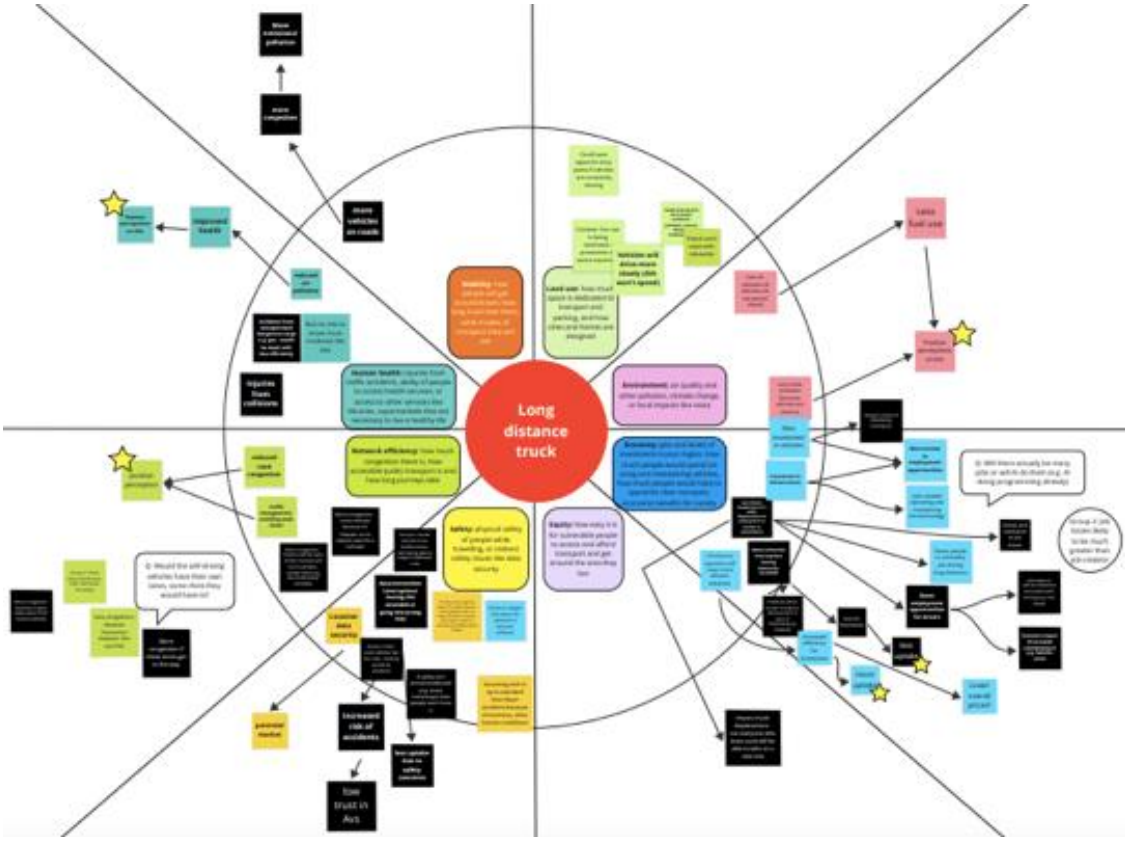


Figure 7: Online citizen workshop exercises – impact diagrams

After taking part in the online engagement platform, citizens in the Netherlands, Poland and Greece took part in 2-hour face-to-face workshops, which followed the exact same format as the online workshops but using materials in printed form. Figure 8 shows two aspects of the workshop in Poland.

Figure 8: Images from face-to-face citizen workshops

After the workshops, project partners in each country shared notes and co-created diagrams. Data from all workshops and countries were then drawn together to refine and expand the causal effect diagrams by looking at the potential positives and negatives from across the sample. They were further refined using data from the co-creation activities with organisations, to capture views expressed across different audiences.

2.2.2 Sample overview

The table below shows the number of participants in each country. A total of 232 citizens were involved, across eight countries. Table 6 show the sample composition.

Table 5: Qualitative assessment (citizens) – sample sizes by country

All	**232**
United Kingdom	34
Germany	28
France	11
Netherlands	33
Spain	29
Poland	40
Greece	40
Cyprus	17

Table 6: Qualitative assessment (citizens) – sample composition

		Netherlands* Poland, Greece	Other*
Age	18-34	16	26
	35-64	33	41
	65+	32	15
Gender	Man	43	49
	Woman	37	56
Working status	Works full-time	39	22
	Works part-time	7	13
	Student	5	9
	Seeking work	1	2
	Homemaker	6	2
	Retired	8	7
Household composition	Single	21	9
	Shared home	2	3
	Lives with parents/family	6	7
	Single parent with children	1	0
	Lives with partner	24	22
	Lives with partner and children	16	32
Residence location	City centre	16	15
	City, not in the centre	18	19
	Small city	0	0
	Small town	6	26
	Village	28	11
Driving attitude*	Enjoys driving	43	19
	Would prefer to do something else	13	13
Disability	Has a disability impacting mobility	2	4

Note: *: some data is missing

2.2.3 Allocation of use cases

A total of ten use cases were introduced across the sample (Table 5). Each use case was a self-driving electric vehicle. Each country explored a set of four use cases, with two use cases (consolidated delivery bot and self-driving e-hailing) common across all countries because they emerged in previous co-creation activities as the most common, suggested in all locations. A further two use cases were selected based on services that had gained greater levels of interest or been identified as more relevant during previous activities held in each country.

Table 7: Use case allocation by country

		Greece	Poland	Netherlands	United Kingdom	Germany	Spain	Cyprus
Passenger	P1. Self-driving e-hailing (shared)	■	■	■	■	■	■	■
	P2. Self-driving car (private)	■						■
	P3. Self-driving bus service			■	■		■	
	P4. Mobility bus on demand			■				
	P5. Emergency transportation		■			■		
Freight	F1. Consolidated delivery bot	■	■	■	■	■	■	■
	F2. Delivery drone							■
	F3. Long-distance truck				■	■		
	F4. Single-supplier delivery bot	■						
	F5. Medical delivery drone		■				■	

2.3 Results by use case: passenger services

2.3.1 Self-driving e-hailing

Table 8: Self-driving e-hailing use case (citizens)

Description	The self-driving e-hailing service is a platform that uses self-driving vehicles to provide on-demand rides to passengers. It allows passengers to go to any location within a 10km radius in the city/area, similar to e-hailing services now but without a driver.
Countries tested	Cyprus, Germany, Greece, Netherlands, Poland, Spain, United Kingdom

Across all regions, there was debate about whether self-driving e-hailing would improve the transport network efficiency, for example by reducing the need for private vehicles. Most agreed that this could be a positive outcome, easing congestion and therefore emissions, leading to a positive perception of self-driving vehicles. However, there was scepticism that e-hailing would genuinely lead to reduced private car ownership.

Safety was also salient for all countries and audiences. Citizens recognised that self-driving e-hailing vehicles could significantly reduce road traffic accidents by removing human error and limiting speeds, but they were concerned about passenger safety in the event of a software or hardware malfunction. Participants felt that a driver can provide a sense of security, as well as assistance when needed, thus contributing to passenger safety, despite the risk of human error. In addition, participants were concerned about the risks associated with increased data sharing.

Equity proved to be another key domain across countries. Most participants felt that self-driving e-hailing services would allow greater accessibility to car use, particularly for those who cannot drive, for example due to mobility impairments. However, citizens in the Netherlands and UK thought the service could be too expensive for some to use regularly.

Table 9: Self-driving e-hailing use case: results of qualitative assessment (citizens)

Mobility	• Citizens in Poland assumed that this service would improve mobility by shortening waiting times compared to public transport services. They also felt it could encourage car sharing, thereby reducing the demand for private vehicles. • However, participants in Greece felt that the service could increase travel times for people choosing it over a private car. • Participants in Germany also stressed the importance of a quick, responsive service if it were to replace private car use. See also Equity.
Public health	• For citizens across countries, the impact of reduced emissions was a frequent theme, and seen as a positive influence on public health and therefore perceptions of self-driving vehicles. • However, there was some concern from Germany about potential impacts on mental health, contributing to social isolation in situations where taxi rides are a key social interaction in a passenger's day-to-day life.
Land use	• Land use was a key theme for citizens who identified that a reduction in private vehicles could reduce congestion. In Germany, however, citizens questioned whether there would in fact be a reduction in the number of private vehicles – some felt there could be an increase instead (see Environment). • Participants also thought that an e-hailing service could reduce the need for private car ownership and, therefore, parking spaces, which could lead to more room for green spaces or electric charging stations.
Safety	• Safety was the most commonly expressed concern across citizens in all countries. • Most participants recognised that self-driving vehicles might be safer on the roads by reducing human error and sticking more closely to speed limits. However, all countries mentioned concern for the physical safety of passengers in the event of a technology malfunction that affects the control of the vehicle. • More specifically, there were concerns from Cyprus and the UK about the safety of vulnerable passengers without a driver acting as a safeguard. • In addition, there were concerns about the security of passengers' personal data that the service might hold, and how secure this would be against theft; this was found to be significantly off-putting in most countries.
Transport network	• Citizens from all countries saw the potential for reduced private vehicle use to reduce congestion. However, some were cautious about the level of uptake needed to make a tangible difference in this space. This is true of citizens in Germany, who feared that the introduction of additional vehicles into the network might simply increase congestion.
Environment	• There was widespread agreement among citizens that self-driving e-hailing has the potential to reduce emissions through reduced private car use. • However, views differed on the certainty of this outcome. For example, there was a strong expectation of this for citizens in Poland and the Netherlands, while others, particularly in Germany, questioned whether e-hailing services would significantly reduce personal car use. These citizens feared that the introduction of more vehicles might instead increase congestion, and therefore pollution, overall. • Elsewhere, citizens in Cyprus expressed concern over battery manufacturing and its environmental cost.
Economy	• There was considerable variation in discussions of this domain across countries. • Spanish citizens highlighted that a positive impact might be felt from increased investment in infrastructure • The UK and Poland felt there could be negative impacts on private business if new self-driving vehicles were unreliable. • Meanwhile, citizens in Germany and Spain expressed concerns for the job security of current taxi drivers.

Equity	• Most participants felt that self-driving e-hailing services would allow greater accessibility to car use, particularly for those who cannot drive, for example due to mobility impairments. • However, citizens in the Netherlands and UK thought the service could be too expensive for some to use regularly.
Timeline	• Citizens' ideas for when this technology would be operational varied considerably between countries. • Most felt that there would be at least some degree of rollout by 2026 (typically between 3-5%, but as high as 50% in Cyprus), and many were optimistic of a 50-70% rollout by 2050. • Those in the UK compared this to the rollout of Uber which received considerable backlash but still penetrated (and came close to dominating) the market. • In Germany, citizens' estimates were based on the pace of technological, regulatory, and social factors. • Polish citizens also saw regulation as a considerable hurdle for a service that they felt was technologically ready.

2.3.2 Self-driving car

Table 10: Self-driving car use case (citizens)

Description	This car is completely self-driving. The owners can use it to go anywhere at any time, just like a private car today but without the need for a driver.
Countries tested	Greece, Cyprus

Safety was the most salient topic for citizens across both Greece and Cyprus. Participants envisioned a reduction in road traffic accidents due to lack of human error but felt concerned about the likelihood of technological malfunctions, such as signal loss, which could put passengers in danger.

With regards to land use, participants could see the technology leading to large infrastructure improvements to accommodate self-driving vehicles. Some thought this could bring about new industries and employment opportunities.

Participants could also see positive impacts in equity, through the potential to increase mobility for citizens with impairments, as well as in public health, through reduced air pollution from electric vehicles.

Table 11: Self-driving car use case: results of qualitative assessment (citizens)

Mobility	• There was debate among citizens in Cyprus about whether this use case would lead to more or less congestion on roads. On the one hand, participants pointed to a greater number of privately owned vehicles being in circulation; on the other, self-driving cars could have a positive impact on congestion due to better and more efficient driving. • There was also a lack of consensus in Greece, where some citizens felt that this technology would reduce congestion if manually driven cars were phased out, as the price of a self-driving private car is likely to be too high for most people. Others thought it would increase congestion as more people would be able to use it, such as those who cannot drive.
Public health	• Consistent across both countries, benefits to health were often described as a secondary – albeit positive – impact of better air quality from electric technology (see Environment). • Citizens in Greece also thought this use case could lead to fewer accidents due to less human error and self-driving cars more closely following speed limits.

Land use	• Citizens in both countries felt that the impacts on land use could be positive, expecting improvements to infrastructure to come along with the new technology. • Some citizens in Greece, however, viewed a possible reduction in parking spaces (due to decreased private vehicle ownership) as a negative. • In Cyprus, citizens could also see this use case leading to less availability of parking spaces but due to an uptake in private ownership, rather than a reduction.
Safety	• As with other use cases, safety was one of the most important themes. • Citizens felt that automated vehicles would lead to increased safety standards on the roads, for example by reducing the rate of accidents. • However, particularly in Greece, others were concerned that issues like signal loss and poor reaction times could decrease safety for the passenger. • Greek participants also highlighted the importance of regulation and data security before the vehicles come to market due to worries about the unauthorised use of personal data.
Transport network	• Not discussed
Environment	• Citizens considered the reduction in air pollution from using electric technology to be a key positive of self-driving cars; they felt this would encourage uptake among the public. • Citizens in Greece mentioned the reduction of visible air pollution specifically.
Economy	• Economy was a key theme for citizens in Cyprus. Overall, they expected investment to come with the updates to infrastructure needed for this technology to take hold, and they believed that this could open up a whole new industry and offer new employment opportunities. • There was however a concern that this might not happen and that the labour market would not be prepared for the skills shift.
Equity	• Citizens in Cyprus had concerned that self-driving cars would be expensive and therefore inaccessible for people on low incomes. More positively, however, they believed that the technology could increase mobility for disabled passengers, since it takes away the need to be physically able to drive. • For citizens in Greece, there were concerns that citizens in rural areas would not be able to use these vehicles due to narrow roads and lack of network coverage.
Timeline	• Citizens across both countries were not hopeful of any kind of penetration of fully self-driving cars by 2026. • Participants anticipated on average a 35% penetration level by 2050 but acknowledged that they would be more willing to use services as time goes on so these numbers may change.

2.3.3 Emergency shuttle pod

Table 12: Emergency shuttle pod use case (citizens)

Description	The Emergency shuttle pod is a dedicated service that is able to pick people up in medical emergencies and take them to the nearest hospital. It is a bit like an ambulance but with no driver or medical professional on board.
Countries tested	Germany, Poland

There were significant concerns in both Germany and Poland about safety and public health in this use case. This most notably related to the lack of staff on board the pods. Citizens in each country felt that this would put patients at risk of unnecessary harm and would not be appropriate for emergency situations.

In terms of land use and transport network efficiency, both countries also felt that significant improvements would have to be made to infrastructure before this use case would be viable and safe. They were not convinced of the pod's ability to navigate complex urban environments in emergency situations.

Under mobility, German citizens did feel that there was potential for this technology to reach areas that would be hard for traditional ambulances to reach.

However, Poland was more sceptical on these pods increasing overall access from the perspective of equity. While existing ambulances in Poland are free at point of use, some citizens were concerned that the vehicles in this use case might have a cost to use them, and therefore only benefit those who can afford them.

Table 13: Emergency shuttle pod use case: results of qualitative assessment (citizens)

Mobility	• Citizen groups in Germany felt that this use case could increase access to medical services, for example by expanding service to hard-to-reach rural areas, as well as to those who can not drive or those with limited mobility who might find it difficult to get to a doctor. They also thought that the service might help people with medical anxieties, as it could feel like a less intimidating form of transport. The service was primarily seen as an addition to the ambulance service, rather than a replacement. Participants imagined a central control room that could allocate the pods to emergency situations or those who need help getting to appointments. • Polish groups felt that this use case would be ineffective compared to a self-driving taxi that could provide the same service. They also raised concerns about limited range hindering a pod's reach to isolated areas.
Public health	• Citizens in Poland had many concerns with this use case relating to public health, including the potential for misdiagnosis and incorrect handling of certain • conditions such as head traumas. • Citizens in Germany had a more positive perspective, but assumed the pod would only be used for minor injuries, potentially as a shuttle service to the hospital or in the same capacity as an individual paramedic, to triage before hospital. • Both countries' participants also noted the possible risk of immunocompromised patients picking up viruses from the vehicles, possibly under the assumption that the pods would be cleaned less frequently compared to traditional ambulances.
Land use	• Polish citizens were concerned about limited range hindering a pod's reach to isolated areas. • Meanwhile, German citizens noted that the pods might require less parking space at the hospital compared to ambulances and private vehicles, leading to more room for green space around the hospital. • Participants in both countries raised the point that without improvements in infrastructure these pods would only add to congestion on roads.
Safety	• Citizen groups in Poland and Germany were very concerned about passenger safety in this use case, for example the (lack of) stability of the pods affecting passengers with significant injuries. • Polish citizens were particularly keen to point out that if patients could not be adequately assessed, then transport in the pod may do more harm than good. • Both countries were also concerned about digital safety, particularly the misuse of location and/or medical data. However, there was recognition in both countries that this use case might reduce the chance of safety crews being exposed to dangerous situations.

Transport network	• Citizens felt that infrastructure is not currently adequate for this use case to take full effect, due to reservations around the technology's ability to navigate complex urban environments under emergency conditions. • They did however think that the use case would lead to increased access to medical services in rural areas and faster and more targeted care overall, due to the added capacity across the service. • To Polish groups, this use case felt like an unnecessary alternative to automated taxis that could provide the same service, and there was a concern that limited battery range could hinder reach into isolated areas.
Environment	• Citizens in both Germany and Poland agreed that if this use case were to lead to a reduction in private vehicle use, and in turn a reduction in air pollution, then it would increase positive perceptions of self-driving vehicles. • Additionally, Polish groups thought that there would be a reduction in noise pollution, because the vehicles in the use case would be electric.
Economy	• Participants in Germany suggested that this use case could lead to increased efficiency in the medical industry due to fewer staff being needed in emergency transport, while increasing the number of patients served, and that supporting the medical profession in this way would increase the positive perception of self-driving vehicles. • They also suggested that this use case could lead to increased investment in infrastructure, which could provide jobs. • However, there were concerns about the large upfront cost to both the transport and health systems that this use case might require.
Equity	• Existing ambulances in Poland are free at the point of use. Therefore, Polish citizens felt that this use case could negatively impact the acceptance of self-driving vehicles if the service was costly, i.e., only available to those who can afford it. • Meanwhile, German groups felt that a control centre would be essential to ensure pods were sent to the most appropriate cases.
Timeline	• Polish citizen groups did not think the service would ever be an appropriate use of the technology. • Some German citizens felt that early adoption could happen within the next 5-10 years, but others anticipated operational challenges that would mean adoption would be much further away.

2.3.4 Mobility bus on demand

Table 14: Mobility bus on demand use case (citizens)

Description	This vehicle will transport passengers to their destination with onboarding and security features that will ensure a controlled ride for everyone.
Countries tested	Netherlands

Citizens considered this use case to have the potential to encourage much needed transport infrastructure development. They saw benefits in the domains of land use and economy, such as better-quality road networks and a potential reduction in the cost of running public transport. However, they also agreed that there are concerns about the safety of the use case, regarding the potential misuse of location data and the assistance of vulnerable passengers once on board.

Citizens debated across mobility, land use and transport network efficiency how much the service is likely to lead to a decrease in private car ownership and therefore congestion. They also debated the credentials of the use case in relation to the environment and public health; some felt a reduction in fossil fuel use could be beneficial to air quality, while others felt this would be offset by particulate matter from wear and tear of the vehicles.

Table 15: Mobility bus on demand use case: results of qualitative assessment (citizens)

Mobility	• Citizens were keen to point out that for this use case to work there must be consolidation with other users, so the service is open to everyone, potentially by having different vehicle types (see also Equity). • They felt that a service for only a certain group of people, such as those with mobility impairments, does not maximise the potential of the technology. • Some were concerned that the service could lead to pavement congestion from people waiting to board and questioned whether it would actually reduce private car use and free up road space (see also Land use).
Public health	• Citizens debated whether the use case would lead to better air quality. • Some participants felt that reduced fossil fuel consumption would improve air quality, but others felt that particulate waste matter from brakes and tyres would counteract this positive impact. • Citizens did agree however that benefits to public health might be seen through reduced traffic accidents, but there was disagreement as to the extent of these benefits.
Land use	• There was debate in the groups about the type of roads suitable for this service, and where, if at all, new lanes would be required. • Some also questioned how the vehicle would navigate interactions with emergency vehicles. • However, there was positivity towards the use case being accompanied by infrastructure redevelopment, with secondary impacts such as better road capacity and more navigable cities.
Safety	• Citizens were concerned about the potential misuse of location data of vulnerable people, and the lack of a driver to assist those who might need it, particularly when boarding and disembarking the vehicle.
Transport network	• As with other use cases, citizens cited the potential for reduced road congestion through decreased private vehicle use. • Some also noted that there may need to be a maximum number of stops per trip to ensure efficiency. This was in response to a concern of uptake exceeding capacity, i.e., should the service be taken by too many passengers, it would become difficult to use, for example by facilitating too many stops or minimising entering and exiting times for passengers.
Environment	• Citizens highlighted environment as a key area where there could be positive perception of self-driving buses, if they were to lead to a reduction in private vehicle use, congestion, and air pollution. • However, some were concerned that because of the increased weight of the vehicle, particulate matter from tyre wear and brakes would be an issue.
Economy	• There was widespread agreement between citizens that investment in infrastructure would be beneficial for the economy, and that the service had the potential to reduce transport costs for users, presumably as a result of decreased staffing costs. • They also felt that there would be less cost associated with repairs, due to fewer accidents.
Equity	• Citizens felt that this use case could lead to a safe travel option for people with disabilities, but that to be truly equitable, the service should be available to everyone by providing a variety of vehicle types tailored to different groups and locations. • They also felt that efforts should be made to support people on lower incomes to access the service, implying that uptake and acceptance rely on efforts being made around accessibility.
Timeline	• Participants thought that the public would need time to adjust to this technology and did not envision this service being available at all by 2026. • However, they felt that rollout could be between 15% and 20% by 2035, jumping to 50% to 65% by 2050, suggesting slow initial uptake but trust eventually building in the service.

2.3.5 Self-driving bus service

Table 16: Self-driving bus service use case (citizens)

Description	This self-driving bus service provides passengers with connection between local towns and villages at specific times from designated spots, much like a regular bus service but without a driver.
Countries tested	Netherlands, Spain, United Kingdom

The theme of safety was a salient topic across countries, but specific concerns varied. They ranged from a concern for the safety of passengers without a driver present, particularly those considered vulnerable such as elderly people or those with disabilities, as well as how adept a self-driving bus would be in navigating pedestrians and other road users. There was also concern about the potential for a loss of connectivity resulting in buses being unable to operate.

The necessary updates to infrastructure were also a key topic of discussion in relation to economy across all countries. There was broad concern that infrastructure updates will be expensive if vehicles cannot use the current road network as it is, but also a view that this service would be a good opportunity to invest in improved infrastructure, which would demonstrate commitment to the technology, and provide jobs.

Across the board, citizens had positive views on the theme of environment, emphasising the improvement in air quality, if the potential of the use case could be fully realised by encouraging less private car use and individual travel.

This use case was seen as one of the most “realistic” ones and expected penetration sooner rather than later.

Table 17: Self-driving bus service use case: results of qualitative assessment (citizens)

Mobility	• Citizens in the UK felt this service had the potential to increase accessibility for people with mobility impairments, if the service could be designed to specifically cater to any additional needs. • Participants in the Netherlands felt similar, adding that this service could lead to increased flexibility for disabled people, as bespoke transport services currently need to be booked 24 hours before.
Public health	• Across citizen groups, every country identified a potential reduction in air pollution from reduced private vehicle use that could positively impact public health, leading to a more positive perception of self-driving vehicles. • However, in the UK there was concern that quieter vehicles could pose a traffic safety risk which needs to be considered.
Land use	• Most citizen groups assumed that self-driving buses would replace traditional buses and that this could be a more comprehensive service, reaching places where current buses can not go and running later without a driver to consider. • In Spain, this was seen to be a potential solution to the societal problem of depopulation in rural areas. In other words, this use case could deliver mobility to – often older – citizens in isolated villages, therefore making it more feasible and attractive to live in such places. • In the Netherlands, groups assumed that these buses would be more frequent as the technology could allow them to respond to where customers are in real time or create a timetable that reflects better knowledge of demand. • Across all countries, some citizens felt that this could lead to decreased private vehicle use leading to a reduced need for parking spaces in urban centres, and less space needed for bus infrastructure. • However, others felt it would have no impact on private car use.

Safety	• The safety of automated buses was a big concern for citizens across countries. • In the UK, participants were concerned about cyber security issues such as the 'hackability' of these vehicles and passenger safety in the event of a hacking incident. • Participants in the Netherlands meanwhile were concerned about what would happen in the event of a crash without a driver to alert emergency services. They were also concerned for pedestrian and cyclist safety, suggesting that robust testing – and possibly separate lanes – would be needed for these vehicles before they could be rolled out. • Concerns were also raised in the UK and the Netherlands that the bus is currently a safe place for vulnerable passengers and without a driver that may no longer be the case.
Transport network	• Participants in the Netherlands felt that if buses were reliable, they would be the most efficient use of the network and should be encouraged over private electric vehicle use. They felt they could be used as shuttle buses for specific events or for specific routes from rural to urban areas. • Groups in Spain meanwhile thought that significant uptake would reduce individual transport use, in turn reducing congestion.
Environment	• For citizens across all countries, there was a generalised sense that self-driving buses would increase the efficiency of public transport, improving the service, and therefore reducing private vehicle use and the negative environmental impacts associated with that, including air pollution.
Economy	• Economy was a salient theme for citizens across countries. Job losses of drivers were a particular concern, however there was also an acknowledgment that this could be more efficient and cost effective for the public transport network. • For many, job losses would only be acceptable if significant improvements were made to public transport. • There was also concern from UK citizens that 'bad signal' stopping the bus from working could lead to a bad reputation for businesses and a loss of income.
Equity	• For citizens in the UK and Netherlands, the lack of a driver to help vulnerable passengers was a concern (see also Safety). • Additionally, with the lack of driver, citizens in the Netherlands highlighted the need to keep the payment system simple and in line with the current system.
Timeline	• Some citizens in Spain felt that deployment in the near future is realistic. However, most across the countries felt that the technology has a long way to go before it is viable in everyday life. • Citizens in the Netherlands and the UK expected penetration of 0-5% by 2026, but potentially as high as 70% by 2050; these estimates came with the caveat that this use case must become more popular than driving or travelling individually to encourage uptake.

2.4 Results by use case: freight services

2.4.1 Consolidated delivery bot

Table 18: Consolidated delivery bot use case (citizens)

Description	A consolidated delivery bot transports packages like products or food items from several companies to people in their homes, much like a private courier service, e.g., DPD Courier.
Countries tested	Cyprus, Germany, Greece, Netherlands, Poland, Spain, United Kingdom

In the domain of transport network efficiency, there was consensus across all countries that the current pavement infrastructure would not be suitable to accommodate these bots. Under mobility and safety, many worried about space being taken away from pedestrians and the risk of collisions causing injury. There was also concern that there would be an increase in theft without a human present. More positively, on the environment, most agreed that there is potential to improve air quality through electric technology and reducing the number of larger delivery trucks.

In terms of safety, data privacy was an area of debate among UK citizens, who expressed concern about the potential misuse of personal data. Another area of disagreement related to the efficiency and value of the service. Participants in the Netherlands, for example, struggled to understand how this service would be better than what is currently available.

Lastly, some citizens were concerned about the accessibility of the bots themselves and the difficulty some people may face in retrieving packages without a driver to help.

Table 19: Consolidated delivery bot use case: results of qualitative assessment (citizens)

Mobility	• Citizens felt that this use case might reduce road congestion, but simply offset this by further crowding pavements (see Transport network). • The potential of reduced mobility for pedestrians was identified as a negative impact which participants felt would lead to negative perceptions of self-driving vehicles (see also Equity). These concerns were raised by participants across all countries, but notably in Greece.
Public health	• Citizens in all countries expected that the bots would improve public health via improved air quality, due to their electric power and as a consequence of fewer large delivery vehicles in populated areas (see also Environment).
Land use	• Land use was a particularly important theme for citizens across all countries. • Most were concerned that their regions do not have the necessary infrastructure to support this use case, particularly in relation to giving up space on pedestrian pavements, as well as the practical considerations of where to locate supporting infrastructure such as charging stations and storage units. • For citizens in Spain, there was general unease about private companies using technology that takes up additional space in places that are intended for use by pedestrians.
Safety	• Much like the concerns discussed under the themes of mobility and land use, citizens in all countries were concerned about the possibility of pedestrian and/or cyclist-related accidents on pavements, which would very negatively impact public perceptions of this technology. • Dutch participants in particular highlighted an intolerance to self-driving vehicles causing injuries, as the technology feels too new for there to be the necessary levels of public trust. • There was also concern for the theft of goods across all countries, demonstrating less trust in this technology than in human couriers. • Citizens in the UK also voiced concerns over misuse of personal data. • However, groups in Spain felt more confident that data and privacy issues would be manageable and did not see this as a barrier to uptake.
Transport network	• Citizens in all countries broadly agreed that any perceived benefit to reducing traffic congestion in this use case would be negated by increased congestion on pavements, inconveniencing the public and negatively affecting the uptake of self-driving vehicles. • In the Netherlands, citizens felt that this technology would be less efficient than delivery and courier networks already in place, which could negatively affect perceptions and uptake further. • Citizens also emphasised that if goods are not safe, or if there are no guarantees of responsibility from the manufacturer/retailer then uptake would be limited (see also Safety).

Environment	• Citizens across all countries highlighted the environmental impact as a positive aspect of this use case, due to the reduction of delivery vehicles on the road. If this led to less congestion and therefore less air pollution, they felt it would positively influence the uptake of this technology.
Economy	• There was significant concern across all countries regarding job losses for drivers. • However, citizens in Spain felt that the negative impact of this may be overstated provided that other jobs were created in the process. • Participants from Greece and the Netherlands saw economic incentives in the form of new businesses and business models which would take advantage of the presumed convenience and direct-to-consumer relationship this use case could provide.
Equity	• Citizens across countries expressed significant concern for vulnerable and less mobile groups. • The UK, Germany, and Poland all stressed the importance of a human to support people with restricted mobility to retrieve parcels or use the service at all. A lack of human there could lead to negative perceptions of the use case and self-driving vehicles more generally. • Similarly, citizens in Greece and Cyprus emphasised that it would also be difficult for digitally excluded groups to benefit from this technology.
Timeline	• Although estimated uptake varied between 50% and 90% by 2050, most countries agreed that this technology was likely to be adopted soon and exist in a lengthy experimental phase. • Germany's participants anticipated legal and regulatory hurdles but saw this use case being introduced in tech-friendly cities, while groups in the Netherlands felt it would initially only be introduced in closed, controlled areas such as warehouses, harbours, or airports.

2.4.2 Single-supplier delivery bot

Table 20: Single-supplier delivery bot use case (citizens)

Description	The single supplier delivery service replaces a retailer's previous fleet of delivery vans and drivers. Depending on the retailer, the delivery service can operate nationwide.
Countries tested	Greece

Across multiple domains, citizens debated whether this use case would reduce the amount of traffic on roads. For those who thought it could, positive benefits like reduced congestion and air pollution followed.

Similarly, most citizens were concerned that current infrastructure is unsuitable for this use case, however some felt optimistic that infrastructure improvements could bring about transport network efficiencies and economic benefits through a better managed traffic flow.

There was a general concern regarding the risks to safety for pedestrians on pavements, and the need for regulation about where the bots would operate, to mitigate those risks. Theft of unsupervised deliveries and vulnerability to data leaks also raised concern.

Under Equity, participants were particularly concerned about people who are digitally excluded or in rural areas where bots might struggle to navigate the terrain.

Table 21: Single-supplier delivery bot use case: results of qualitative assessment (citizens)

Mobility	• Participants thought that control centres would be needed for the roll out of this use case. However, should rollout be successful, some felt that this use case could reduce congestion on roads, and therefore support better mobility and increase positive perceptions of self-driving vehicles.
Public health	• Citizens felt that the self-driving vehicles being electric could have a positive effect on public health from reduced air pollution, and that advanced traffic management from self-driving vehicle technology could also support this goal through more efficient driving. • They also felt that there would be a reduction in accidents caused by human error.
Land use	• Citizens were concerned that current infrastructure is unsuitable for this use case, with congested roads and narrow pavements likely leading to accidents and low trust in the bots. • They felt that considerable investments to local infrastructure would need to be made to make this technology feasible.
Safety	• Although citizens felt that this use case could reduce traffic accidents on roads, they worried about increased accidents involving pedestrians on pavements. • They were also concerned about how goods on board would be protected from theft, as well as how sensitive personal data would be handled and protected; there was appetite for regulation around the latter issue to build trust and facilitate uptake. • Participants also anticipated legal issues relating to responsibility in the event a package is lost or stolen, and what would happen in the case of lost signal.
Transport network	• For some citizens, the potential to reduce road traffic and present opportunities for advanced traffic management could have a positive effect on transport network efficiency. • However, others felt that current capacity and infrastructure is already inadequate, and so the introduction of this use case would only create congestion for pedestrians and reduce overall transport network efficiency.
Environment	• Many citizens felt there was potential for the bots to reduce the number of vehicles on the road, leading to less fuel use and less noise and air pollution, and resulting in positive perceptions of self-driving vehicles. • However, others concerned that renewable energy sources might not provide enough power and that the necessary charging infrastructure would not be available, leaving bots stranded.
Economy	• Most citizens felt that this use case could result in job losses for couriers and delivery people, and fewer employment opportunities overall • However, some foresaw new opportunities in manufacturing from investment in new vehicles.
Equity	• While citizens said that this technology could be used by elderly and vulnerable groups, they also felt that these are the groups that might struggle to access it most due to a lack of driver to help them. • They were particularly concerned for those who are digitally excluded or those in rural areas where bots might struggle to navigate the terrain.
Timeline	• All citizens felt there would be very limited uptake in the near future but were more varied in their estimates for the longer-term; most settled on 30% by 2050, while others were more optimistic with figures between 65% and 70%.

2.4.3 Medical delivery drone

Table 22: Medical delivery drone use case (citizens)

Description	Self-driving delivery drones designed to transport medicines and healthcare products to people with reduced mobility.
Countries tested	Poland, Spain

Across both countries citizens saw various applications of the use case that could have positive outcomes. For example, they saw a wide range of possible applications across Mobility and Public health for the use case beyond individual deliveries, such as deliveries in emergency situations (e.g. flooded areas or war zones), as well as quick deliveries of essentials (such as blood) to hospitals.

Both countries could see positive impacts in transport network efficiency such as reduced traffic congestion, particularly in urban areas. However, some were concerned about the potential for increased noise and visual pollution.

Both countries also raised concerns about safety, seeing medicines at an increased risk of theft in unsupervised drones. Other concerns around not being able to operate in bad weather or areas with poor connectivity, as well as limited capacity for charging, also remained.

Table 23: Medical delivery drone use case: results of qualitative assessment (citizens)

Mobility	• Citizens in Poland saw this use case as having more applications than deliveries to individuals. They felt it could be used to transport medicines and medical equipment between pharmacies, but that it would have to be fully integrated with the current transport network to work efficiently. They stressed that this service should not be seen as a substitute for pharmacy visits. Participants also saw the opportunity for deliveries at night (due to them being self-driving) as a positive, however there was concern that they would not be able to operate in bad weather. • Citizens in both Spain and Poland felt there was potential for the use case to ease traffic congestion on the roads, particularly from delivery vans but that this might be offset by increased air congestion causing visual pollution.
Public health	• Citizens in Poland saw many applications for the use case resulting in positive impacts on public health, for example a service that could reduce exposure to viruses through the lack of human contact or facilitate a wider and more efficient distribution of medicines, supporting those who cannot leave their homes. They felt it could be useful for delivery of medicines in flooded areas or war zones, as well as offering new opportunities for research. However, if the drones in this use case failed to deliver, for example through an accident or lost connection, this could result in poorer health outcomes. • Citizens in both Spain and Poland agreed that this use case may not be suitable for unstable medications, such as those that need to be stored at a particular temperature, and Spanish citizens worried about the impact of collisions causing injuries.
Land use	• Citizens in Spain felt that drones would not require significant infrastructure development, which was seen as a positive, although they were unsure of how drones would be stored when not in use. • Polish citizens however saw a need for a network of vertiports, including on private land, which they felt could complicate their management.
Safety	• Citizens in both Poland and Spain were concerned about the security of personal data being used by the drones and its vulnerability to misuse and hacking. They felt this could lead to distrust from users, affecting perceptions of the technology. They also questioned how reliable the technology would be, seeing drones as at increased risk of accidents and theft compared to traditional deliveries. • However, some in Spain felt that concerns about personal data and accidents were overstated and expected the technology to have developed enough to offset this negative impact.

Transport network	• Citizens in both countries were positive about the use case for services such as blood delivery and felt it could improve efficiency of health services. • Some citizens in Spain expressed concern about drones flying in high density areas and the potential disruption this could cause but saw a potential reduction in road traffic as a positive impact. • Citizens in Poland felt this use case would have limited coverage due to charging capacity and limited charging infrastructure and have limited utility in bad weather. They could not see applications beyond individual deliveries such as transfers between hospitals, as currently hospitals do not communicate with each other. They did however think that the use case could lead to less road congestion and increased potential for night deliveries but foresaw problems with returns.
Environment	• Citizens in both countries had concerns about the pollution associated with battery production and disposal, despite the potential for reduced local air pollution. They were also both concerned about increased noise pollution. • Citizens in Poland were concerned that the drones would increase visual pollution and collisions with birds.
Economy	• Polish citizens were concerned the use case would incur large costs to the healthcare service. They did see potential for job creation and innovation with private investment, but worried that this initial outlay could increase the cost of medicines to users. • Citizens in Spain also felt there is potential for job creation, but only with a significant amount of upskilling.
Equity	• Spanish citizens expressed concern about unnecessary technification making services harder to access for digitally excluded people but felt this could be overcome with training and the right support. They also foresaw access issues for people who are unable to leave their homes to retrieve packages. • Citizens in Poland felt that charging stations would end up being concentrated in urban environments leaving rural locations with poorer service.
Timeline	• Citizens in Poland felt that this technology is likely already available but requires regulation before it can be introduced properly. • Citizens in Spain estimated that the penetration rate of this technology could be anywhere between 50%-100% by 2050.

2.4.4 Long-distance truck

Table 24: Long-distance truck use case (citizens)

Description	This long-distance truck transports goods efficiently and safely, eliminating the need for drivers. The truck navigates routes, delivers cargo, and optimises supply chains, ensuring timely and reliable freight transportation.
Countries tested	Germany, United Kingdom

Both countries' participants agreed that there is currently a lack of appropriate infrastructure to support this use case. However, if changes could be made, such as dedicated lanes for the vehicles, this could lead to higher transport network efficiency and lower congestion, as well as potentially repurposing land use currently dedicated to rest stops and parking.

Citizens in both countries were concerned about the safety of the vehicles, particularly around the likelihood of more accidents, loss of connection, theft of goods and the oversight of dangerous cargo. They felt that these aspects could affect perceptions of the technology and decrease uptake.

Table 25: Long-distance truck use case: results of qualitative assessment (citizens)

Mobility	• Mobility was a low salience issue across countries and audiences. • However, citizens in the UK felt that this use case could lead to more trucks on the road, due to numbers not being restricted by available drivers; they thought that this could lead to more congestion. • German citizens, meanwhile, felt the lack of need for rest periods could lead to faster, more efficient deliveries, as well as fewer traffic jams due to more efficient autonomous driving.
Public health	• UK citizens had mixed views around public health. They had concerns about injuries resulting from collisions but felt there was an opportunity to reduce pollution leading to better air quality and therefore health. There were also concerns about how dangerous cargo might be overseen without a driver. • German citizens shared this optimism for better air quality and a concern for dangerous cargo, as well as the safety and stability of hydrogen as a fuel (see also Safety).
Land use	• UK citizens expressed concern that current infrastructure is not suitable for self-driving vehicles, which may in turn limit the uptake of this technology. They also felt that roads would need to be in better condition, for example free of potholes in case the technology can not cope with these obstacles. They did, however, think that self-driving trucks would save space through the reduced need for lorry parks and rest stops. • German citizens shared this view of space saving and the need for development of road infrastructure and capacity, and they also wondered whether this use case would lead to greater traffic at night.
Safety	• Citizens in both the UK and Germany raised concerns about how adaptive to obstacles and traffic hazards the vehicles would be, as well as what would happen in the event of a mechanical failure, and the ability of the technology to replicate a drivers' 'feeling' for safety and vehicle health. • Despite this, German citizens saw opportunities to reduce accidents related to fatigue of drivers, while UK citizens felt that speed limits might offset any potential negative impacts; both wanted to assume the technology would be safe by the point of rollout. • Some participants recalled previous examples such as smart motorways, which worked in theory but had to be scrapped. • They also saw potential impacts for this use case on the policing of traffic accidents and border crossing. • Some had concerns about the size of the vehicles, making them a hacking target to use as a weapon. • Overall, UK citizens felt that the perceived dangers of these large vehicles on busy motorways may be a serious impediment to their uptake. • Germany also expressed concern regarding theft of trucks as well as the oversight of dangerous cargo.
Transport network	• UK citizens were unsure if this use case would help congestion, for example through more efficient movement in dedicated lanes, or make it worse, likely through an overall increase in trucks on the road. • German citizens saw potential for increased accidents and breakdowns to negatively impact transport network efficiency. They also took a more international view, citing the need for Europe-wide laws and regulations that would manage this technology; they were also concerned for the potential impact of increased human trafficking.
Environment	• Both UK and German citizens saw potential impacts of reduced emissions from hydrogen use which could lead to an increased positive perception of self-driving vehicles. German citizens also felt that savings in fuel could be made through autonomous driving, perceived to be more efficient that human driving. They also pointed out a reduction in noise pollution.

Economy	• UK citizens felt that job losses would be significant for drivers and associated service industries, potentially leading to strikes. However, with the trajectory of technological innovation and use of Artificial Intelligence, they recognised this as an inevitability to some extent, leading to only a limited effect on uptake. • German citizens felt this use case could help with overcoming the shortage of lorry drivers, a job where interest is decreasing. However, they were concerned about data connection issues causing problems for businesses. They also saw an investment in infrastructure leading to a positive impact of new and different types of jobs.
Equity	• UK citizens were concerned about job displacement, noting that not everyone will be able to get a new job. • German citizens were worried about impacts to smaller businesses that may be priced out of using this technology.
Timeline	• UK citizens generally agreed on a slow initial uptake but increasing to between 50% and 95% by 2050. This was seen to be dependent on factors such as cost, infrastructure upgrades, and feasibility of use for smaller companies. • German citizens also felt that uptake would rely on infrastructure developments; they thought that the current road network in Germany needs a lot of work, and so full deployment across the country would be difficult.

2.4.5 Delivery drone

Table 26: Delivery drone use case (citizens)

Description	The drone will pick up your package and navigate on its own, delivering it to a specified location within its area of coverage. It operates on-demand, and will transport products, goods, or food items.
Countries tested	Cyprus

Under Equity, citizens identified the potential for greater delivery coverage for isolated and rural areas, which could also have a positive impact on public health. Most other pros to this use case, such as more space in urban areas, fewer road accidents and less air pollution, depended on the potential for this use case to reduce congestion on roads.

Other risks, for example around personal data and job losses, were raised as in other use cases.

Table 27: Delivery drone use case: results of qualitative assessment (citizens)

Mobility	• Citizens felt that this use case would decrease the number of large delivery vehicles on the road, and their associated trips, reducing congestion and increasing positive perceptions of self-driving vehicles.
Public health	• Citizens felt that delivery drones could reduce the number of traffic-related accidents as a result of fewer large vehicles on the road (see also Mobility and Safety).
Land use	• Citizens felt that decreased road congestion could have a positive effect on the amount of land given over to green space, particularly in urban areas.
Safety	• There was a perception that less traffic congestion could lead to fewer accidents on roads. • However, there was a general concern about the safety of personal data and vulnerability to cyber attacks that could negatively affect uptake.
Transport network	• Again, citizens think that this use case could lead to a significant reduction in congestion, improving driving conditions. • However, there was a concern that they may increase air traffic congestion which would negatively affect perceptions of the technology.

Environment	• This theme was important to citizens. They felt that the reduction of congestion would lead to less air pollution and better air quality. • However, the manufacturing of batteries to power this technology as well as increased noise pollution were mentioned as being significant concerns that could offset any perceived improvements to air quality.
Economy	• Citizens felt that this technology would lead to job losses for delivery drivers and couriers, though this negative impact would be offset by the new jobs and employment opportunities that would emerge with the new technology. • Participants also identified risks to businesses if the technology were to malfunction and lose public trust.
Equity	• Citizens highlighted that this service could increase access to more remote areas, leading to more equal access to goods between rural and urban areas, and encouraging the uptake of this technology.
Timeline	• Citizens felt that penetration rates for this use case would remain low in the short term at around 0-15% by 2026, but would be between 70-100% by 2050, indicating the belief that almost all small packages will eventually be delivered by drone.

2.5 Conclusions

The potential role and benefits of use cases

Across use cases, citizens saw the biggest benefits to self-driving vehicles in improving mobility for those who are underserved by existing technologies and services. However, there were strong concerns about the user-friendliness (particularly for those with reduced digital capabilities), safety, and security of the technology – and to what extent they would be better, rather than just different, to what already exists.

They could see themselves making use of self-driving vehicles once they had become more established, particularly where they would be replacing existing services (such as manually driven buses).

Positive and negative impacts

On safety, citizens see fewer collisions on roads as a great positive, however the lack of driver is considered disconcerting at best, or dangerous at worst. For example, citizens see drivers as necessary both in emergencies and in helping passengers with additional needs; drivers are also seen to deter theft (in the cases of freight) and antisocial behaviour (in the cases of passenger vehicles).

Most feel that self-driving vehicles would be capable of driving well and safely at the point of rollout. However, some remain cautious about issues with lack of connectivity (particularly in rural areas), driving in bad weather or on uneven terrain, and passenger safety in cases of hardware or software failure. In multiple use cases, participants think the rollout of self-driving vehicles would only be possible with a central hub or control room to coordinate the vehicles.

Citizens tend to interpret 'safety' very broadly, and associate concerns about data and hacking with this domain. There are frequently raised concerns around the security of any personal data stored by the self-driving vehicles or their operating systems. Participants do not see many solutions to this other than regulation in this space. Larger freight or passenger vehicles being hacked and controlled remotely by bad actors is also a concern.

Currently, participants see a big challenge in the introduction of new legislation to manage instances such as road accidents or theft of goods. They assume that new regulation will be necessary to determine who is culpable in cases of collisions and/or theft of goods, which they feel could take time to establish.

Certainty about impacts

Citizens are unsure to what extent these solutions will change how we travel. For use cases that were seen to be similar to existing technology (e.g. private car, e-hailing, self-driving bus service), the self-driving aspect was not seen to fundamentally change how citizens might move around, except perhaps giving more autonomy to those who do not want to or are unable to drive.

So far as these use cases can reduce the amount of private vehicle use (in passenger vehicles) or delivery journeys (for freight), participants see many benefits associated with reduced congestion on roads. However, whether this would indeed be the case is up for debate: firstly, in some use cases there is a question of whether this congestion would simply move elsewhere (e.g., the pavement for delivery bots, or the air for drones); secondly, there is a question of whether congestion would decrease due to more efficient driving from self-driving vehicles, or increase due to a higher total number of vehicles on the road (i.e., self-driving vehicles are adding to, not replacing, overall vehicle use and ownership). Many thought that shared services were unlikely to lead to a reduction in private car ownership, the convenience of which was seen as hard to beat.

In addition, infrastructure is currently not felt to be adequate to facilitate the rollout of these use cases. However, participants are fond of the possibility that the infrastructure improvements required to rollout self-driving vehicles might lead to more investment and improvements in transport more broadly. One large aspect of this is charging infrastructure, but also the improvement in electric vehicles themselves, which sceptics view as unreliable currently (i.e. lack of range and access to charging points).

There is a prominent fear of job losses for delivery and public transport drivers, but equally an acceptance that more jobs and industries may be created in the rollout of self-driving vehicles. Participants are not unanimous on which way this dial would swing.

Citizens do not want self-driving vehicle use cases to only benefit or be available to those who can afford it. There were also concerns about the exclusion of already marginalised groups and those who feel more vulnerable. While many felt that those with physical disabilities and mobility impairments may benefit from self-driving vehicles, those using mobility aids themselves were concerned about accessing the vehicles without human assistance.

There is uncertainty on the environmental and health impacts. Most participants think that self-driving vehicles being electric would mean reduced air and noise pollution, which they see as a good thing. The most frequently mentioned benefit to public health is better air quality, but this assumed that self-driving vehicles both reduced congestion and were indeed electrically powered. In addition, some citizens have environmental concerns about how batteries are manufactured and disposed of, as well as the particulate matter from tyre wear and brakes, which could result in air pollution. The potential number of collisions on roads and pavements also contributed to citizens perceptions of self-driving vehicles' impact on health, whether positively or negatively.

Timelines are difficult to estimate but use cases that are "closer" to what already exists feel possible. Self-driving bus services, e-hailing, and private cars are seen as most "realistic", with penetration expected sooner rather than later. Meanwhile, use cases that would take us further away from current norms are seen to potentially face more hurdles before implementation.

3. Demonstration of self-driving vehicles - citizens

3.1 Overview

A demonstration of self-driving vehicles was organised in Helmond, the Netherlands, involving 35 local citizens. Helmond is a city in the South of the Netherlands, with a population of 95,940. The demonstration had five objectives:

- To capture citizens' feelings and opinions about self-driving vehicles after using and observing them
- To compare feelings and opinions about several types of self-driving passenger and freight vehicles
- To assess whether using the vehicles change opinions and intentions, compared with those expressed before the event
- To assess how people compare self-driving and human-driven vehicles
- To assess whether feelings and opinions about self-driving vehicles are related to the characteristics of participants

A demonstration is a useful approach to gather data on opinions and intentions about self-driving vehicles, as most people have not yet experienced using these vehicles. Previous trials and demonstrations mainly featured a single vehicle. Our demonstration in Helmond adds to the literature by offering citizens the opportunity to try more than one type of self-driving passenger vehicle, as well as to observe a self-driving freight distribution vehicle. In addition, both passenger vehicles were for public transport, not private vehicles. This corresponds to the emphasis given in this project to use cases of shared use of vehicles. The inclusion of a distribution vehicle also brings value added, as few studies to date have reported how people perceive these vehicles, especially after experiencing them.

Overall, the demonstration was expected to produce insights on citizens' views about the range of vehicles that will be using the roads in the future, and how citizens perceive the possible impact of those vehicles on their lives and on the lives of others in their region.

The rest of this chapter is organised as follows

- Section 3.2 describes the **methods** used to organise the demonstration and in data collection and analysis, including ethics considerations
- Section 3.3 describe the **characteristics** of participants and their travel context and behaviour
- Section 3.4 report the **results** of the demonstration
- Section 3.5 synthesises the key **conclusions** of the demonstration

3.2 Methods

3.2.1 Design of the demonstration

The event was organised by the City of Helmond, with support from the Helmond Automotive Campus, Future Mobility Network, and University College London. Questionnaires were designed by University College London.

The demonstration was held on 20 January 2024 in the Helmond Automotive Campus. This coincided with the virtual reality experiments reported in Chapter 4 of this report, which had the same participants. The day was divided into eight 2-hour slots. In each slot, there were two groups of four participants. In the first hour, one group engaged in the virtual reality experiment and the other one in the demonstration. In the second hour, the groups swapped. This means that across the whole day half of participants completed the virtual reality first and the other half completed the demonstration first. Differences in results for these groups are tested later in this chapter.

The demonstration included three self-driving vehicles: a bus, a mini-shuttle, and a delivery robot (Table 28).

Table 28. Vehicles used in the demonstration in the Netherlands - specifications

	Bus	Mini-shuttle	Delivery robot
			
Name	Karsan Autonomous e-Atak	Auvetech Iseauto	Macrostep Autonoom Delivery Robot
Type	Low-floor electric bus	Electric vehicle, 25km/h maximum speed	Electric vehicle with a container
Size	8.3 x 3.2 x 1.7m	3.5 x 1.5 x 2.4m	2 x 1.1 x 1.7m
Seats	18 seats	8 seats	0 seats
Web	https://www.karsan.com/en/autonomous-e-atak-highlights	https://auve.tech/products/iseauto	https://www.macrostep.eu/nl/?option=com_sppagebuilder&view=page&id=16

The vehicles circulated in the parking lots of the Helmond Automotive Campus. Barriers, barricade tapes, and traffic cones were installed to separate other users of the campus from the vehicle driving areas. Safety stewards were also present whenever a vehicle was moving. Safety drivers were in the passenger vehicles in case of possible emergencies requiring them to take over the vehicle.

Figure 9 is an overview of the demonstrations of the three vehicles. The event occupied with a length of around 600m, but separate spaces were used for each vehicle.

Organisers guided participants through the various experiences. Participants first observed the delivery robot moving for 3 minutes. They then walked a short distance to the location of the mini-shuttle, where they used the vehicle for 1.5 minutes. They then used the bus for 3 minutes. The mini-shuttle brought participants back (another 1.5 minutes). Before each experience, participants gathered in tents, where they were briefed on what was going to happen (for about 2 minutes). At the end of each experience, participants had opportunities to ask questions (for 2-3 minutes). The whole event, for each group, took about 35 minutes. At the end of the last experience, participants were escorted to the main building, where they answered a questionnaire.

Several events were programmed for the vehicle movement, to show participants how the vehicles handled specific situations. Pedestrians crossed the path of the self-driving bus twice. All three vehicles turned several times and demonstrated that agile manoeuvres were possible. The bus also did a U-turn and had acceleration and braking events. Figure 10 shows aspects of some of the paths of the vehicles. Figure 11 shows various aspects of the demonstration of the three vehicles.

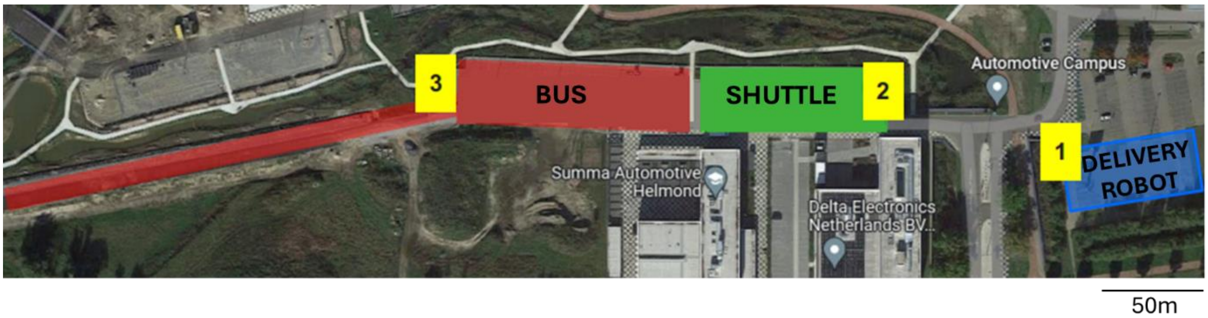


Figure 9. Overview of the three vehicle demonstrations

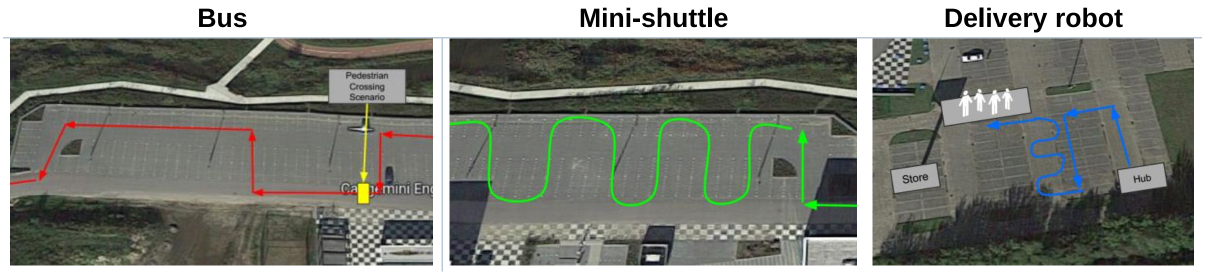


Figure 10. Examples of vehicle routes and events

Top left: bus; **top right**: delivery robot; **bottom**: mini-shuttle

Figure 11. Aspects of the demonstration in the Netherlands

3.2.2 Participant recruitment

Participants were recruited from the Move2CCAM project network of “satellites”, i.e. citizens who were invited to previous activities organised by the project. The aim was to recruit a balance of men and women, and proportions of participants in three age groups (18-34, 35-64, and 65+) that are aligned with the population of the City of Helmond.

3.2.3 Pre-event questionnaire

Participants answered a questionnaire before the event. This was done online, through the Qualtrics platform. Participants who had joined previous activities of the project filled this questionnaire before they joined their first activity, in 2023. Participants whose first activity was the demonstration filled this questionnaire in advance to the event. The questionnaire was in Dutch. Appendix 2 contains the English version of this questionnaire. It includes questions to capture the context in which the participants travel and their actual travel behaviour:

- Residential area characteristics, i.e., how far from the participant’s home are four types of places (work/study place, shopping areas, health centre, and leisure places)
- Travel frequency and main mode used to travel to the four types of places listed above
- Health problem or disability affecting mobility
- How the participant feels about driving
- Use of travel time while using public transport

Another set of questions captures attitudes and intentions regarding self-driving vehicles:

- Awareness on self-driving vehicles
- Three main concerns about self-driving vehicles
- Adoption of self-driving vehicles (if the participant would use, would pay to use, and would buy a self-driving vehicle)
- Use of travel time in self-driving vehicles

Finally, participants were asked about their demographic characteristics: age, gender, migration background, employment status, income, qualifications, educational background, and type of residence location (urban vs rural). These questions were included as appendix in a previous report of this project (Deliverable 3.3., Appendix 1).

3.2.4 Post-event questionnaire

A questionnaire was designed to capture the participants’ views after the demonstration. This was a paper-based questionnaire in Dutch, answered by participants after experiencing the three vehicles. Appendix 4 contains the English version of the questionnaire.

The first section of the questionnaire asked for previous experience using or observing different types of self-driving vehicle.

The following two sections asked about the experience using the self-driving bus and mini shuttle. The two sections include a similar set of questions, covering:

- Overall feelings during the experience. Participants could choose all feelings that applied to them, from a list of 18 possibilities
- What they liked and disliked about the experience (open ended question)
- How safe they felt, on a 5-point scale during various parts of the trip: boarding, departing, moving forward, turning, pedestrian crossing the bus path (asked in the bus experience only), stopping, and getting off.

- How self-driving buses will compare with buses with a human driver: which trips will be more interesting, faster, cheaper, more stressful, more comfortable, more dangerous (in terms of accidents), and more insecure (in terms of crime).
- Three main concerns about using a self-driving bus/mini-shuttle
- Intention to use self-driving buses/mini shuttles in the future.

The last two questions above are similar to questions asked in the pre-event questionnaire described in the previous section. This was to assess whether people's perceptions and intentions changed after the demonstration.

The section about the bus experience included two extra questions, answered only by participants who had joined the virtual reality experiment held on the same day in the same location (Chapter 4 of this report). Half of the participants experienced the virtual reality experiment first and the other half experienced the real vehicles first. The questions asked whether there was anything participants liked in the real bus that they had previously disliked in the virtual bus, or the opposite.

The final section of the questionnaire asked about the experience observing the delivery robot:

- What participants liked and disliked about the vehicle
- How deliveries made by this type of vehicles will compare with deliveries made by vehicles driven by humans (e.g., vans): which deliveries will be faster, cheaper, more dangerous, and more insecure (in terms of stolen deliveries)
- Intention to order goods delivered with this type of vehicles in the future
- Three main concerns about ordering goods delivered by these vehicles

3.2.5 Ethics

The event received ethical approval from the Bartlett School of Environment, Energy and Resources at University College of London (ID: 20231120_EI_ST_ETH_ Move2CCAM). The City of Helmond was also informed by the event organisers of the various activities planned and the safety measures applied. A formal permit from the municipality was not required since all participants were pre-registered, the number of participants was below the city's threshold of 250 for a permit, the activities were within closed sections of the Automotive Campus, and safety measures were put in place.

The demonstration involved participants interacting with a technology they may not be familiar with. This raised several ethical issues. The safety of participants and organisers (e.g. risk of collision of the vehicle) was addressed by having safety drivers prepared to take over the vehicles in case something went wrong. Participants were also informed, before riding the vehicles, that this type of vehicles have been tested widely in multiple contexts around the world and are considered safe. They were also informed about the duration of the ride, route, and other details, and reassured that they could opt-out of the ride if they felt unsafe.

Before the event, participants were provided with an information sheet and an informed consent form, which they filled before joining the event or when they arrived in the site. The information sheet contained details about the event, funder and organisers, use of personal data, capture of photos and video recordings of the event, reporting, and other ethics-related information. Participants gave they consent by confirming (by ticking a box) that they understood what the research involved and what was expected of them. The information sheet and consent form were included as appendices in a previous report of this project (Deliverable 3.3., Appendix 19).

The pre- and post- event questionnaires did not capture any information that could identify individuals. Participants were identified through an ID number. The data was analysed by University College London researchers, who did not have access to the file matching ID numbers with participant contact details. Only the event organiser (City of Helmond) had access to this file.

3.3 Participant characteristics

3.3.1 Demographic and socio-economic characteristics

Figure 12 shows the key demographic characteristics of the sample, as reported in the pre-event questionnaire. The 35-64 age group included 19 individuals, i.e. 56% of all participants, a considerably high number compared with the 18-34 group (6 individuals, i.e., 18%) and 65+ (9 individuals, i.e. 26%). However, these proportions are reasonably aligned with those in the Helmond adult population (27%, 50%, and 22% in the 18-34, 35-64, and 65+ groups, respectively)[1]. The gender distribution is also roughly balanced (20 men, 14 women, i.e. a 59-41% split).

Six participants (i.e., 18%) reported that one or more of their parents were not born in the Netherlands. The majority is currently working. All income groups were represented, with a slight predominance of higher-income ones (for reference, the average household income in Helmond is €48,900/year). The majority had a university degree or a higher degree (e.g. Master's, PhD). The same number lived in a city but not in the centre. 23 (68%) lived with their partner, with or without children.

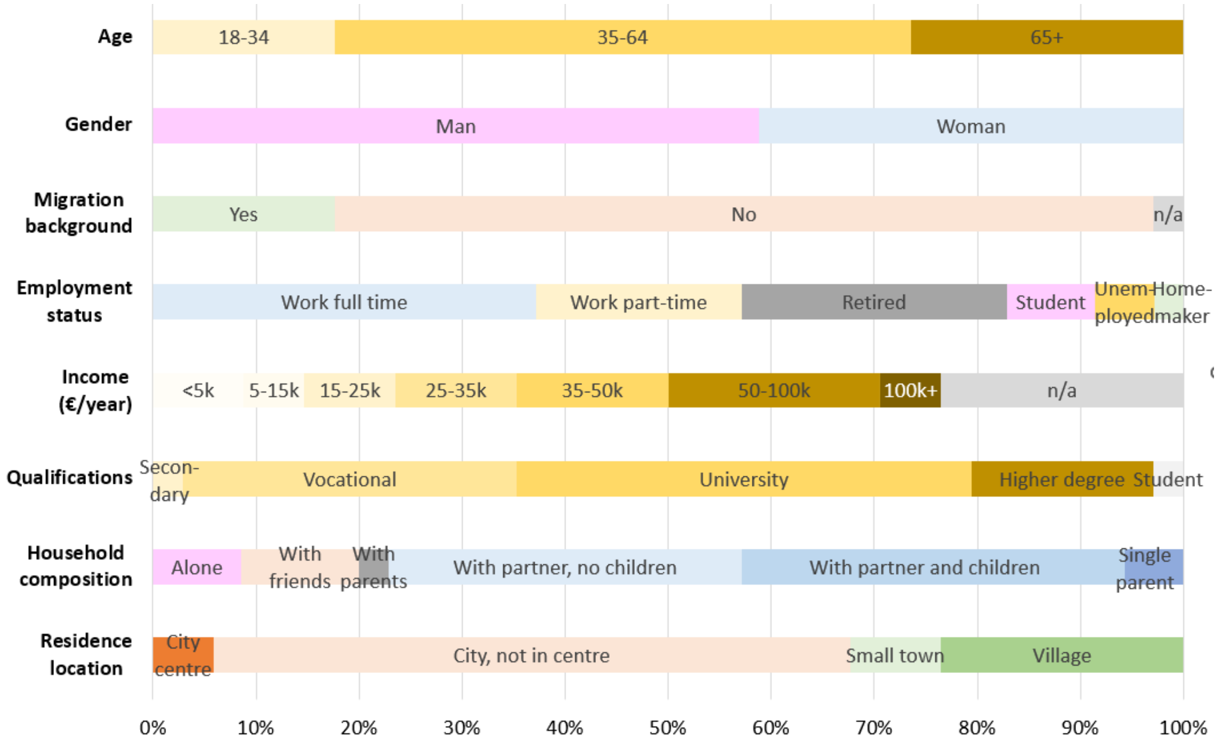


Figure 12. Demonstration of self-driving vehicles – participant characteristics

[1] https://helmond.incijfers.nl/mosaic/gemeente-informatie/bevolking

While the sample is consistent with the population in terms of age and gender, it differs from the population in terms of migration background (18% in the sample, 32% in population), workers (59% vs. 73%), and university graduates (62% vs. 24%).

3.3.2 Current travel context and behaviour

Figure 13 shows several characteristics of the participants' current travel context and behaviour, as reported in the pre-event questionnaire. 17% reported a health issue affecting their mobility. 85% have a driving licence and can drive. Only 3 participants (9%) have a licence but no car and only one does not have a licence. About half drives and enjoys driving, 21% drive but would rather use the time to do something else, and 29% does not drive. 40% travels to work four or more days a week. Most participants travel for shopping or leisure 1-3 times a week.

Figure 14 shows the travel modes that participants use for at least one of four possible purposes (work, shopping, leisure, or go to health centre). The results reveal the context of a typical mid-sized city in the Netherlands. 31 of the 35 participants (i.e. 89%) cycle, the most common travel mode among the sample. 69% drive alone. Using bus or tram is uncommon - only two of the 35 participants (6%) uses these modes. This is an important statistic to keep in mind in the analysis that follows, as the demonstration of passenger vehicles featured both a public bus and a mini-shuttle intended to be used as public transport.

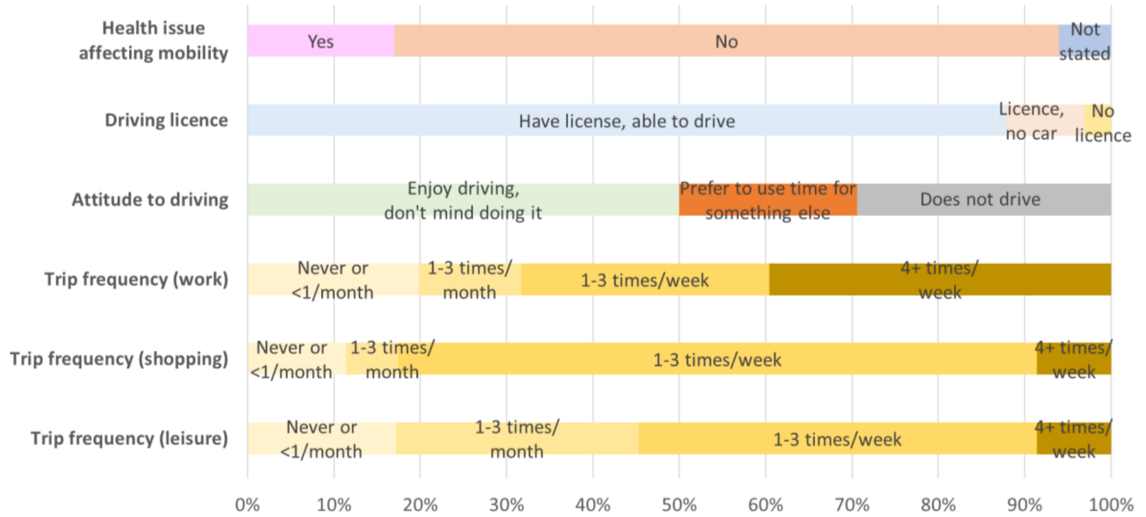
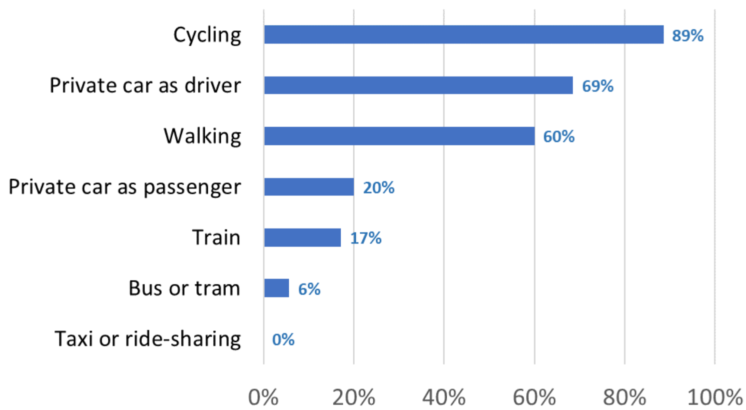


Figure 13. Demonstration of self-driving vehicles – participant's current travel behaviour



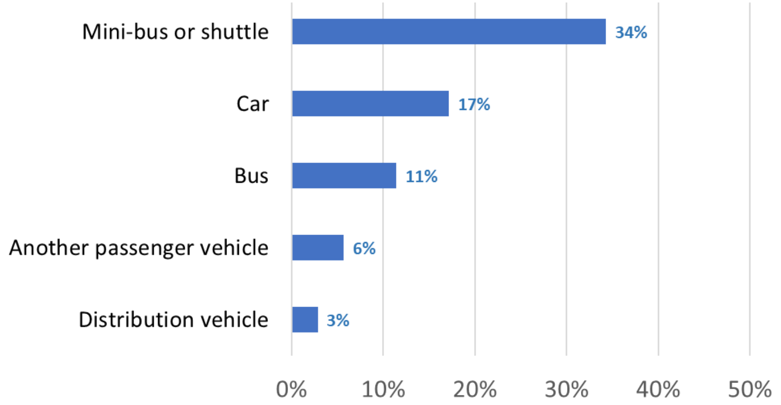
Note: participants could indicate more than one vehicle

Figure 14. Demonstration of self-driving vehicles – participant's usual travel modes

3.3.3 Prior awareness and experience with self-driving vehicles

Participants stated their levels of awareness of self-driving vehicles in pre-event questionnaires. 17 participants (i.e., 49%) said they were aware of these vehicles and have been following developments. Another 16 (i.e., 46%) said they were aware but did not know much about them. Only two (i.e., 6%) said they were not aware.

In the post-event questionnaire, participants stated whether they had previous experience involving fully self-driving vehicles. 20 of them (i.e., 57%) had experienced some type of self-driving vehicle. As shown in Figure 15, 34% of the sample had experienced a self-driving mini-bus or mini-shuttle and 17% and 11% had experienced a self-driving car and bus, respectively.



Note: participants could indicate more than one vehicle

Figure 15. Prior experience involving fully self-driving vehicles

3.4 Results

This section reports all the results of the demonstration including aspects participants liked and disliked (sub-section 3.4.1), feelings (3.4.2), safety perceptions (3.4.3), comparison between self-driving and human-driven vehicles (3.4.4), main concerns (3.4.5), and intentions to use self-driving vehicles (3.4.6). In the last two sub-sections, we analyse how intentions are related to opinions about the vehicles (3.4.7) and how both are related to the participant characteristics (3.4.8).

3.4.1 Aspects participants liked and disliked

Participants were asked open ended questions about the three aspects they liked and disliked about each of the three vehicles. We coded all the answers. Answers stating that participants did not have anything to report (e.g. “nothing”, or “I liked everything” when the question was about dislikes) were removed from further analysis. The table below shows the number of valid responses across the whole sample, after excluding those mentioned above. Even though participants were asked for three aspects, not all of them did indicate three aspects. On average, participants indicated more “likes” than “dislikes”, for all vehicles, although in the case of the mini-shuttle, the numbers were close.

Table 29. Aspects participants liked and disliked: number of responses

	Like		Dislike	
	Responses	**Responses per participant**	**Responses**	**Responses per participant**
Bus	86	2.5	29	0.8
Mini-shuttle	65	1.9	53	1.5
Delivery robot	75	2.1	26	0.7

Notes: Each participant could indicate up to three aspects. Table shows valid responses only

The following figures show the aspects mentioned by at least three participants (i.e., by at least 9% of the sample).

Participants liked that that the bus felt safe (34% of all answers) and familiar (29%) (Figure 16). They also liked that the vehicle was quiet (20%) and the ride was smooth (20%). Some “likes” are related to safety, such as perceived safety when the bus encountered a pedestrian crossing, and presence of a safety driver inside the bus who could take over the vehicle command in case of an emergency. Other “likes” include comfort, the fact that the vehicle was regarded as innovative, the external design, and the space available. Interestingly, lack of space was also one of the main “dislikes” (20%), which shows that participants’ views differ in this respect. The other major “dislike” was the low speed of the bus.

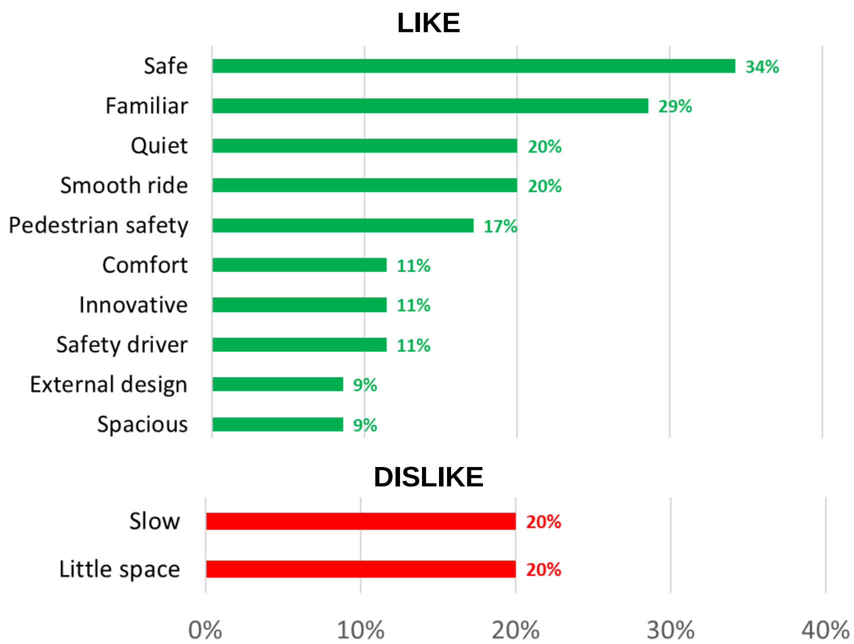


Figure 16. Self-driving bus: main aspects participants liked and disliked

Some of the “likes” in relation to the bus were also mentioned in relation to the mini-shuttle, such as perceived safety (20%) and the smooth ride (20%) (Figure 17). Other “likes” were the fact that the vehicle was in control (i.e., there was no driver), the information provided in screens inside the vehicle, the fact that the vehicle was innovative and quiet, and its suitability for small groups. On the negative side, a consistent opinion (held by 77% of the sample), was that the vehicle was narrow, with little space between passengers. In addition, there was no space for luggage. Some people did not like to sit backwards to the movement of the mini-shuttle, and others thought the mini-shuttle moved too slow.

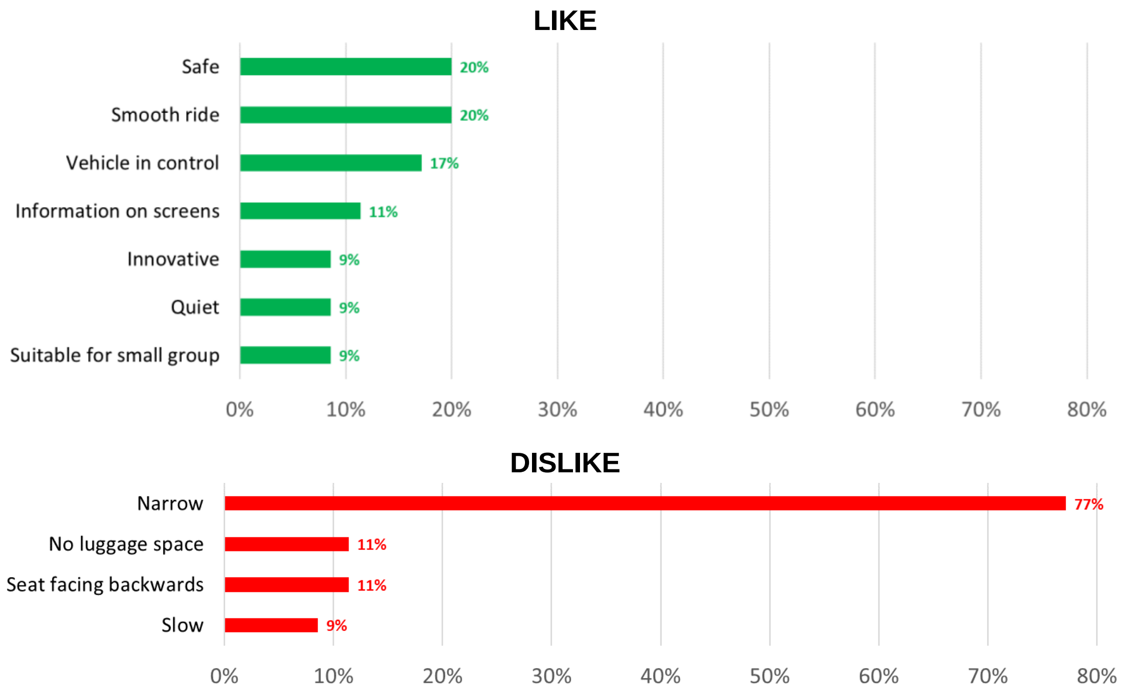


Figure 17. Self-driving mini-shuttle: main aspects participants liked and disliked

The main aspects participants liked about the delivery robot (Figure 18) were its perceived safety (26% of all answers), the design (23%), and its multi-functionality (as a modular vehicle) (20%). They also liked that the vehicle was practical, quiet, compact, environment-friendly, and funny (in its design and/or movement). Some people liked that the vehicle had no driver. The main "dislike" was that the vehicle can be vandalised, it is slow, and small.

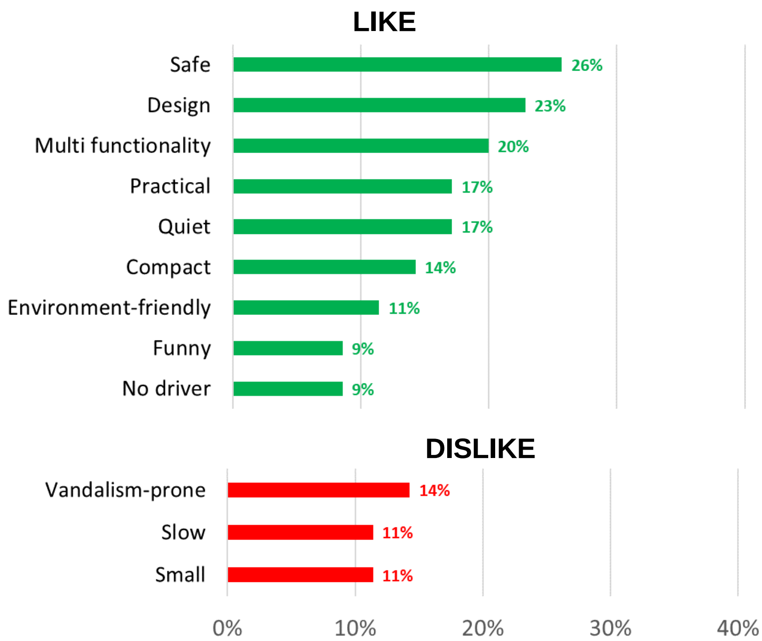


Figure 18. Self-driving delivery robot: main aspects participants liked and disliked

3.4.2 Feelings

Figure 19 shows the feelings participants reported regarding their experience while riding the self-driving bus and mini-shuttle. The feelings were broadly positive and similar between the two vehicles (with only slightly more positive experiences reported for the bus than for the mini-shuttle). The most common feeling, reported by over 70% of participants was safety, followed by feeling “content”, “in control”, “surprised”, “motivated”, “amused”, and “confident”.

Other feelings were reported by less than 20% of the sample (i.e. by less than 7 people). This included all seven negative feelings (sad, melancholic, irritated, worried, annoyed, bored, and scared), but also “happy”. None of the 35 participants reported feeling sad, worried, or annoyed in the bus. Only one reported feeling melancholic or irritated. None reported feeling scared in the mini-shuttle and only one reported feeling worried, annoyed, or bored. Overall, the results point to a positive experience.

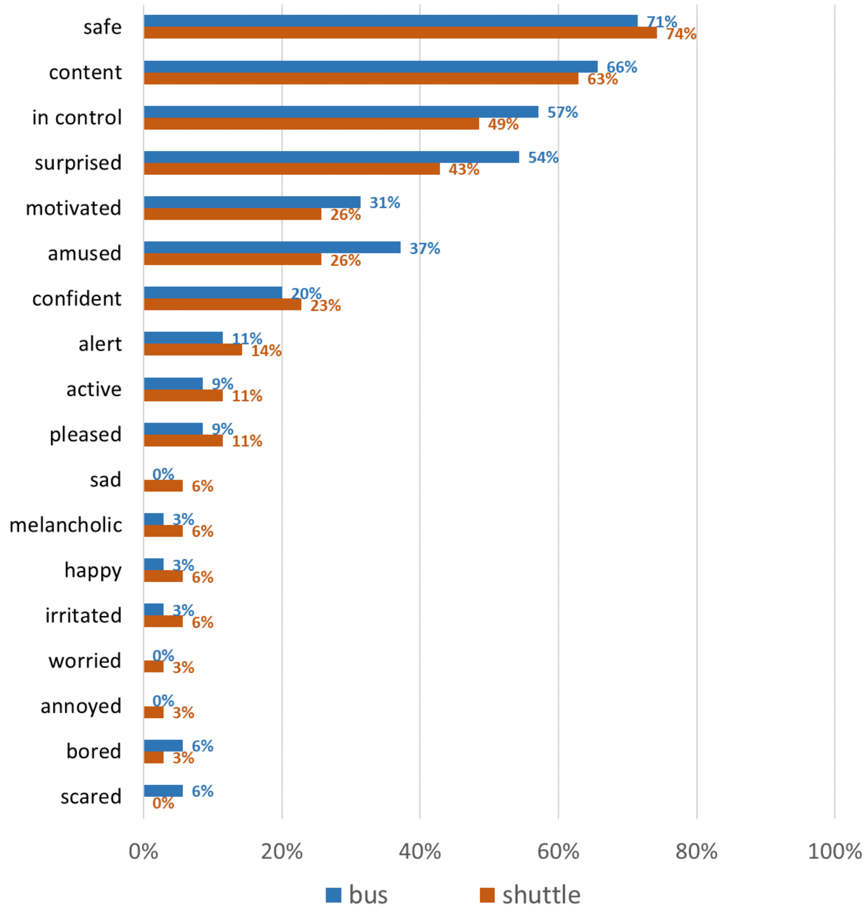


Figure 19. Feelings while riding in the self-driving passenger vehicles

3.4.3 Safety perceptions

The results on safety perceptions are also positive. The proportions of participants reporting feeling safe or very safe in the bus range between 83% and 97%, depending on the event (Figure 20). Only two participants reported feeling unsafe when getting off, and only one reported feeling unsafe when boarding and turning.

The perceptions are even more positive in the case of the mini-shuttle, with proportions of participants reporting feeling safe or very safe ranging from 86% to 100% (Figure 21). Only two participants reported feeling unsafe when boarding and getting off, and only one reported feeling unsafe when the vehicle was turning.

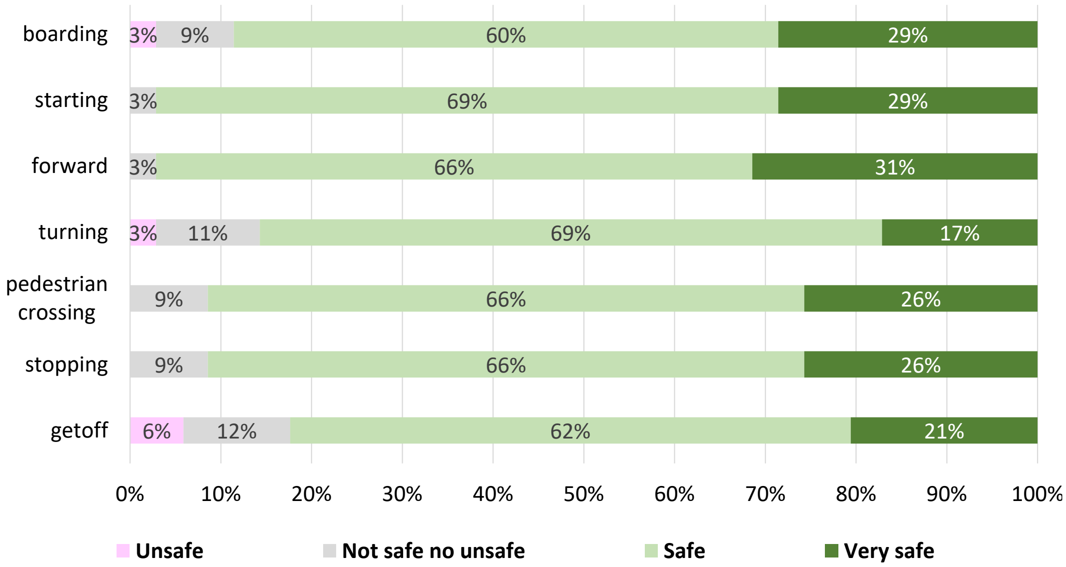


Figure 20. Safety perceptions (bus)

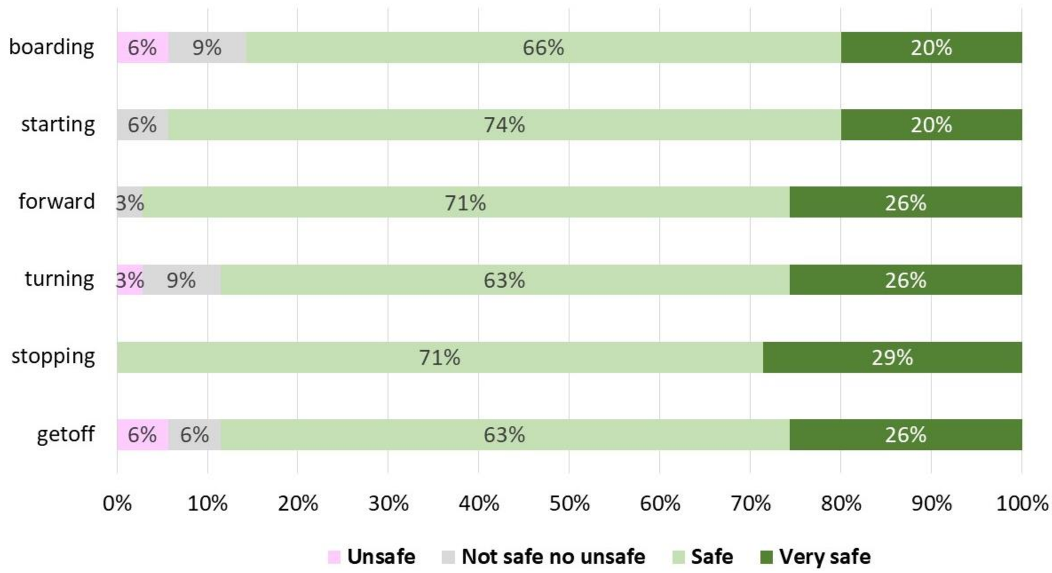


Figure 21. Safety perceptions (mini-shuttle)

The three vehicles were also generally perceived to be safe from the perspective of pedestrians and cyclists, although safety perceptions were not as positive as the ones from the perspective of the vehicle users, as reported above. The proportions of participants reporting that it will be safe or very safe for pedestrians to walk in streets used by self-driving vehicles were 86% (bus), 78% (shuttle) and 60% (delivery robot). The proportions reporting that it will be safe for cyclists were lower, at 79% (bus), 53% (shuttle) and 52% (delivery robot). However, only a few participants reported the vehicles as unsafe. In comparison with safety perceptions as user, the main change was the increase in the number of participants reporting “not safe not unsafe”.

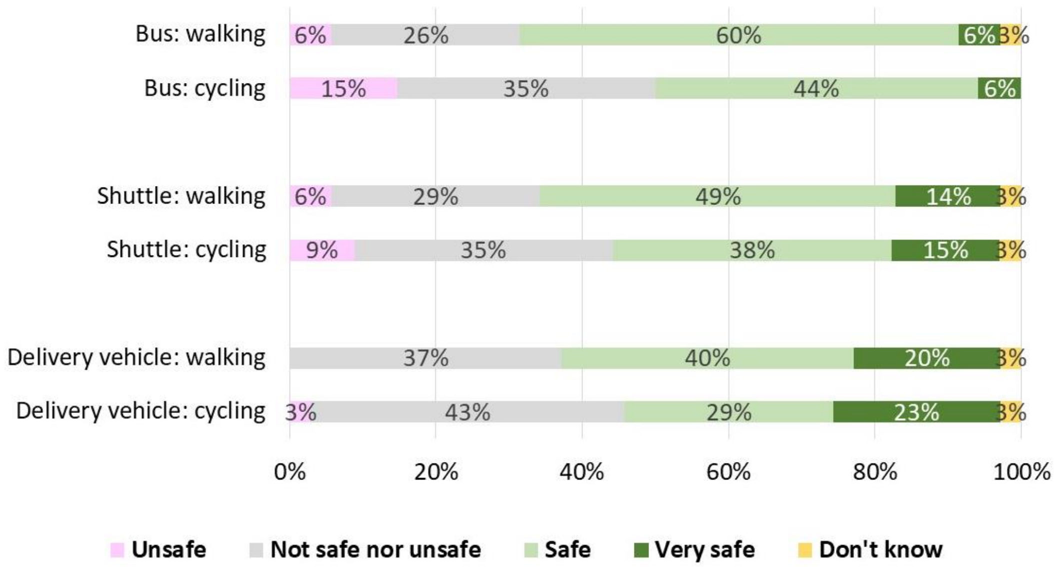


Figure 22. Safety of walking and cycling in streets used by self-driving vehicles

3.4.4 Assessment of self-driving vs. human-driven vehicles

The following three figures show how participants compared self-driving vehicles to human-driven ones. The results for the bus and mini-shuttle are similar (Figure 23 and Figure 24). On average, self-driven buses and mini-shuttles were judged to be more interesting, cheaper, but also slower and more insecure (in terms of crime) than human-driven ones.

Most people either did not know or thought that human-driven and self-driven buses and mini-shuttles will be equal in terms of stress, comfort, and danger in terms of accidents. However, among participants who did have an opinion, there were more people thinking that self-driven buses and mini-shuttles will be more comfortable, less stressful, and less dangerous (safer) in terms of accidents, than their human-driven counterparts.

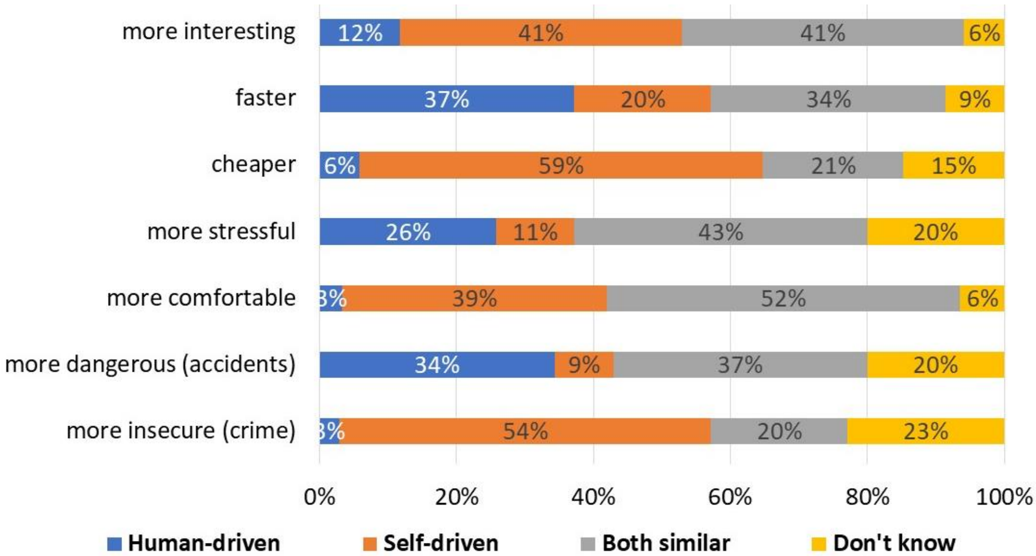


Figure 23. Assessment of self-driving vs. conventional bus

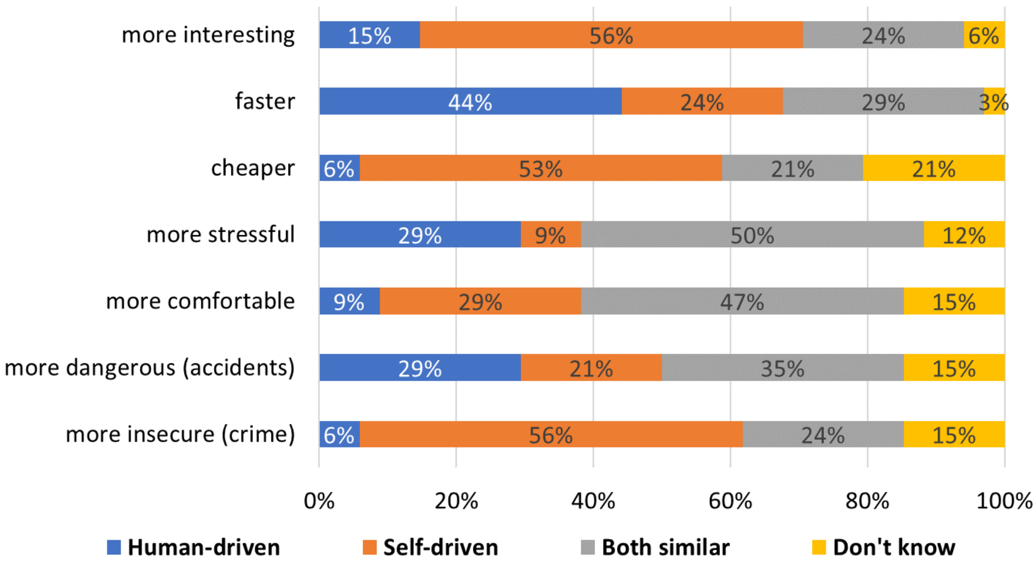


Figure 24. Assessment of self-driving vs. conventional mini-shuttle

The large majority (71%) thought that the delivery robot will be cheaper than human-driven vehicles (Figure 25). This is a higher percentage than in the cases of the self-driving bus and mini-shuttle in the previous figures. Only two participants (6%) thought the delivery robot is more dangerous in terms of accidents (this compares with 21% in the case of the mini-shuttle). There is a balance of opinions regarding speed, although more people thought that that human-driven vehicles are faster (35%) than the delivery robot (21%).

On the negative side, the delivery robot was judged to be more insecure (in terms of crime) than human-driven vehicles.

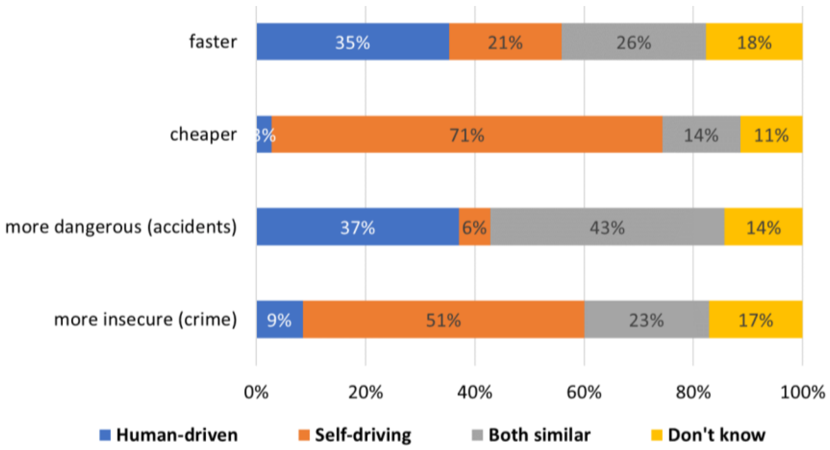


Figure 25. Assessment of self-driving delivery robot vs. conventional delivery vehicle

3.4.5 Main concerns

Participants were asked open ended questions about three concerns about each of the three vehicles. We then coded all the answers. Answers stating that they did not have anything to report (e.g. "nothing) were removed from further analysis. The table below shows the number of valid responses across the whole sample. Fewer concerns were reported about shuttle (1.1 per person) than about the other two vehicles (1.7-1.8).

Table 30. Concerns about self-driving vehicles: number of responses

	Responses	Responses per participant
Bus	62	1.8
Mini-shuttle	39	1.1
Delivery robot	60	1.7

Notes: Each participant could indicate up to three aspects. Table shows valid responses only

The following figures show the concerns mentioned by at least three participants (i.e., by at least 9% of the sample). The five concerns meeting this threshold for the bus and mini-shuttle were the same (although not in the same order of frequency). For this reason, they are shown in the same chart (Figure 26). The main concern is fear of crime and anti-social behaviour from other passengers. This was mentioned by 46% and 54% with regards to the bus and shuttle, respectively. The other concerns were what happens in unexpected emergency situations, technology failure, interaction with other road users, and general safety.

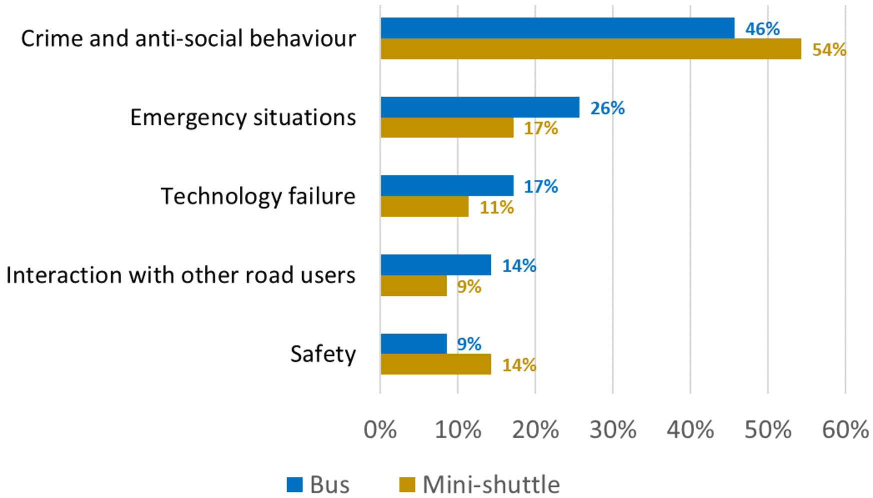


Figure 26. Main concerns about buses and mini-shuttles, after experiencing them

The main concern about the delivery robot (Figure 27) is also related to crime: the fact that goods can be stolen from the vehicle (mentioned by 46% of the sample). The other major concerns are accessibility to front door, delivery time, vandalism, and delivery failures in general. Whether robots can deliver goods at people's front doors or not was a concern expressed mainly in terms of individuals who may have disabilities and cannot walk to the location where the robot stops.

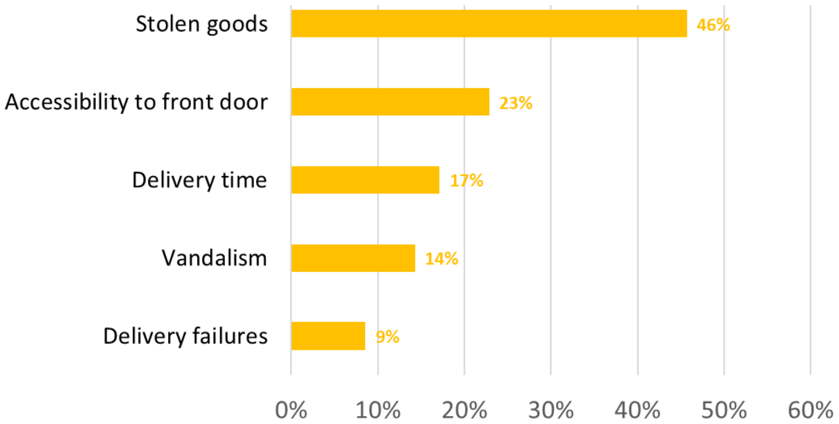
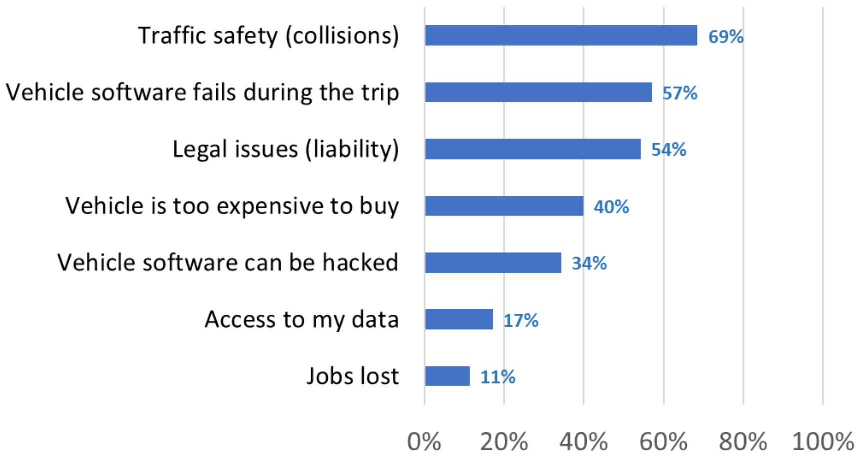


Figure 27. Main concerns about delivery robots, after experiencing them

A rough comparison is possible between the results above, which capture the concerns that participants expressed about the three vehicles after the demonstration, and their previous concerns. In the pre-event questionnaire, participants stated their concerns about self-driving vehicles in general, among a list of seven possible concerns. They could also add their own concerns. Full comparisons of proportions of the sample stating a given concern in the pre- and post-event questionnaires are not possible, as in the pre-event questionnaire participants had a list of concerns they could choose from, while in the post-event one there were no such list, i.e. the question was fully open-ended. However, it is possible to compare the rank of each concern.

As shown in Figure 28, safety (with regards to traffic collisions) was the main concern in the pre-event questionnaire. In the post-event questionnaire (as shown in the previous three figures), safety was only ranked fourth and fifth, in the case of the bus and mini-shuttle respectively, and not ranked among the top five concerns in the case of the delivery robot. However, technology failures remained an important concern in both questionnaires. Price was a concerned stated by 40% of participants in the pre-event questionnaire. In the post-event questionnaire, almost no participant mentioned this as a concern. The main concern expressed in the post-event questionnaire (i.e. security issues related to crime and anti-social behaviour or stolen goods) was not mentioned by any participant in the open ended box of the pre-event questionnaire.

Overall, this rough comparison suggests that participants express different concerns before and after experiencing self-driving vehicles.



Note: participants could indicate up to three concerns

Figure 28. Main concerns about self-driving vehicles before experiencing them

3.4.6 Intention to use

At the end of each section of the post-event questionnaire, participants were asked if they would use the vehicles they have experienced. At the end of the questionnaire, they were also asked if they would buy a vehicle that was not a part of the demonstration: a self-driving car. These results can be compared with the ones from similar questions asked in the pre-event questionnaire. In that questionnaire, participants stated if they would use or buy a self-driving vehicle, with the question not specifying the type of vehicle.

Figure 29 shows the results. The majority of the sample said they would use the self-driving vehicles they experienced: 71% would use the bus, 62% the mini-shuttle, and 68% the delivery robot. The rest of the answers are “maybes”. Only two participants (6%) said they would not use the bus and only one would not use the mini-shuttle.

These intentions are more positive than the ones expressed before the demonstration, where only 29% stated they would use self-driving vehicles (in general) and 15% said they would not use them.

The intentions regarding using the vehicles experienced are also more positive than the intentions regarding buying a self-driving car (which was not part of the demonstration). Only 20% said they would buy the car, the same number who said they would not buy it. However, in this case, intentions also became more positive compared with the situation before the demonstration. In the pre-event questionnaire only one participant (3%) said they would buy a self-driving vehicle (in general) and 47% said they would not do it.

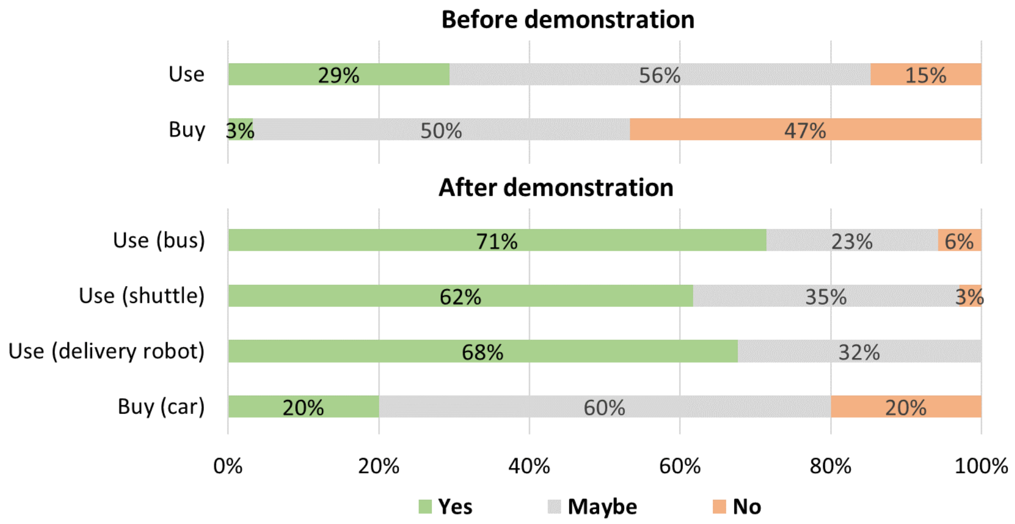


Figure 29. Intention to use or buy self-driving vehicles

3.4.7 Relationships between opinions and intentions

In this sub-section, we estimate how the participants' stated intentions to use the vehicles relate to their opinions about them. We do this by comparing the intentions among two groups: participants who have a certain opinion about the vehicle and those who do not have that opinion. The opinions examined, in the case of the bus and mini-shuttle, are thinking that the self-driving vehicle is:

- More interesting
- Slower (i.e., the human-driven bus is faster – as the question was about which vehicle was faster)
- Cheaper
- More insecure

In the case of the delivery robot, we only examine the opinion about insecurity.

We test whether the proportion of participants stating they will use the vehicle differs between the participants with the opinions above and those who do not hold these opinions. We use the chi-square test of proportions[2].

Opinions about whether self-driving vehicles are more stressful, more comfortable, or more dangerous are not examined. In the case of the delivery robot, opinions about whether the

[2] Swinscow, T D V. (1997) *Statistics at Square One*. BMJ Publishing Group., https://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one, Chapter 8

vehicle is slower, or cheaper are also not examined. This is because the chi-square test of proportions is not reliable for tabulating the intention variable versus variables measuring these opinions, due to the small sample. A common rule of thumb for this test is that sample size should allow for a minimum of five observations for each combination of values of the two variables. This rule could not be observed for the variables mentioned above, and so they were dropped from the analysis.

While perceived safety is an important variable, no suitable replacements were possible. Alternatives included: 1) the answers to the safety questions, 2) the proportion of participants who mentioned "safe" as one of their feelings, one of the things they liked in the vehicles, or one of their concerns about these vehicles, and 3) the concerns about self-driving-vehicles reported in the pre-event questionnaire. All these alternatives suffered from the same problem of small sample size.

As the sample is small even when the rule of thumb above is observed, in the results below we report differences in proportions that are significant at the usual significant levels of 5% and 10%, but also those significant at the 15% level. It should be emphasised that these are low levels of significance.

Table 31 shows the results. Only one variable is related to intention to use the vehicles at the 10% level: people who think the self-driving mini-shuttle is more secure that a human-driven mini-shuttle are more likely to say that they intend to use the self-driving one. At lower levels of significance, security is also related to intention to use the delivery robot. In addition, those who think that the self-driving bus is cheaper and those who think the self-driving mini-shuttle is faster are more likely to say they intend to use them.

Table 31. Proportion of sample intending to use vehicles, by opinion

	Intends to use vehicle		
	Bus	**Mini-shuttle**	**Delivery robot**
All	71	60	66
Less interesting	67	56	
More interesting	79	63	
Faster	77	70^{+}	
Slower	62	47	
More expensive	60	53	
Cheaper	80^{+}	67	
More secure	75	75^{*}	76^{+}
Insecure	68	47	56

Note: Significance levels refer to the differences in intentions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: **10%, $^{+}$20%.

3.4.8 Relationships between opinions, intentions, and participant characteristics

In this sub-section, we estimate how opinions and intentions to use the vehicles relate to the participant characteristics. We do this by comparing the opinions or intentions among two groups: participants with a given characteristic and those without it. The opinions examined are the same as those in the previous section, i.e. thinking that the self-driving vehicle is more interesting, slower, cheaper, and more insecure. Again, we test whether the opinions and intentions to use the vehicle differ among between groups of participants, using the chi-square test of proportions.

Given the need to have a sample size that follows the rule of thumb of having a minimum of five observations for each combination of opinions and participant groups, we reclassified the variables that measure participant characteristics as binary variables. The variables included in the analysis are:

- **Gender**: men vs. women
- **Employment status**: not working vs. working
- **Education**: no university degree vs. university degree
- **Household composition**: no children in household vs. children in household
- **Residence location**: small town or village vs. city
- **Awareness of self-driving vehicles**: aware but not following developments vs. not aware vs. aware and following developments
- **Previous experience using self-driving vehicles**: no previous experience vs. previous experience
- **Activity done first on the day**: demonstration vs. virtual reality

Some variables were potentially relevant but could not be reclassified so that the rule of thumb could be observed. These include income, migration background, health issue affecting mobility, driving licence, attitude to driving, use of bus, use of car, and previous intentions to use self-driving vehicles (as expressed in the pre-event questionnaire).

Other variables met the rule of thumb but were always insignificantly related to opinions and intentions. These include frequency of travelling for shopping and leisure, and previous concerns with self-driving vehicles (as reported in the pre-event questionnaire). Results for these variables are not shown in the analysis that follows.

Again, we report differences in proportion that are significant at the usual significant levels of 5% and 10%, but also those significant at the 15% and 20% level, with the caveat that these two levels of significant are low.

Table 32 shows the proportions of the different groups holding each type of opinion about self-driving buses and intending to use those buses. The opinion that self-driving buses are more interesting is significantly higher for participants with no children in the household, and for those who first joined the virtual reality experiment. As it will be described in Chapter 4, the virtual reality experiment featured a virtual bus, with several events happening during the ride. The virtual reality can be regarded as interesting in itself. This could contribute to participants thinking a real self-driving bus is also more interesting than a conventional one.

The opinion that self-driving buses are slower than human-driven ones is not significantly related at the 10% level with any variable. At the 20% level, individuals with university degree, those who are not following developments of self-driving vehicles, who had no experience with these vehicles before the demonstration, and who joined the demonstration before the virtual reality experiment, had higher propensity to think that self-driving vehicles will be slower than human-driven ones. This last result will be discussed below, when examining the case of the mini-shuttle.

Men and individuals living in cities are significantly more likely to think self-driving buses will be cheaper, at the 5% significance level. At the 20% level, those who are aware of self-driving vehicles and following developments are also more likely to have this opinion.

Men and city residents think self-driving vehicles will be more insecure than human-driven ones. The result for individuals in cities is as expected, as crime in public transport tends to be more of a problem in cities. The result for men is unexpected, as women tend to express more concerns about personal security in public transport. However, this could be related to the type of vehicle.

As it will be seen below, women show higher propensity to think that self-driving mini-shuttles will be more insecure than human-driven ones.

Intention to use self-driving buses is not related to any sample segment at the 10% level. At lower levels of significance, intention is higher for people with university degrees, without children in the household, aware and following developments in self-driving vehicles, and with previous experience of using these vehicles.

Table 32. Opinions and intention to use self-driving bus, by sample segments (%)

	Opinion about self-driving bus				Intends to use self-driving bus
	More Interesting	Slower	Cheaper	More insecure	
ALL	40	37	57	54	71
Man	45	35	70**	65*	70
Woman	36	43	36	36	71
Not working	40	27	60	60	67
Working	40	45	50	50	75
No university degree	29	21	50	57	57
University degree	48	48+	62	52	81++
No children in household	52*	38	57	57	81++
Children in household	21	36	57	50	57
Small town or village	33	33	33	33	75
City	43	39	70**	65*	70
Not following or not aware	33	50+	44	44	61
Aware and following	47	24	71++	65	82+
No previous experience	40	53+	47	40	67
Previous experience	40	25	65	65	75+
First: demonstration	24	47+	65	53	65
First: virtual reality	59**	24	47	53	76

Note: Significance levels refer to the differences in opinions or intentions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: **5%, *10%, ++15%, +20%

Table 33 shows the proportions of the different sample segment holding each type of opinion about self-driving mini-shuttles and intending to use those mini-shuttles.

The opinion that self-driving mini-shuttles are more interesting is not related to any variable. The opinion that self-driving mini-shuttles are slower is significantly higher, at the 5% or 10% level, for individuals who are working, had no previous experience in using self-driving vehicles, and first joined the demonstration (not the virtual reality experiment). In the latter case, this could be because the self-driving bus that the participants experienced in virtual reality moved faster than self-driving cars, using dedicated road lanes, so they may think that self-driving buses will be faster in general. This result was also obtained above in the case of the bus, although only significant at the 20% level.

At lower levels of significance, individuals with university degree and those that are not following developments in self-driving vehicles also have higher propensity to think that self-driving mini-shuttles are slower.

The opinion that self-driving mini-shuttles are cheaper is only related to other variables at the 20% level. Men and individuals who are following developments and had previous experience think they will be cheaper.

Individuals with children in the household think self-driving mini-shuttles will be more insecure. While not statistically significant, even at 20% level, it is worth noting that women have a higher propensity than men to say these vehicles will be more insecure, unlike in the previous case of self-driving buses.

Intention to use self-driving mini-shuttles is significantly related, at 5% or 10% level with individuals with university degree, and those who are following developments and had previous experience.

Table 33. Opinions and intention to use self-driving mini-shuttle, by sample segments (%)

	Opinion about self-driving mini-shuttle				Intends to use self-driving mini-shuttle
	More Interesting	Slower	Cheaper	More insecure	
ALL	54	43	51	54	60
Man	65	40	60+	45	65
Woman	43	50	36	64	50
Not Working	47	27	47	53	60
Working	60	55*	50	55	60
No university degree	43	29	43	64	43
University degree	62	52+	57	48	71*
No children in household	57	43	52	43	62
Children in household	50	43	50	71*	57
Small town or village	42	50	50	58	58
City	61	39	52	52	61
Not following or not aware	50	56++	39	61	44
Aware and following	59	29	65++	47	76**
No previous experience	60	60*	27	40	53
Previous experience	50	30	70++	65	65**
First: demonstration	53	59**	41	53	59
First: virtual reality	59	24	59	53	59

Note: Significance levels refer to the differences in opinions or intentions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: **5%, *10%, ++15%, +20%.

Table 34 shows the results for the delivery robot. The only variable related to the opinion that this type of vehicles is more insecure than conventional distribution vehicles is gender: men are more likely to have this opinion. At lower levels of significance, having a university degree is also related to this opinion. No variables are related to the intention to use the delivery robot.

Table 34. Opinions and intention to use delivery robot, by sample segments (%)

	Opinion about delivery robot	Intends to
	More insecure	use delivery robot
ALL	51	66
Man	65*	60
Woman	36	71
Not Working	53	67
Working	50	65
No university degree	36	71
University degree	62++	62
No children in household	57	62
Children in household	43	71
Small town or village	50	75
City	52	61
Not following or not aware	44	72
Aware and following	59	59
No previous experience	47	53
Previous experience	55	75
First: demonstration	47	71
First: virtual reality	53	59

Note: Significance levels refer to the differences in opinions or intentions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: **5%, *10%, ++15%, +20%.

3.5 Conclusions

This section collects the key conclusions from the demonstration, organised of terms of the five objectives stated in the introduction to the chapter.

The demonstration was done in a middle-size city. The sample aligned with the population in terms of age and gender, but had an under-representation of people with migration background, not working, or without university degrees. Almost none of the participants regularly use buses. Cycling is the dominant mode but car travel is also important. Participants had a good level of prior awareness of self-driving vehicles and even experience using them.

3.5.1 Feelings and opinions about self-driving vehicles after using them

There was a general positive feeling among participants when using the vehicles, with most reporting feeling safe, both when asked specifically about safety and in open-ended questions probing for aspects they liked. Most participants felt safe in all situations when riding the vehicles. They also tended to report that the vehicles will be safer for other road users (pedestrians and cyclists). On average, the view is that self-driving vehicles will be safer than human-driven ones. Participants also liked that the self-driving vehicles are quiet and that the ride was smooth. Using self-driving vehicles is also expected to be cheaper than human-driven ones. The majority of participants intends to use the three vehicles. However, intention to use the mini-shuttle is significantly related to perceptions of personal security when using them.

The main negative aspects are the perception that vehicles can be dangerous in terms of exposure to crime and anti-social behaviour from other passengers, vandalism, and, in the case of the delivery robot, stolen goods. The general view was that the vehicles are slow – this is related to the design of the experiment, as vehicles were programmed to move slowly. There were also concerns about the design of the vehicles. While the bus felt familiar, the large majority thought the mini-shuttle was too narrow, with not enough seating space.

Table 35 maps the key results of the demonstration onto the nine Move2CCAM impact dimensions.

Table 35. Conclusions of demonstration: feelings and opinions

Mobility	• The vehicles were regarded as something that could enhance mobility, and participants thought about several possible uses • The majority think that using self-driving vehicles will be cheaper than human-driven ones • General view that riding in self-driving vehicles was smooth but that the vehicles were too slow • A few people were happy that the bus is comfortable, but there were many negative views about the self-driving shuttle being narrow
Transport network	• Almost no participant expressed opinions about impacts on congestion or other transport network indicators
Land use	• Almost no participant expressed opinions about impacts on land use
Environment	• General view that the vehicles are quiet and environmentally-friendly
Economy	• Almost no participant expressed opinions about economic aspects
Equity	• Some participants expressed concerns that delivery robots may not be a good solution for people with disabilities, if they do not stop at people's front doors.
Public health	• Slight tendency to think that self-driving vehicles will reduce stress
Safety	• The majority thought that all three vehicles were safe, in terms of traffic collisions • The vehicles were regarded as safe in all situations, and both for vehicle users and for other road users (pedestrians and cyclists) • Some concern about what can happen in emergency situations
Security	• Strong concern that self-driving passenger vehicles can create situations when passengers fear about crime and anti-social behaviour from other passengers • Strong concern that delivery vehicles will be vandalised or have goods stolen

3.5.2 Feelings and opinions about different types of vehicles

Participants were generally happy with the self-driving bus, one of the reasons being that the vehicle felt familiar. The other vehicles had much different designs, compared with that participants are used to see on the road, which raised some concerns (Table 36).

Table 36. Conclusions of demonstration: comparison of different vehicles

Bus vs. mini-shuttle	• Participants reported more things they liked for the bus than for the mini-shuttle (2.5 vs. 1.9 per person respectively), but more things they disliked for the mini-shuttle (1.5 per person, compared with 0.8 for the bus) • More people reported feeling safe and comfortable in the bus than in the mini-shuttle • Participants were less happy with the mini-shuttle than the bus due to its narrow space or to innovative features such as movement in both directions (as this implied seating backwards to the vehicle movement) • Slightly stronger intention to use the bus
Passenger vehicles vs. delivery robot	• The delivery robot gathered more opinions regarding its possible uses • Stronger belief that delivery robots will be cheaper and safer than human-driven vehicles, when comparing with the bus and mini-shuttle • Similar intentions to use self-driving passenger and delivery vehicles

3.5.3 Change in concerns and intention to use

Changes in participants' views can be assessed for two variables, collected in questionnaires before and after the event: the concerns expressed about using self-driving vehicles, and the intention to use them. Both point to a general improvement in participants' views about self-driving vehicles (Table 37). However, crime and anti-social behaviour emerged after the demonstration as people's main concern, while before the demonstration the main concern was safety.

Table 37. Conclusions of demonstration: change in concerns and intentions

Concerns	• Safety was the main concern expressed before the event, but after the demonstration most participants thought self-driving vehicles are safe and expressed fewer concerns, expect about what happens in emergency situations • Crime and anti-social behaviour emerged as the main concern after the demonstration • Cost was a major prior concern but was hardly mentioned after the demonstration
Intentions	• Intention to use self-driving vehicles was 29% before the event but 62%-71% after the event • Intention to buy a self-driving car (a vehicle not featured in the demonstration) also increased

3.5.4 Comparison between self-driving and human-driven vehicles

Self-driving vehicles tend to compare well with human-driven ones. Table 38 shows the main tendency among the sample when comparing the two types of vehicles. The table does not imply that all participants have the opinions shown, but only that more participants have these opinions than those who have opposite ones. In this assessment, the opinions that both types of vehicles are similar, and lack of opinion, are not accounted for. However, the table identifies opinions held by the majority of all participants, accounting for those who think both vehicles will be similar and those who have no opinion. The results show that self-driving vehicles are judged to be better than human-driven ones in all aspects expect speed and security in terms of crime.

Table 38. Conclusions of demonstration: comparison with human-driven vehicles

	Self-driving vehicles	Human-driven vehicles
Positive	• More interesting⁺ • Cheaper* • Less stressful • More comfortable • Safer (accidents)	• Faster • More secure (crime)*
Negative	• Slower • Less secure (crime)	• Less interesting • More expensive • More stressful • Less comfortable • More dangerous (accidents)

Note: *: opinion held by more than 50% of participants for all three vehicles, ⁺: opinion held by more than 50% of participants in the case of the mini-shuttle only.

3.5.5 Variations in opinions and intentions among sample

Opinions and intentions were significantly related to several characteristics of the participants, as synthesized in Table 39. All demographic characteristics were relevant. There were also some significant different between participants who joined the demonstration before vs. after the other project event happening on the same day, involving virtual reality.

Table 39. Conclusions of demonstration: variations among sample

Gender	• Men more likely to think self-driving vehicles will be cheaper than human-driven ones, compared with women • Men more likely to think self-driving buses and delivery robots will be more insecure in terms of crime
Employment status	• Workers more likely to think the self-driving mini-shuttles will be slower than human-driven ones
Education	• Individuals with university degree more likely to use self-driving vehicles even though they think they will be slower
Household composition	• Individuals in households with children more likely to think the self-driving bus is more interesting and to use it • Those in households without children more likely to think the self-driving shuttle will be more insecure
Residence location	• City residents more likely to think the self-driving bus will be cheaper and more insecure
Awareness	• Participants who were more aware of self-driving vehicles before the demonstration more likely to think they will be cheaper and to use them • Those less aware are more likely to think self-driving vehicles will be slower
Previous experience	• Participants who had used a self-driving vehicle before the demonstration more likely to think they will be cheaper and to use them • Those without that previous experience are more likely to think self-driving vehicles will be slower
Order of activities	• Participants who joined the demonstration before the virtual reality experiment more likely to think self-driving vehicles will be slower • Those who joined the demonstration after the virtual reality experiment more likely to think self-driving vehicles will be more interesting

3.5.6 Final remarks

This chapter showed that although safety is a major concern about self-driving vehicles, the experience of using them tends to mitigate these concerns. In general, the participants in the demonstration think self-driving vehicles will be safe. These vehicles also compare well with human-driven ones in terms of other aspects, although there is some variation across the types of vehicles and different groups in the sample.

However, the demonstration also raised concerns among participants about the implications of self-driving vehicles for security in terms of crime, both for passenger and delivery vehicles. Slow speed was also a concern, although this is related to the experimental nature of the demonstration, where speed was programmed to be slow. Other concerns relate specifically to the narrow space provided by the self-driving shuttle.

4. Virtual reality experiments

4.1 Overview

Virtual reality experiments were organised in Helmond (Netherlands), Katowice (Poland), and Mitylene (Greece), involving a total of 92 citizens. The three sites provide a variety of geographic, economic, and social contexts. As mentioned in Chapter 3, Helmond is a mid-sized city in the Netherlands (population=95,940). Katowice is a larger city (population=286,960), part of Metropolis GZM, a metropolitan area. Mytilene is a smaller city (population=33,523), the largest settlement in the island of Lesbos.

The overall aims of the virtual reality experiments were to collect information on citizen needs and requirements when using self-driving private and public transport, and to assess their feelings when using these vehicles, both as stated in questionnaires and group discussions, and revealed in physiological measurements.

The experiments had five specific objectives:

- To compare citizens' perceptions and preferences about different aspects of travelling in self-driving private and public transport vehicles
- To assess physiological reactions to different aspects of travelling in self-driving private and public transport vehicles, using electroencephalogram data (EEG)
- To capture perceptions about the possible impact of self-driving vehicles on several dimensions of the lives of citizens
- To assess whether perceptions, preferences, physiological reactions, and perceived impacts are related to the characteristics of participants, or if they differ across the three countries studied
- To gather feedback on the effectiveness of virtual reality as a research method to study perceptions, preferences, and physiological reactions to self-driving vehicles

Virtual reality provides an immersive experience that can realistically replicate realities that not yet exist, such as trips on self-driving vehicle in a context where all vehicles on the road are also self-driving. At the same time, virtual reality can introduce variations in the conditions of those trips. This method is relevant to study self-driving vehicles, as these vehicles have mainly been deployed in temporary trials in small areas. Self-driving vehicles are not yet the main mode of road transport and citizens may find it hard to imagine how they will operate with only images or videos. While demonstrations such as the one described in Chapter 3 help citizens to better understand these vehicles, they are usually done in off-road sites, not accounting for the new types of infrastructure and travel environments that will exist in the future. Virtual reality provides citizens with experiences of these new infrastructures and environments in a realistic way.

Previous virtual reality studies have usually involved participants using headsets showing a road, other vehicles, and the road surroundings. The interior of the vehicle is shown less often. In addition, most previous studies featured only one type of vehicle, not allowing for comparison between different types of vehicles. In most cases, the vehicle was a private car, not a public transport vehicle. However, in the future, the choice between private and public transport will have different determinants, if both vehicles are self-driving, compared with the case when both vehicles are human driven. For example, not having to drive opens up possibilities for using travel time for other purposes, even in private cars, which may affect the choice between car and bus. For this reason, the experiments described in this chapter feature both a private and a public transport vehicle.

The virtual reality experiment is complemented with the collection of physiological data (electroencephalogram, or EEG), which assess the individuals' mental states when using self-driving cars and buses. These mental states are important in themselves, as they are related to the individuals' wellbeing and satisfaction using the two modes. They can also provide insights on the individuals' preferences for the two modes, and thus on the possible choices they would make if both modes were available in the real world.

Virtual reality is an underexplored method in transport research. These experiments are an opportunity to gather data on the effectiveness of the method for collecting transport passenger user data. Previous studies have been limited by the small samples used, and even more by using unbalanced samples, almost exclusively of younger participants (mostly students), and with a predominance of males. The experiments reported in this chapter address these gaps by using samples that are balanced in terms of gender and age, including participants aged over 65 – a group forgotten in most of previous studies. This allows us to understand possible inequalities in how different groups perceive and react to self-driving vehicles and the impact in their mobility and other aspects of their lives.

Finally, both virtual reality and physiological measure collection methods have potential ethical issues, such as concerns about data privacy, apprehension or embarrassing related to using headsets, motion sickness, and possible negative reactions to some of the scenarios represented in virtual reality. However, most published studies give only perfunctory information about how these issues were dealt with. The experiment reported in this chapter addresses and reports a comprehensive set of possible ethical issues.

The rest of this chapter is organised as follows

- Section 4.2 describes the **general design** of the experiment
- Section 4.3 describes the two **virtual reality scenarios** (bus and car)
- Section 4.4 describes the **data collection methods**
- Section 4.5 describes the methods to **recruit participants** and to address **ethics** considerations.
- Section 4.6 describes the **characteristics** of participants and their travel context and behaviour
- Section 4.7 and 4.8 analyse participant **choices** and **EEG** data
- Section 4.9 analyses the results of the post**-experiment questionnaire**
- Section 4.10 analyses the results of the **group discussions**
- Section 4.11 synthesises the key **conclusions** of the demonstration

4.2 General design of the experiment

The experiments were designed by University College London and organised by project partners in the three regions: City of Helmond (Netherlands), the GZM government (Poland), and Eloris (Greece). These partners also conducted the group discussions at the end of the experiment. All data collection materials were designed in the local languages. All results were translated into English.

Data was collected in five stages (Table 40). Participants provided demographic data and answered a questionnaire before the event. During the event, they first engaged in the virtual reality experiment, then answered a questionnaire, and finally participated in group discussions (Table 40).

Table 40: Data collection stages

Stage	Description	Timing	Duration
1	Provision of demographic data	Before the event	-
2	Pre-questionnaire	Before the event	-
3	Virtual reality experiment	-	20 minutes
4	Post-experiment questionnaire	-	10 minutes
5	Discussion groups	-	20 minutes

The events in each site were held over a day, in December 2023 (Greece and Poland) and January 2024 (The Netherlands). Figure 30 shows aspects of the events.

The day was divided into eight slots. In Poland and Greece, each time slot had four participants. In the Netherlands, as mentioned in the previous chapter, the event coincided with the demonstration of self-driving vehicles, which had the same participants. Here, the day was divided into eight 2-hour slots, each with two groups of four participants, one engaged in the virtual reality experiment and the other in the demonstration, each lasting for one hour. In the second hour, the groups swapped. Participants were briefed at the beginning of the day and before each of the activities (experiment, post-questionnaire, and discussion groups)

Figure 30. Aspects of the event: virtual reality experiment and group discussions

4.3 Virtual reality scenarios

4.3.1 Overview

A 6-minute virtual reality game was designed for Meta Quest Pro headsets (https://www.meta.com/gb/quest/quest-pro). The literature shows that longer durations may induce boredom or even motion sickness among participants. All text interacting with the user was translated into the local languages (Dutch, Poland, Greek). Monetary values were also shown in the local currencies. Participants were briefed before the game, with information explaining the rules of the game and the nature of the choices they had to make.

The game represents a future reality where self-driving vehicles are widely available. The game includes two scenarios: a trip on a car and a trip on a bus, both self-driving. Participants can choose between them at the start of the game (Figure 176Figure 31). At the beginning, a screen was presented with information about the two modes. The car and bus trips both start at the city centre and end at the participants' home, travelling along the same route. The participant is informed that they will be alone in the car and the trip is expected to take 18 minutes. The bus takes 15 minutes, which is shorter than the car because the bus uses a dedicated road lane. The car is paid per use and costs four times more than the bus (with the bus fare set as the current fare for a 15-minute ride in each of three experiment sites).

Participants could choose to switch from bus to car or from car to bus on eight occasions during the trip. This en-route mode switch is something that is plausible in the future, if both cars and buses are self-driving. Only one switch was allowed in the game. When participants switched to the other mode, they could not switch back to the original mode. The possibility of switching, and the restriction to only one switch, was mentioned in the participants briefing and also on the initial screen seen in the game, showing the two options.

Immediately after the trip starts, in both the car and the bus, participants were asked to choose what they would do during the trip (use a device to work, use a device for entertainment, or just look around). This was just to record their preference – the chosen time use was not represented in the virtual scenes that follow.

Figure 31. Virtual reality experiment: initial choice between self-driving bus and car

The scenarios change during the trip. Table 41 shows a list of the attributes that change in the car and bus scenarios. These attributes were selected on the basis of being potential determinants of mode choice or mode switch in the future. In the game, it is expected that some changes would trigger a mode switch and/or certain physiological reactions measured by EEG. Each stage of the car and bus scenario is thus defined by a combination of attributes level (for example "*city centre, daytime, uncrowded, human supervision, passengers minding their own business*").

Table 41: Attributes of the virtual reality scenarios

Attribute	Values	Car	Bus
Landscape	City centre, industrial, residential	Yes	Yes
Time of day	Daytime, getting darker, night-time	Yes	Yes
Congestion	No, getting worse, easing up	Yes	
Passenger number	None, fee, many		Yes
Passenger behaviour	Mind their own business, acting in an anti-social manner		Yes
Human assistant	Present, absent		Yes

In the car scenario, the landscape (e.g., what the car passenger can see from the window) is an attribute because in the future driving will no longer be required, so passengers can enjoy the scenery, which becomes more important for trip quality. Travelling at night-time, or in congested conditions, also prevents people from seeing the landscape. Congestion is also an attribute because it is a major determinant of travel mode choice and of traveller stress. We test a situation where buses always move faster than cars, by using dedicated (and uncongested) lanes.

In the bus scenario, emphasis was put on personal security issues of travelling in unsupervised public transport, one of main concerns found in previous literature. This is tested by several attributes: landscape (industrial wasteland with derelict industrial buildings); crowding; time of day (dusk and night-time); and behaviour of other passengers (some acting in an anti-social manner, talking loudly, playing music, and putting their feet on the seats). The presence of a human assistance is important because people are concerned with the risk of collision if no human is present to take over vehicle if needed. Crowding and landscape are part of the trip's perceived quality and can cause stress, regardless of personal security. Time of day and crowding also interact with landscape: it is more difficult to see the landscape at night and in a crowded bus.

The game was designed as an immersive virtual reality, with 3D scenes and sounds corresponding to each scenario stage (e.g., city sounds, bus doors opening and close, bus passengers chatting or making loud noise). The traffic featured mostly self-driving vehicles, but a few conventional ones. Self-driving vehicles were designed without a steering wheel or any other feature associated with human drivers. No pedestrians or cyclists were featured in the scenarios (this was to reduce the cost of building the scenario). Bus passengers were portrayed as simplified silhouettes rather than human-like characters, to avoid associations with any age, gender, ethnic, or socio-economic group. However, these silhouettes can immediately be identified as humans due to their shape, gestures, and sounds.

4.3.2 Self-driving car scenario

The participant enters the vehicle, which starts moving (Figure 32). The scenario changes, following nine stages (Table 42). The landscape changes regularly and it gets progressively dark. The participant can see self-driving buses moving faster in the bus lane. The traffic becomes progressively denser.

The scenario stages start and end at bus stops. At each bus stop, the participant is shown the current delay and expected arrival time. Delays build up during each stage, up to 6.5 minutes at the end of Stage 7. When shown this information, participants are asked if they want to switch mode, i.e., to get off the car and get on a bus. This carries an additional cost, equal to the full-trip bus fare (from origin to destination). If the participant decides to get off, the experiment continues with the bus. If not, the car continues.

At the end of Stage 9, the car stops. The participant's home is just opposite. The participant is asked to choose between: a) send the vehicle to a nearby parking area to reuse the following day (which has a cost), and b) send the vehicle back to the city centre.

Table 42. Virtual reality experiment: car scenario

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	City centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Congestion	No	Gets progressively worse						Eases up	No

Note: Attribute levels represented: city centre, daytime, starting to be congested

Figure 32. Virtual reality: scene from car scenario

4.3.3 Self-driving bus scenario

The participant boards the bus and sits in a vacant seat at the back of the bus (Figure 33). The scenario changes, following nine stages (Table 43). The landscape and time of day attribute levels are identical to the ones in the car scenario, as the vehicles are using the same road. Landscape thus changes regularly, and it gets progressively dark. The bus uses a dedicated lane and moves faster than the private cars in the general lanes. At each bus stop, new passengers join, and others leave the bus.

The scenario stages start and end at bus stops. At each bus stop, participants are shown the expected arrival time (which decreases linearly in each stage). When shown this information, participants are also asked if they want to switch mode, i.e., to get off the bus and get on a car. This carries an additional cost, equal to the full-trip car cost (from origin to destination). If they decide to get off, the experiment continues with the car. If not, the bus continues. At the end of Stage 9, the bus stops. The participant's home is just opposite.

Table 43. Virtual reality experiment: bus scenario attributes

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	City centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Passenger number	Few	Many		Few					None
Passenger behaviour	Mind their own business					Anti-social			No other passenger
Human assistant	Present				Absent				

Note: Attribute levels represented: city centre, not crowded, no human assistant, starting to get dark, passengers mind their own business

Figure 33. Virtual reality: scene from bus scenario

4.4 Data capture

4.4.1 Demographic data

In Greece and Poland, participants provided information about their demographic characteristics when they were originally recruited by market research companies to join the Move2CCAM project network of "satellites" in 2023. In the Netherlands, demographic information was collected in a questionnaire distributed days before the event (see next sub-section).

Demographic variables collected included age, gender, ethnic group (in Poland and Greece only) or migration background (in Netherlands only), employment status, income (in Netherlands only), qualifications, educational background, driving licence, household type, and type of residence location (urban vs rural). These questions were included as appendix in a previous report of this project (Deliverable 3.3., Appendix 1).

4.4.2 Pre-event questionnaire

Participants answered a questionnaire before the event. This was done online, through the Qualtrics platform. Participants who had joined previous activities of the project filled this questionnaire before they joined their first activity, in 2023. In the Netherlands, participants whose first activity was the virtual reality experiment filled this questionnaire in advance to the event.

The questionnaire was identical to the one used in the demonstration of self-driving vehicles described in Chapter 3. Appendix 2 contains the English version of this questionnaire. It includes questions to capture travel context (residential area characteristics, mobility problems), travel behaviour (travel frequency and main mode, feelings about driving, use of travel time in public transport), and attitudes towards self-driving vehicles (awareness and concerns about self-driving vehicles, intention to use them, and use of travel time when using them).

4.4.3 Virtual reality game data

The virtual reality headset recorded the choices made by participants in the game, and the time when they were made. This included the initial choice of car or bus, if/when participants switched from one mode to another, what they chose to do during the trip and, if they end the game in the car, what they decide to do with the car (park it nearby or send it back to the city centre).

The headset also captured the times when participants started and ended each stage of the scenarios, both when the stage started after a switch choice, and when switching was no longer possible and the stages followed each other without prompts to make further choices.

4.4.4 EEG data

Brain activity was recorded using non-invasive electroencephalography (EEG) earbuds (EMOTIV MN8 - https://www.emotiv.com/mn8-eeg-headset-with-contour-app. Electroencephalography records electrical activity in the brain. The EMOTIV MN8 device has two sensors and records electric activity into five frequency bands: theta (4-8Hz), alpha (8-12Hz), low beta (12-16Hz), high beta (16-25Hz) and gamma (25-45Hz).

Low frequencies tend to be more present in relaxed states of mind, while high frequencies are more present in stressed states of mind. As such, the ratio between high and low frequencies is often used as an indicator of stress. We used as our main indicator the ratio between the high beta and alpha frequencies, as previous studies have shown that this ratio is associated with arousal or stress. The high beta and alpha frequencies were averaged across the two device sensors. We then calculated their ratio, for each EEG reading. The ratios were then averaged for each second, then for each combination of participants and scenario stages, and finally for each scenario stage.

The application associated with the EMOTIV MN8 device produces two indicators, based on an algorithm classifying the frequency bands. These indicators are labelled “cognitive stress” and “attention”. We did not use data for these indicators because the details of this algorithm are not clear in the EMOTIV documentation. As such, it is not possible to know with certainty what the two indicators are measuring.

EEG data was recorded during the virtual reality game. Before the game started, a baseline reading was taken. For this reading, participants were asked to relax for 15 seconds with their eyes open, and after a 5-second break, to relax for another 15 seconds with their eyes closed.

4.4.5 Post-experiment questionnaire

Participants filled a questionnaire after the experiment (Appendix 5). The first section of this questionnaire is about the choices people made during the game: which vehicle they chose in the beginning (and why), if they switched to the other vehicle during the trip (and why), and if yes, if they regret switching (and why).

Two sets of questions then ask for opinions about the car and bus scenarios. Participants only answered the questions about the scenario(s) they have experienced (car, bus, or both). The set of questions were similar for the car and bus scenario and covered:

- **Feelings** during the experience. Participants could choose all that applied from a list of 18 possibilities. The list was similar to the one used in the vehicle demonstration in the Netherlands described in Chapter 3, to allow comparisons of real-world and virtual experiences.
- The three things the participant **remembered** the most from the scenario
- Which **changes participants noticed** in the scenarios. The question probed for all attributes of the scenarios described in Section 4.3: landscape (type of buildings), time of day, speed of the vehicle, speed of the vehicles in the other lane, and, in the case of the bus only, the number and behaviour of other passengers and the presence of a human assistant. Participants could also indicate other aspects, as free text.

- How **realistic** the scenario was (on a 5-point scale), and what was not realistic (open ended question).
- How self-driving cars/buses will **compare** with cars/buses with a human driver: which trips will be more interesting, faster, cheaper, more stressful, more comfortable, more dangerous (in terms of accidents), and more insecure (in terms of crime). Again, this question is similar to the one asked in the vehicle demonstration described in Chapter 3, to allow comparisons.

The section about the virtual bus trip had two extra questions, answered only by participants in the Netherlands site who had already joined the self-driving vehicle demonstration on that day. The questions are whether there was anything they liked in the virtual bus that they had previously disliked in the real bus, or the opposite.

The final section of the questionnaire is about travel intentions:

- Whether the participant **would use** a self-driving car and bus in the future. These questions are similar to questions asked in the pre-activity questionnaire, to allow comparisons.
- Whether **travel behaviour would change**, in terms of productive or leisure uses of travel time; worry about parking; and car, bus, and overall trip frequency.

4.4.6 Post-experiment group discussions

After filling the post-experiment questionnaire, participants joined discussions with the other three participants in the group. They were presented with eight slides (Appendix 6) containing images from the two scenarios and probed to give their views on different aspects of their experience.

Participants were first asked about their opinion of:

- The **external design** of the two vehicles
- The **internal design** of the two vehicles
- The **scenery outside** the vehicle (showing images of both the city centre and industrial areas, both at daytime and night-time).

Participants were then asked, if they were in the car when it happened, about their opinion about buses travelling faster in the other lane.

Finally, they are asked, if they were in the bus when it happened:

- How they felt when the bus became **crowded** with passengers
- What they thought about the **human assistant** and how they felt when the assistant left
- How they felt when some passengers started having **anti-social behaviour**
- How they felt when the bus became **empty** of other passengers

4.4.7 Other data

We recorded the games played by each participant, to attempt to extract information about which parts of the virtual scenarios they looked at. However, this information was difficult to be objectively identified and was not used in the analysis.

4.5 Participant recruitment and ethics

4.5.1 Participant recruitment

Participants were recruited from the Move2CCAM network of “satellites”, i.e., citizens who were invited to previous activities organised by the project. The aim was to recruit a balance of men and women, and proportions of participants in three age groups (18-34, 35-64, and 65+) that are aligned with the population of each region. As noted before, a balance between different genders and ages is important because many studies have been limited by using unbalanced samples.

A sample of 30 in each region was deemed necessary to balance the need to simplify planning and save costs (experiments with more than 30 participants would require several days), while still generating enough data to derive robust results and compare them across gender and age groups.

4.5.2 Ethics

The study received ethical approval from the Bartlett School of Environment, Energy and Resources at University College of London (ID: 20231120_EI_ST_ETH_ Move2CCAM). The event addressed several potential ethical issues, as it involved participants wearing two devices (virtual reality headsets and EEG earbuds) that they may be unfamiliar with. As noted before, this aspect has been insufficiently covered in previous studies. The equipment and scenarios were thoroughly tested before the experiment to gauge their suitability and any possible ethical issues. Table 44 lists the ethical issues and the strategies implemented to address them in this study.

Table 44: Virtual reality experiment – ethics issues

Ethics issue	Strategy to address the issue
General concerns about what will happen and how data is collected and treated	• Participants were provided with an information sheet and consent form before the event and only started the experiment upon confirmation the form had been signed • Participants were briefed at the beginning of the event and before every single activity during the event
Discomfort or embarrassment wearing the virtual reality headset and the EEG earbuds	Participants were informed before the experiment about these issues and reassured that they could opt-out at any moment, before or after they started wearing the headset
Motion sickness, headache, skin irritation, or other discomforts while using the virtual reality headset	
Red marks on the forehead for a few minutes after the experiment	
Risks of transmittable diseases through wearing equipment used by others before	The virtual reality headset and EEG earbuds were disinfected after every use.
Discomfort if a researcher of another gender helps participants wearing the headset and EEG earbud.	• Participants were provided with clear instructions on how they could wear and calibrate the headset and wear the EEG earbuds. • Male and female researchers were both present to guide participants on how to wear the two devices
Use of participants' time	Participants received a small monetary compensation for their participation
Risks of fatigue (especially in the Netherlands site, where participants also join a vehicle demonstration)	Participants were provided with food and drinks, and the schedule of the experiment had frequent breaks

Uneasiness with some of the scenarios seen in the virtual reality game (congestion, bus overcrowding, passengers acting in an anti-social manner)	• Participants were informed before the experiment about these issues and reassured that they could opt-out at any moment • The scenarios ended on a positive note, with all situations resolved and the car and bus arriving at the destination.
Identification of virtual figures with specific age, gender, ethnic, or socio-economic groups	Human figures were portrayed as simplified silhouettes

Participants were provided with an information sheet and an informed consent form, which they filled before joining the event. The information sheet contained:

- Details about the event, funder, organisers, and nature and duration of each activity
- Information about the devices that participants would wear during the experiments, including photos and links to the manufacturers' web pages, and reassurance that the devices are standard commercial products and are used by many people, to play games, or monitor their concentration or other types of brain activity
- Reassurance that the devices would be disinfected and that researchers can help them to wear or remove the devices
- A brief description of the virtual reality game (including a screenshot) and the post-experiment activities (questionnaire and group discussions
- Information about use of personal data collected at all stages and of photos and video recordings of the event
- Possible discomforts, and what to do if they do happen
- Advice that participants with certain conditions should not take part in the research

Participants gave they consent by confirming (by ticking a box) that they understand what the research involves and what is expected of them. The information sheet and consent form were included in a previous report of this project (Deliverable 3.3., Appendix 19).

The pre- and post- event questionnaires did not capture any information that could identify individuals. Participants were identified through an ID number. The data was analysed by University College London, which did not have access to the file matching ID numbers with participant contact details. Only the event organisers (Eloris, GZM government, and City of Helmond) had access to this file.

4.6 Participant characteristics

A total of 92 participants completed all data collection activities in the virtual reality experiment: 34 in the Netherlands, 30 in Poland, and 28 in Greece. In the Netherlands, half of participants completed the experiments after riding in the real self-driving bus, as part of the demonstration reported in Chapter 3. The other half completed the virtual reality experiments before riding in the real self-driving bus.

4.6.1 Demographic and socio-economic characteristics

The following tables show the key characteristics of the samples. A good gender balance was achieved in Poland and Greece. In the Netherlands, there were 61% of men and 39% of women (Figure 34). The age distribution was reasonably aligned with the population of the three sites (Figure 35). Sites differed in terms of urbanisation levels (Figure 36). There were higher proportions of city centre residents in Greece, village residents in Poland, and city (but not city centre) residents in the Netherlands.

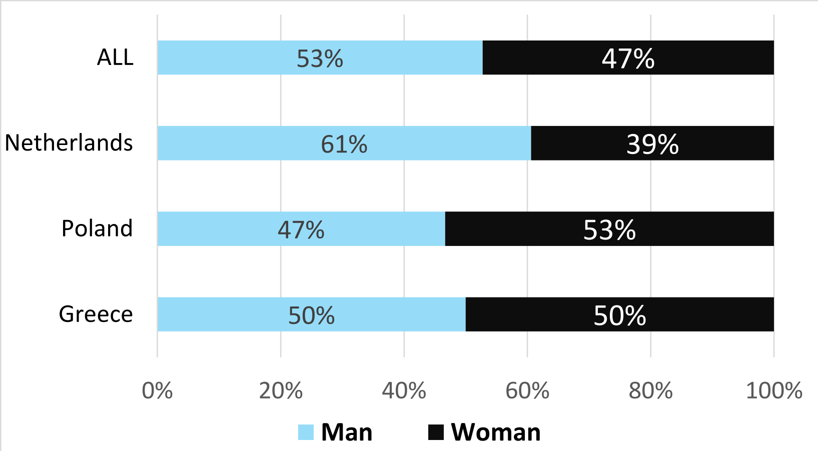


Figure 34. Virtual reality experiment participants – gender

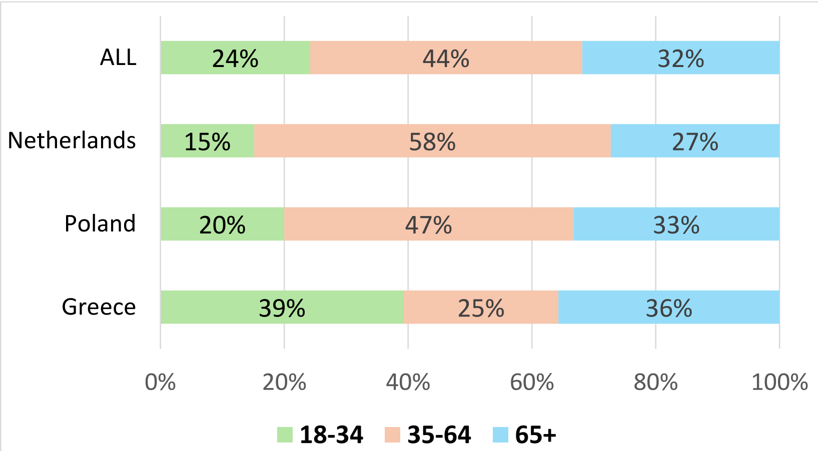


Figure 35. Virtual reality experiment participants – age

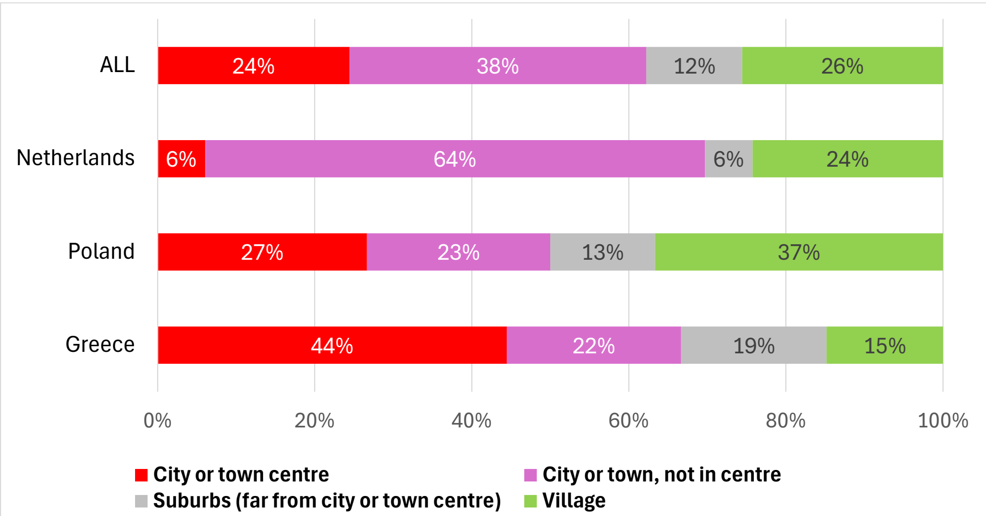


Figure 36. Virtual reality experiment participants – type of residence area

In Greece and Poland, all participants identified themselves as “white” in terms of ethnicity. In the Netherlands, the question was whether at least one of the parents of the participant was born abroad. Six participants (19% of the 32 who answered this question) answered yes. As mentioned in Chapter 3, this is below the proportion in the population of the municipality. Income was only collected in the Netherlands. Data was previously included in Chapter 3 (Figure 12) and shows there is a slight predominance of higher-income groups.

Table 45 shows other characteristics. Most participants are working. In all three countries, the proportions of the sample having a university degree or higher degree are slightly above the population proportions. Most participants live with their partner and/or children.

Table 45: Virtual reality experiment participants - other participant characteristics (%)

	ALL	Netherlands	Poland	Greece
Employment				
Work (full or part time)	58	58	63	54
Student	10	6	10	14
Other (retired, not working, homemaker)	32	36	27	32
Education				
Primary or secondary school (inc. vocational)	43	36	40	56
University degree	33	45	27	26
Higher university degree	20	15	27	19
Still in full-time education	3	3	7	0
Household type				
Lives alone	17	9	23	19
Lives with friends	4	12	0	0
Lives with family	7	3	10	8
Lives with partner	36	36	43	27
Lives with children (and with/without partner)	36	39	23	46

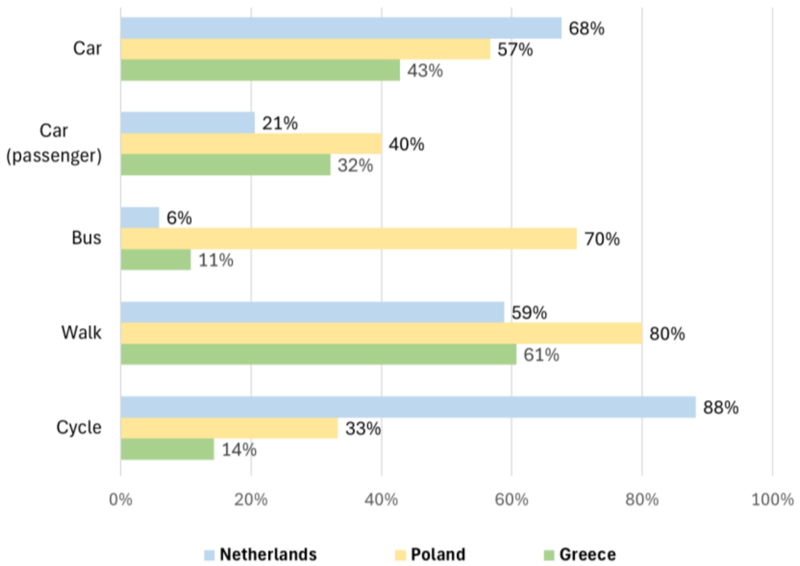
4.6.2 Current travel context and behaviour

Table 46 shows the participants' travel context. Relatively high proportions stated they had a disability or health problem affecting mobility (although in most cases they stated it only affects them a little. The large majority has a driving licence. Only about half of participants in the Netherlands and Poland and one third in Greece drive and enjoy doing it. Shopping trips have different frequency patterns in the three countries.

Figure 37 shows the proportion of participants reporting using each mode for at last one of four possible purposes (work, shopping, leisure, or go to health centre). Car (driving alone) and cycling are more prevalent in the Netherlands site. Bus and walking are more prevalent in Poland.

Table 46: Virtual reality experiment participants - travel behaviour and context (%)

	ALL	Netherlands	Poland	Greece
Disability or health problem affecting mobility				
Yes	17	18	33	0
No	79	76	67	96
Prefer not to say	3	6	0	4
Driving licence				
Have license, is able to drive	78	88	67	79
Have licence, no car	7	9	7	4
Have licence, can not drive because of health	4	0	13	0
No licence	11	3	13	18
Attitude to driving				
Enjoy driving, do not mind doing it	43	50	47	32
Prefer to use time for something else	14	21	10	11
Does not drive	42	29	43	57
Travel for shopping				
Never or less than once a month	8	0	10	15
1-3 times a month	32	18	50	30
1-3 times a week	49	74	37	33
4+ times a week	11	9	3	22



Notes: Numbers for whole sample: car (driver)=57%, car (passenger)=30%, bus=28%, walk=66%, cycle=48%. Other modes: train only in Netherlands (18%), taxi only in Poland (3%) and Greece (3%)

Figure 37. Virtual reality experiment participants – use of travel modes

4.6.3 Prior awareness and concerns about self-driving vehicles

There was some awareness of self-driving vehicles among the sample (Figure 38). Overall, 46% said they were aware of self-driving vehicles and following developments, and another 47% said they were aware but did not know much. Only 8% were not aware of these vehicles. In Greece, 61% said they were aware and following developments, and none said they were not aware.

The main concerns about these vehicles (Figure 39) were traffic safety and vehicle software failing during the trip. Legal issues were also a concern of the majority of the sample in the Netherlands.

The main use participants in all three countries reported for their travel time if they could use self-driving vehicles was “look outside the window” (Figure 40). Other activities include talking to other passengers, listen to music, other activities on a device, and think. Work was mentioned by only 29% of participants in Netherlands and 7% in the other two countries.

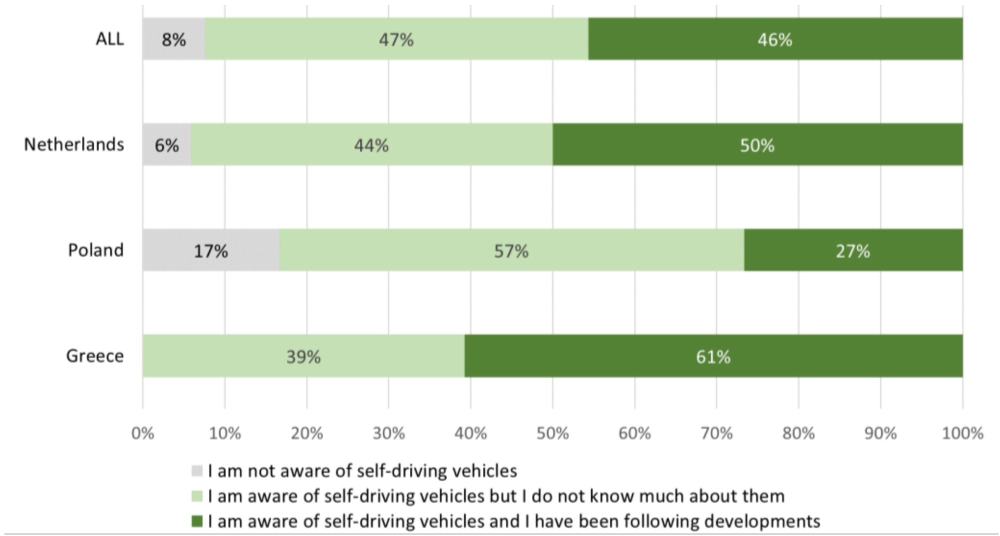


Figure 38. Virtual reality experiment – previous awareness of self-driving vehicles

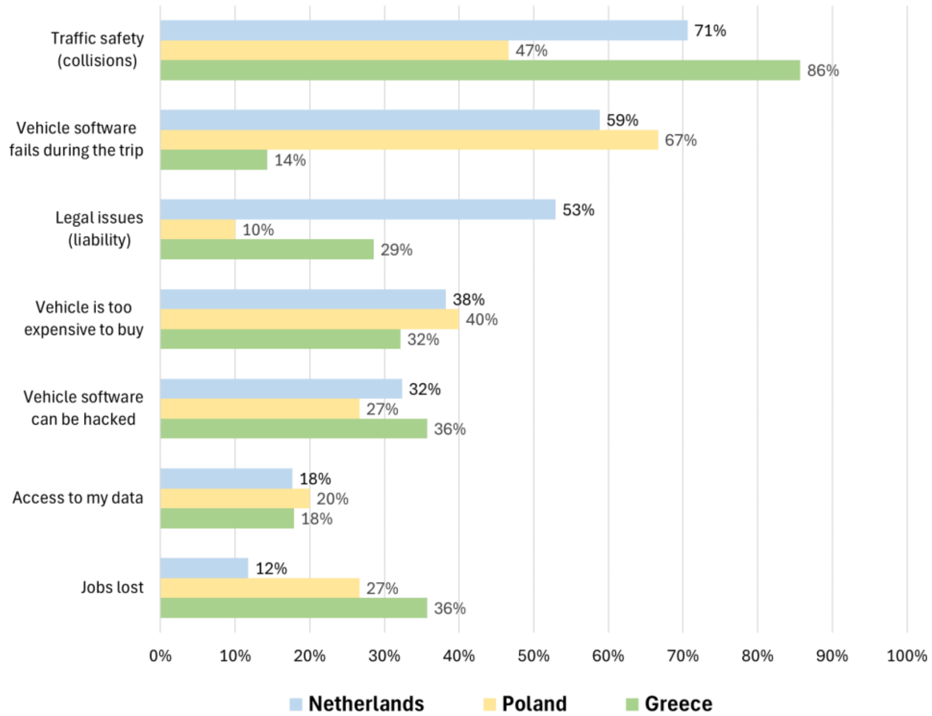


Figure 39. Virtual reality experiment – previous concerns about self-driving vehicles

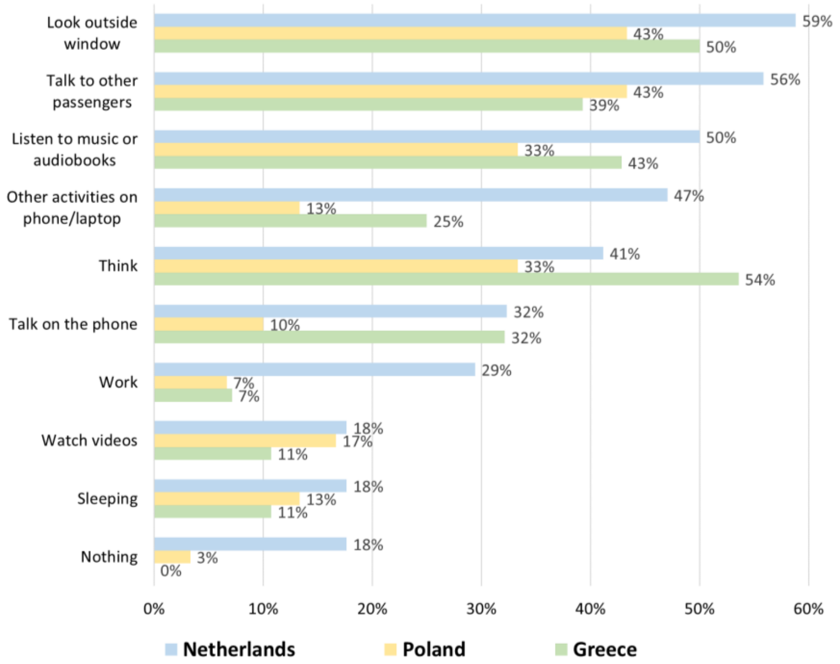


Figure 40. Virtual reality experiment – intended use of travel time in self-driving vehicles

4.7 Choices

4.7.1 Mode choice

Figure 41 shows the participants' initial choices of travel mode in the virtual reality game. Overall, 43% chose the car and 57% chose the bus. The proportion of participants choosing the bus was considerably higher in the Netherlands (71%), and slightly smaller among the younger age group (45%).

We coded all the reasons for the choices, which were provided by participants in an open-ended question. The main reasons for choosing the car (left side of Figure 42) were that is the usual mode participants use, it is more private, and seemed more curious than the bus. The main reasons for choosing the bus (right side of the figure) were that it seemed more curious, followed by two of the trip attributes shown in the game: the bus was cheaper and faster than the car.

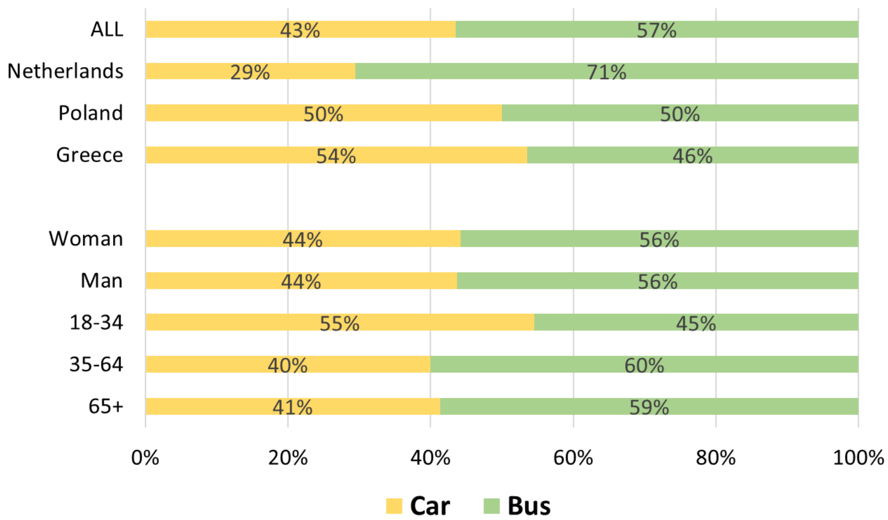
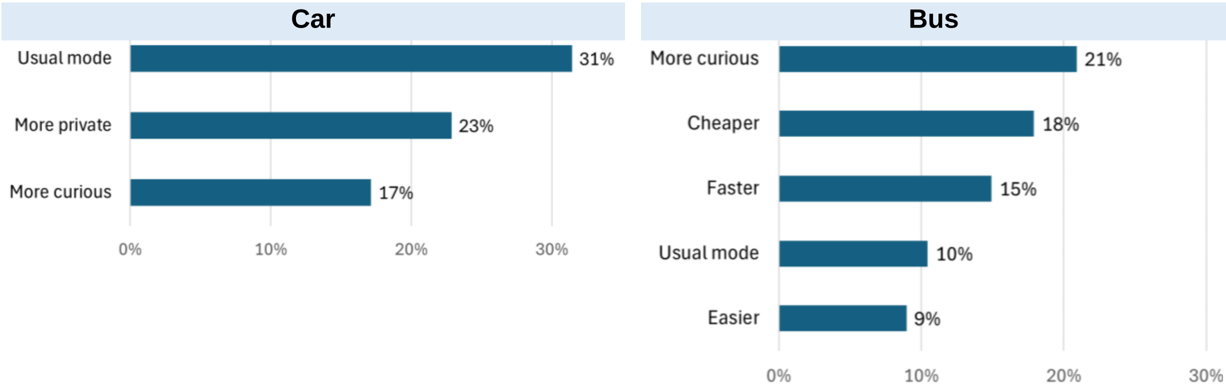


Figure 41. Virtual reality experiment – initial choices



Note: Base is number of different reasons given by participants who chose bus (67) and car (35). Charts show only reasons given by more than 5 participants, i.e. 7% of bus choices and 14% of car choices

Figure 42. Reasons for initial choices

4.7.2 Mode switch

It was expected that most participants switched from one mode to another during the game, as it was likely that they were curious to try both modes in virtual reality. Figure 43 shows the proportions who did not switch.

Only 5% of participants who started in the car did not switch to the bus during the trip. All participants in Poland, women, aged 18-34, or 65+ switched from car to bus. In contrast, the proportion of participants who did not switch from the bus to the car was much larger: 27%. This proportion was even larger among participants aged above 65, at 47%.

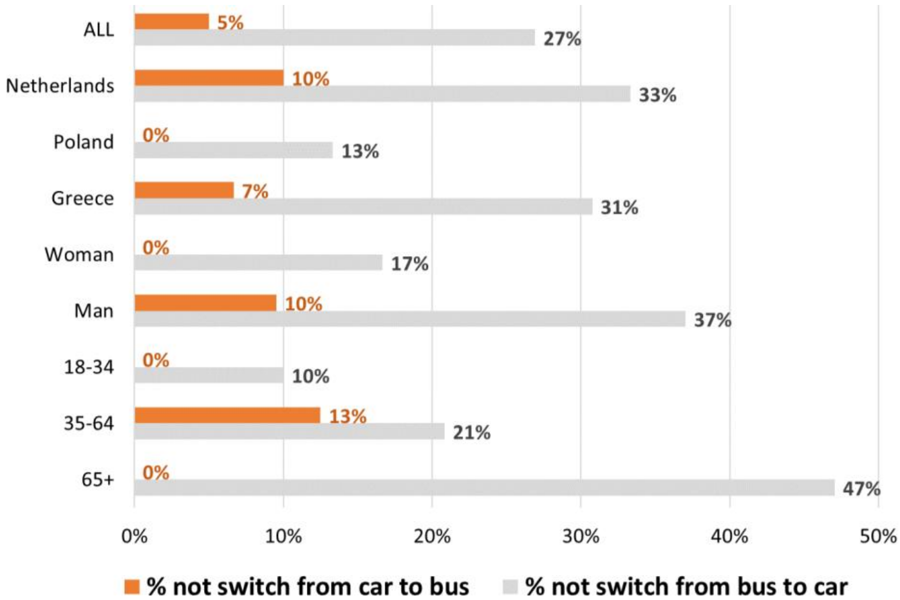


Figure 43. Virtual reality experiment – mode switch

Figure 44 shows the proportion of participants who started in the car and were still in the car at the end of each stage of the bus scenario. Most participants (70%) switched in the first two occasions they could switch (i.e., at the start of stages 2 or 3). This was a general behaviour, with no large differences across countries, genders, or age groups.

Figure 45 shows the proportion of participants who started in the bus and were still in the bus at each stage of the bus scenario. Again, there was a drop in the first two stages, but not as pronounced as in the case of the car. After this, there not many participants switching, until the start of Stage 7, when there was another drop. This coincided with the arrival in the bus (in Stage 6) of the passengers with anti-social behaviour. In the Netherlands and Greece, the drop continued at the start of Stage 8 (as the anti-social passengers were still in the bus in Stage 7). This shift from bus to car after the arrival of these passengers in the bus was considerably more pronounced for women than men.

We coded the reasons that participants gave for switching. The main reasons were curiosity to see what the other mode looked like (78% of reasons to switch from bus to car and 84% of reasons to switch from car to bus). Three participants (i.e. 8% of those who switched from the bus) mentioned the unruly passengers with anti-social behaviour as a reason to switch. Four participants (i.e. 13% of those who switched from the car) mentioned slow speed as a reason.

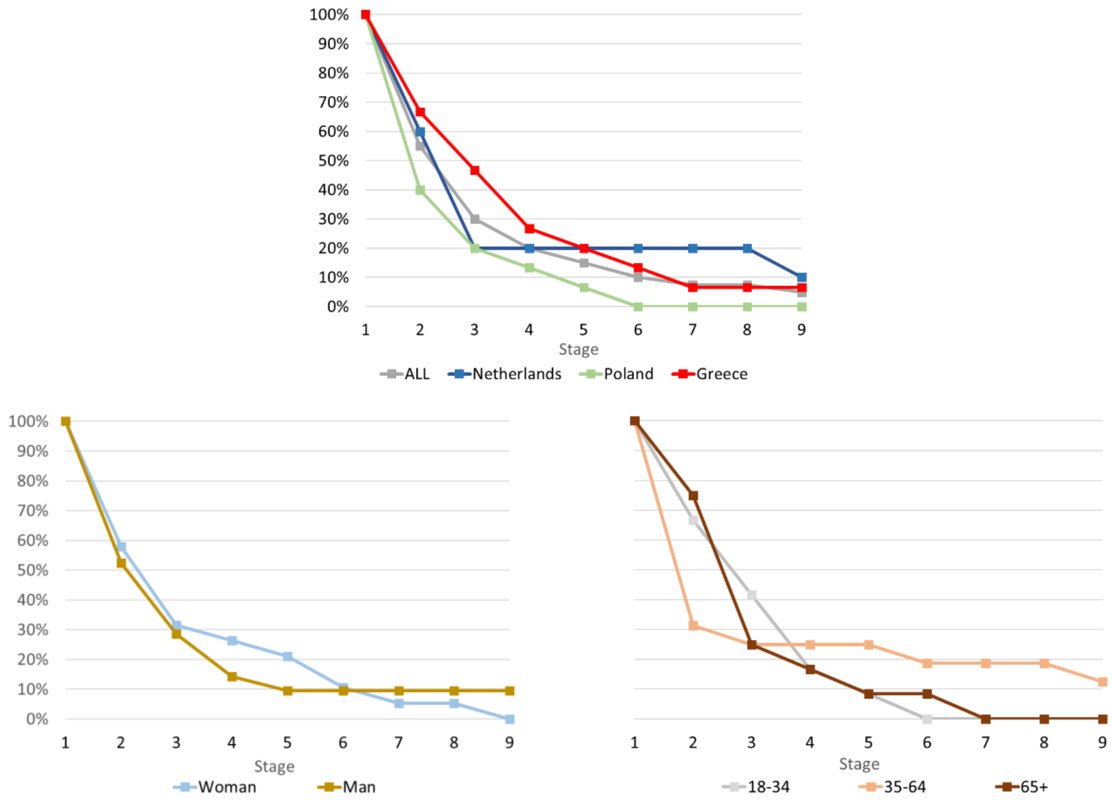


Figure 44. Virtual reality experiment – proportion of participants remaining in the car scenario, by stage, country, gender, and age

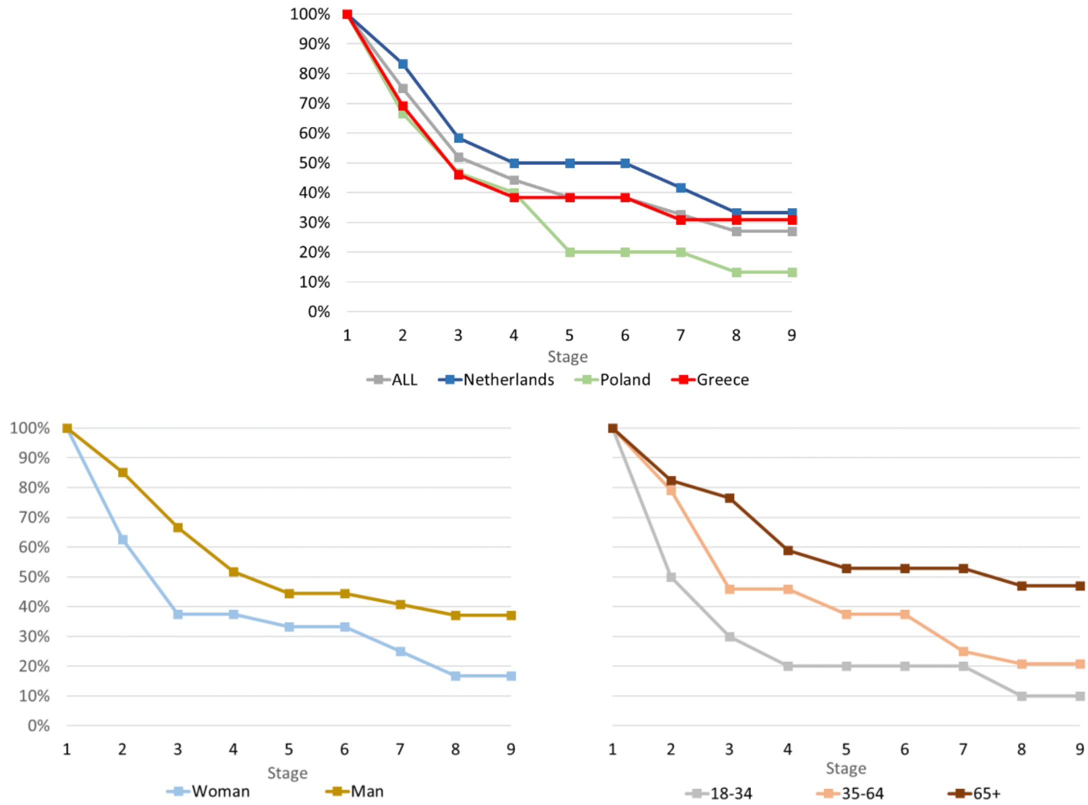


Figure 45. Virtual reality experiment – proportion of participants remaining in the bus scenario, by stage, country, gender, and age

4.7.3 Regret

28% of participants who switched regretted doing so, both in the case of the car and the bus (Figure 46). The proportion of those who regretted switching from bus to car was higher in Poland and among the 18-34 and 65+ age groups. The proportion who regretted switching from car to bus was zero in the Netherlands and lower than average among men and those aged above 65.

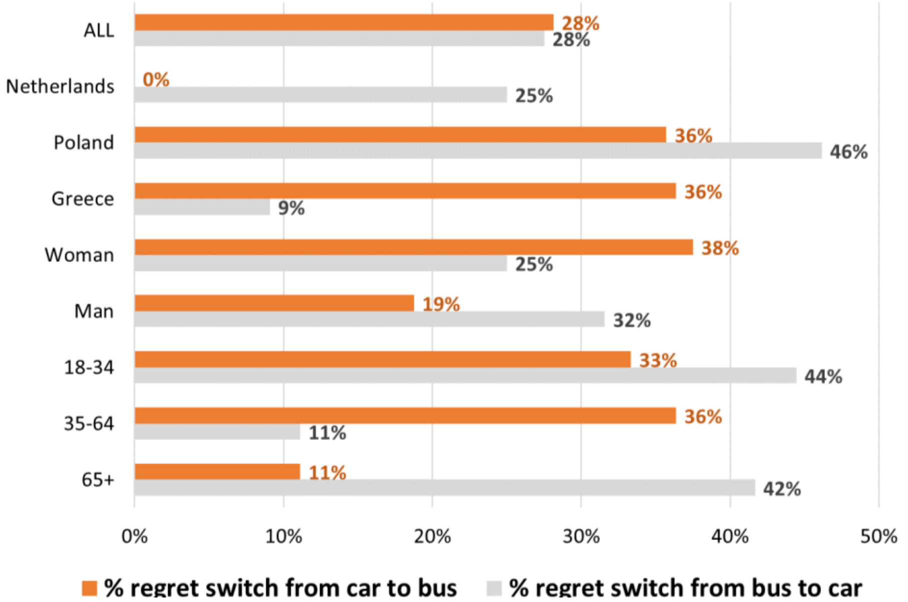


Figure 46. Virtual reality experiment – regret

We coded the reasons given for regretting. The main reasons to regret having switched from car to bus was that the car was slow (eight participants, i.e., 53% of those who regretted) and the ride was boring (three participants, i.e., 20%). The main reasons to regret having switched from bus to car were the unruly passenger behaviour (five participants, i.e., 42% of those who regretted) and the presence of other passengers in general (three participants, i.e., 25%)

4.7.4 Other choices

Figure 47 and Figure 48 show the choices participants made regarding the use of travel time, when prompted to do so immediately after the trip started. "Look around" was the most frequent choice. This is consistent with the responses participants gave in the pre-event questionnaire (compare with Figure 40). Choices were mostly consistent across the two modes and all genders and age groups. However, in the case of the bus, participants aged 18-34 had a considerably lower propensity to choose "look around" compared with others, instead choosing entertainment.

When prompted to choose what to do with the car at the end, two thirds of participants who ended the game in the car chose to send it back, and one third chose to park it nearby to use the following day. However, two thirds of participants aged 65+ chose to park nearby (in contrast with those aged 18-34 (89% chose to send the car back). The majority of Greek participants also chose to park nearby.

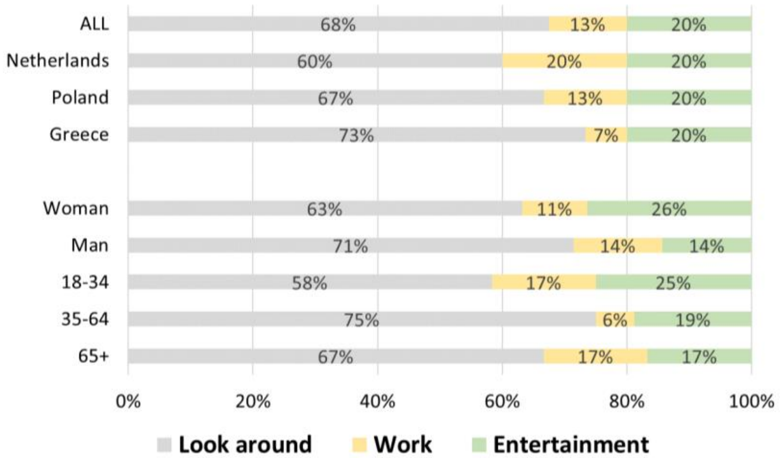


Figure 47. Choices for use of travel time (car)

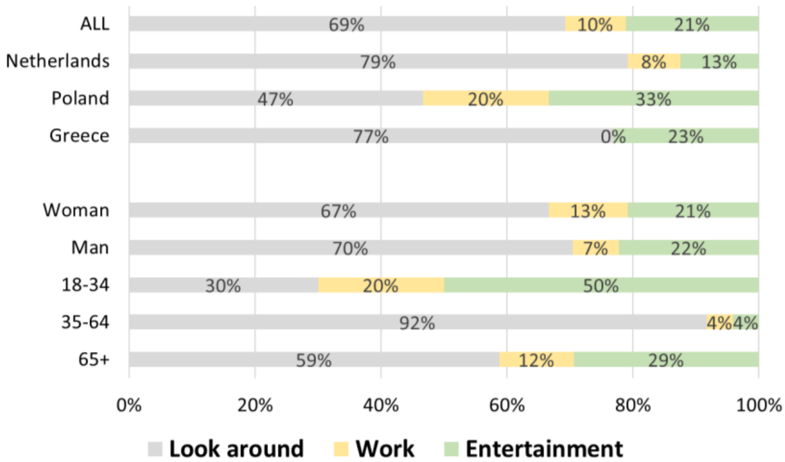


Figure 48. Choices for use of travel time (bus)

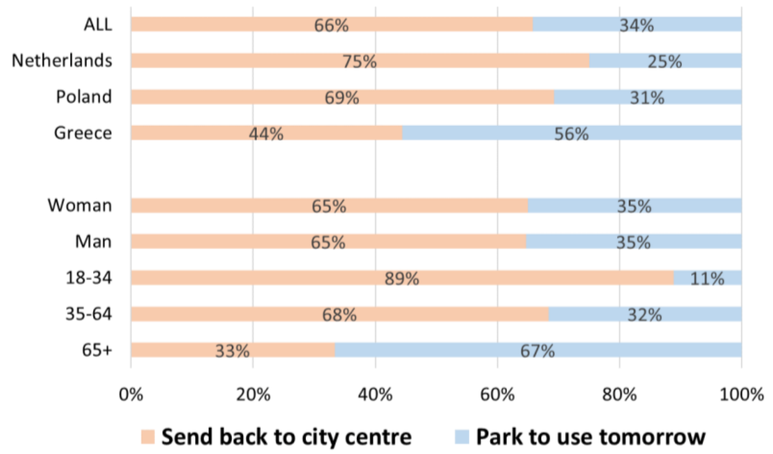


Figure 49. Choices for car return

4.8 EEG results

The following tables show the results of the analysis of EEG data, using the difference between the mean ratio between the beta high and alpha frequencies in each stage and in the baseline conditions (i.e. before the game). As mentioned, this is an indicator of arousal or stress. The tables show the differences of those mean ratios across the participants who experienced each stage of the car trip (Table 47) and each stage of the bus trip (Table 48). The stars in the tables identify the differences that are statistically significant, i.e. the cases when the mean ratios for a stage are significantly higher than the baseline ratios, based on t-tests. The analysis is split by gender and age.

In the car scenario (Table 47), only the Stage 7 difference is significant (at the 10% level), for the whole sample. This corresponds to the peak of congestion. No differences are significant for women, and the 35-64 age group. Men show significant differences in Stages 5 and 7 and the 18-34 group show significant differences in the last stage. The 65+ age group shows significant differences in all stages from Stage 2. This suggests a sustained state of stress/arousal. However, this result was based on data for less than 10 participants.

Table 47. EEG results: difference between beta-alpha ratio in car scenario stages and baseline, by gender and age

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	Centre	Industrial	Centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Congestion	No	Gets progressively worse						Eases up	No
Difference									
All	-0.03	-0.03	0.02	0.05	0.05	0.09	0.11*	0.03	0.08
Men	-0.08	0.00	0.05	0.08	0.08*	0.04	0.06*	0.02	0.06
Women	0.02	-0.05	-0.02	0.03	0.01	0.14	0.15	0.02	0.11
18-34	*-0.19*	*-0.15*	*-0.15*	*0.02*	*-0.02*	*0.08*	*0.08*	*0.07*	*0.09**
35-64	0.00	*-0.23*	-0.02	-0.11	-0.05	-0.07	0.00	-0.08	-0.03
65+	*0.09*	*0.33***	*0.41***	*0.41****	*0.27****	*0.36****	*0.33***	*0.16***	*0.29***

Notes: Values in *italics and smaller font* are based on less than 10 participants. Stars identify differences that are significantly positive, i.e. the ratio is significantly higher than the baseline ratio for the same group of participants, based on t-tests. Significance levels: ***: 1%, **: 5%, *:10%.

In the bus scenario, six of the nine stages show significant differences with the baseline, for the whole sample. In Stage 1, the difference is zero, i.e., the beta-alpha mean ratio is the same as in the baseline. The difference is statistically significant, and grows, during Stages 2-3 (when the bus is crowded) and Stage 4, when the bus crosses the derelict industrial area. It declines and becomes insignificant in Stage 5, when there are few passengers and the bus returns to the city centre. It then grows and becomes significant in Stages 6-8, when the anti-social passengers are in the bus. It reaches a peak in Stage 8, when the anti-social passengers have been in the bus for two stages and it is already night-time. It then decreases and becomes insignificant in the last stage, when the bus is quiet and there are no other passengers.

Men showed no significant differences with the baseline in any stage. In contrast, women show significant differences in all stages from Stage 2. The 35-64 age group shows no significant differences and the 18-34 group shows only one in Stage 2 (when the bus starts to be crowded). In contrast, the 65+ group show significant differences in all stages from Stage 3. For both women and the 65+ group, the differences grow when the bus is crowded (Stages 2-3) and then enters the derelict industrial area (Stage 4), decrease when the bus returns to the city centre (Stage 5), and then grow again when the anti-social passengers are in the bus (Stages 6-8), reaching a peak in Stage 8 when these passengers have been in the bus for two stages and is already night-time. The differences decline sharply when these passengers leave, and the bus is quiet, but remain significant (Stage 9).

Table 48. EEG results: difference between beta-alpha ratio in bus scenario stages and baseline, by gender and age

Attribute	Stages								
	1	2	3	4	5	6	7	8	9
Landscape	City centre			Industrial	City Centre	Industrial	City centre	Industrial	Residential
Time of day	Daytime		Gradually getting darker					Night-time	
Passengers	Few	Many		Few					None
Passenger behaviour	Mind their own business					Anti-social			No other passenger
Assistant	Present				Absent				
Difference									
All	0.00	0.07*	0.16**	0.19**	0.12	0.16*	0.15*	0.20*	0.09
Men	-0.01	0.00	0.13	0.15	0.09	0.12	0.08	0.08	0.06
Women	0.01	0.16**	0.22**	0.26**	0.18*	0.22**	0.28*	0.43**	0.15*
18-34	-0.02	0.13**	0.15	0.12	0.13	0.05	0.09	0.11	-0.05
35-64	-0.06	0.01	0.12	0.12	0.07	0.15*	-0.03	-0.03	0.03
65+	0.09	0.11	0.22**	0.31**	0.17	0.24**	0.37**	0.47**	0.21*

Notes: Stars identify differences that are significantly positive, i.e. the ratio is significantly higher than the baseline ratio for the same group of participants, based on a t-test. Significance levels: ***: 1%, **: 5%, *:10%.

4.9 Post-experiment questionnaire results

This section reports the main results of the post-experiment questionnaire, including the feelings stated by participants (Section 4.9.1), aspects they remembered or noticed in the scenarios (4.9.2), assessment of the realism of the scenarios (4.9.3), comparison between self-driving and human-driven cars and buses (4.9.4), intentions to use self-driving cars and buses (4.9.5) and intended changes in travel behaviour (4.9.6).

4.9.1 Feelings

Figure 50 compares the feelings reported by participants about their experience using the virtual bus and car. Most feelings were positive. More participants reported positive feelings regarding the bus and the car. The main feelings were of being content, safe, amused, and pleased. The main negative feeling was boredom in the car scenario, reported by 27% of those who tried that scenario.

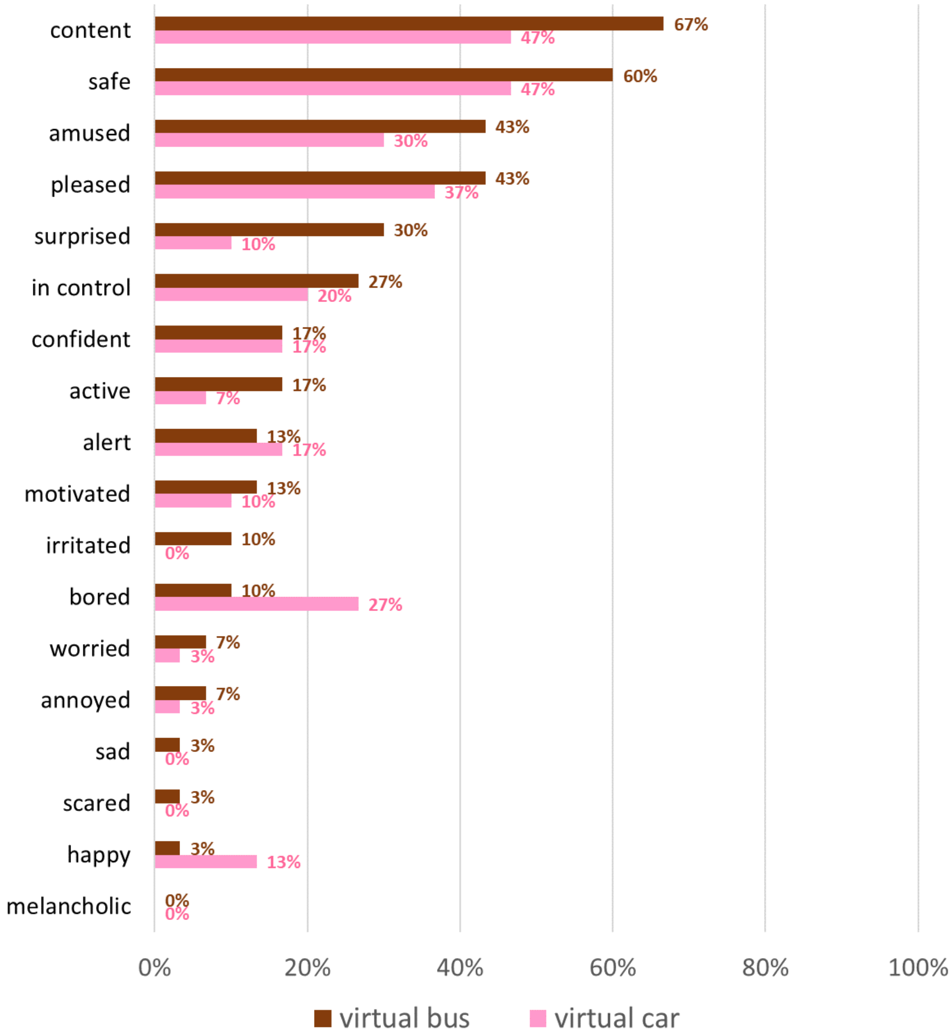
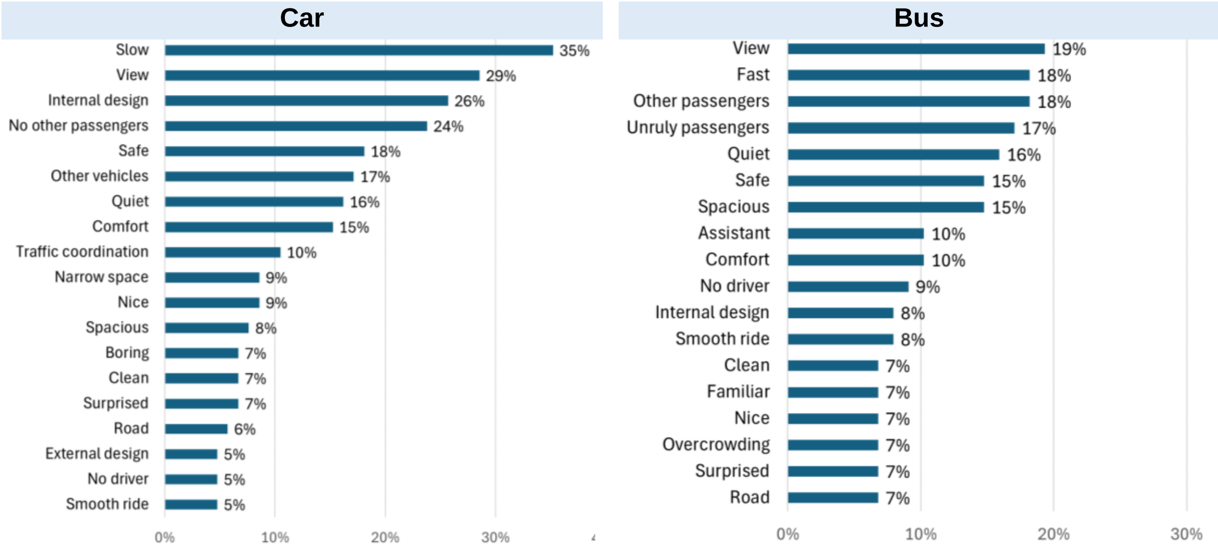


Figure 50. Feelings while riding in the virtual vs. real self-driving bus

4.9.2 Aspects participants remembered and noticed in scenarios

Participants stated, in open-ended questions, the three things they remembered about each trip. We coded all the answers. Figure 51 shows the results. The main things they remembered from the virtual car trip was that the car was slow (and slower than the bus), the view from the window, the internal design of the car, the absence of other passengers, being safe, the other vehicles on the road, and the fact that the car was quiet and comfortable.

The main things they remembered about the virtual bus trip were the view from the window, the fact that the bus was fast (and faster than the car), the presence of other passengers in general, the specific situation of the unruly passengers, and that the bus was quiet, safe, and spacious.



Note: Base is number of different aspects participants remembered about the bus (88) and car (105). Charts show only reasons given by more than 5 participants, i.e. 6% of bus aspects and 5% of car choices

Figure 51. Aspects participants remember from the scenarios

These results can be compared with those in Figure 52 and Figure 53, which show the changes that participants stated they noticed in the scenarios, after being shown a list of these changes. The majority or almost majority of participants stated that they noticed the changes listed for the car (Figure 52). About the same proportion noticed the changes in the speed of the vehicle they were in (i.e. the car) and those in the speed of the vehicle they were not (i.e. the bus). This is consistent with the results above (Figure 51), as speed (and its relationship with the bus) was the main aspect participants remembered about the car trip.

The majority or almost majority of participants stated that they noticed the changes listed for the bus (Figure 53). The main change noticed was in the number of passengers. Again, about the same proportion noticed the changes in the speed of the vehicle they were in (i.e. the bus) and those in the speed of the vehicle they were not (i.e. the car). More than half said that they noticed a change in the presence vs. absence of the human assistant. This compared with only 10% who said they remembered the assistant, as stated in the previous (open-ended) question (Figure 51).

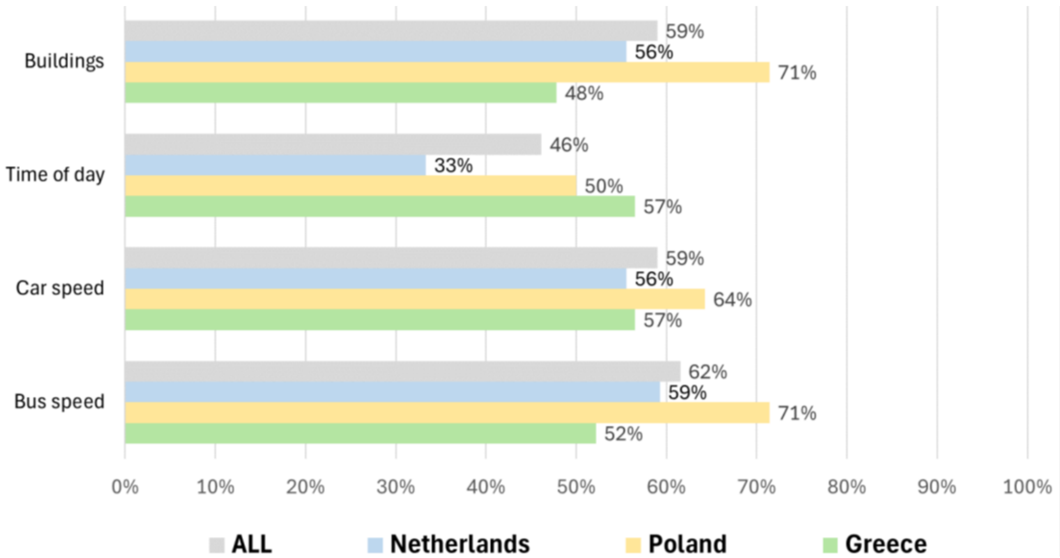


Figure 52. Aspects participants retained from virtual car

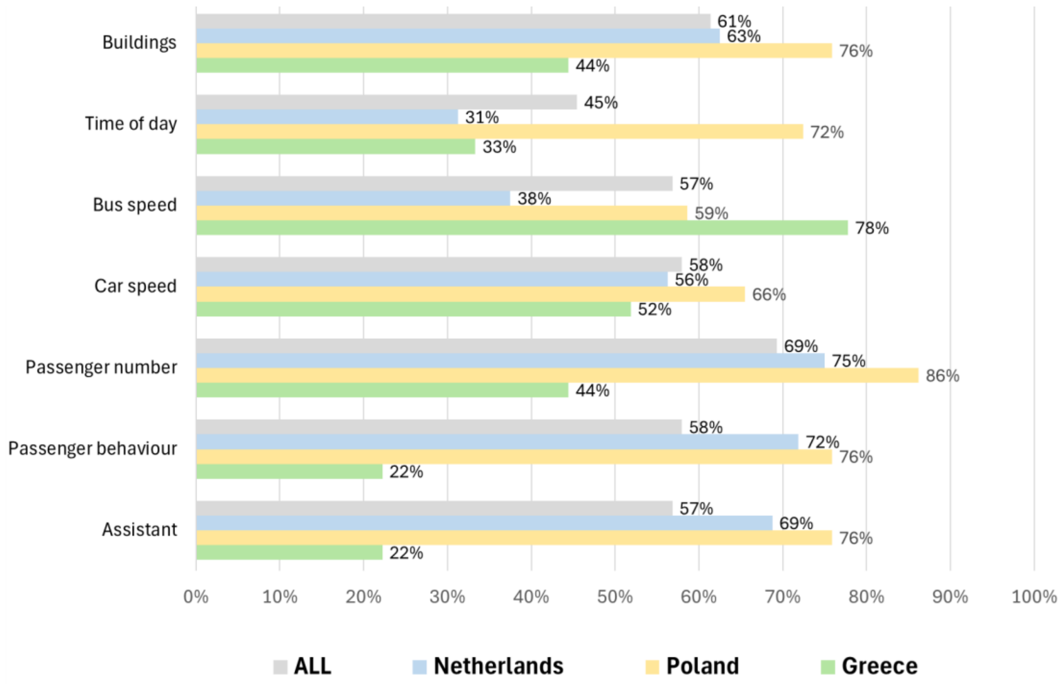


Figure 53. Aspects participants retained from virtual bus

4.9.3 Participant assessment on realism of scenarios

The majority of participants thought that both car and bus scenarios were realistic or very realistic (Figure 54). The main aspects people thought were not realistic (Figure 55) were, in the case of the car, the movement (e.g., slow, no lane change or overtaking, smooth movement and no breaking), the road (straight, with few intersections, and no potholes), the absence of pedestrians or cyclists, the buildings, and the ride (too short and quiet).

In the case of the bus, the main aspects thought to be unrealistic were the passengers (number, appearance, repetitive behaviour, and non-response), traffic (too harmonious, no unexpected situations, too many or too few vehicles), bus movement (fast and smooth), the ride (could not use phone, unclear if it was standing or seating), and the road (straight, signals always green).

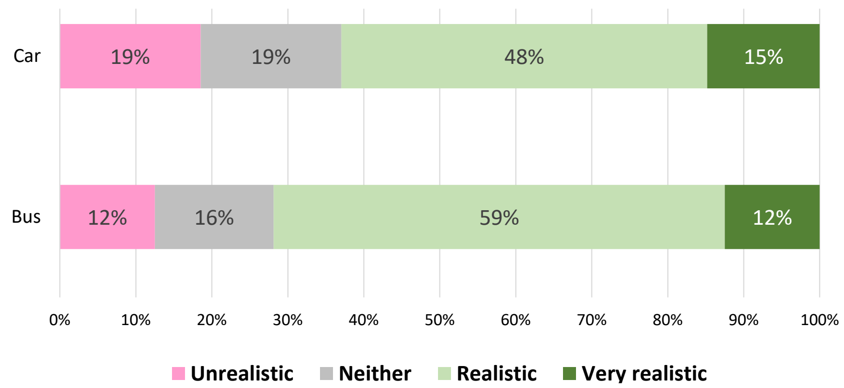
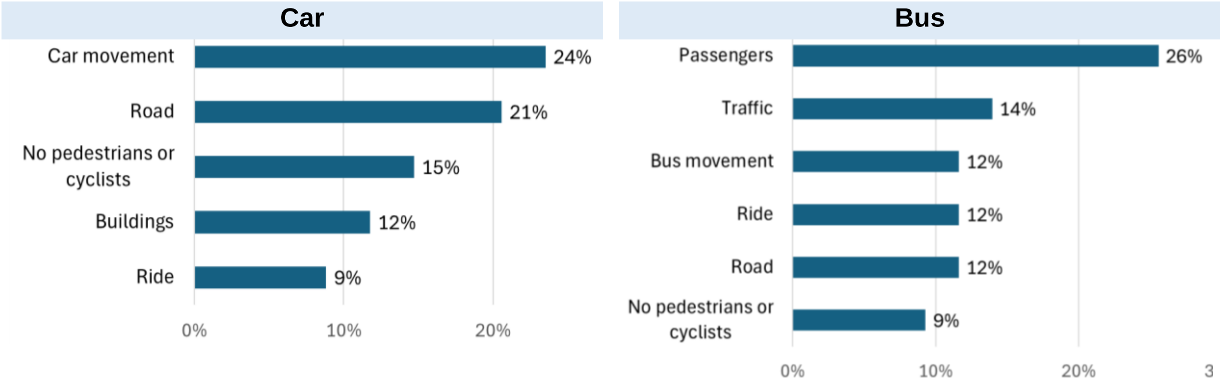


Figure 54. Participants' assessment of realism of virtual reality scenarios



Note: Base is number of different aspects participants thought were not realistic about the bus (43) and car (34). Charts show only reasons given by more than 3 participants, i.e. 7% of bus aspects and 9% of car choices

Figure 55. Aspects participants thought were not realistic

4.9.4 Assessment of self-driving vs. human-driven vehicles

Figure 56 shows how participants compare human and self-driven vehicles regarding interest, speed, cost, stress, comfort, safety (from collision) and security (from crime), after experiencing the two self-driving vehicles in virtual reality.

More participants thought that self-driving vehicles are more interesting (39%) than those who think that human-driven ones are more interesting (11%). This result is consistent across countries.

The sample is more balanced when it comes to speed, with a small advantage for self-driving (35% vs. 22%), but this is mostly derived from the opinion of the Greek participants. There is also a balance regarding which vehicles will be more stressful.

The majority of Poland and Netherlands participants think self-driving vehicles will be cheaper, safer, but also more insecure than human-driven ones. Opinions are different in Greece: the majority thinks human-driven vehicles are cheaper and is unsure about safety and security.

The majority of participants in Poland and Greece think self-driving vehicles are more comfortable, but most of those in the Netherlands are unsure.

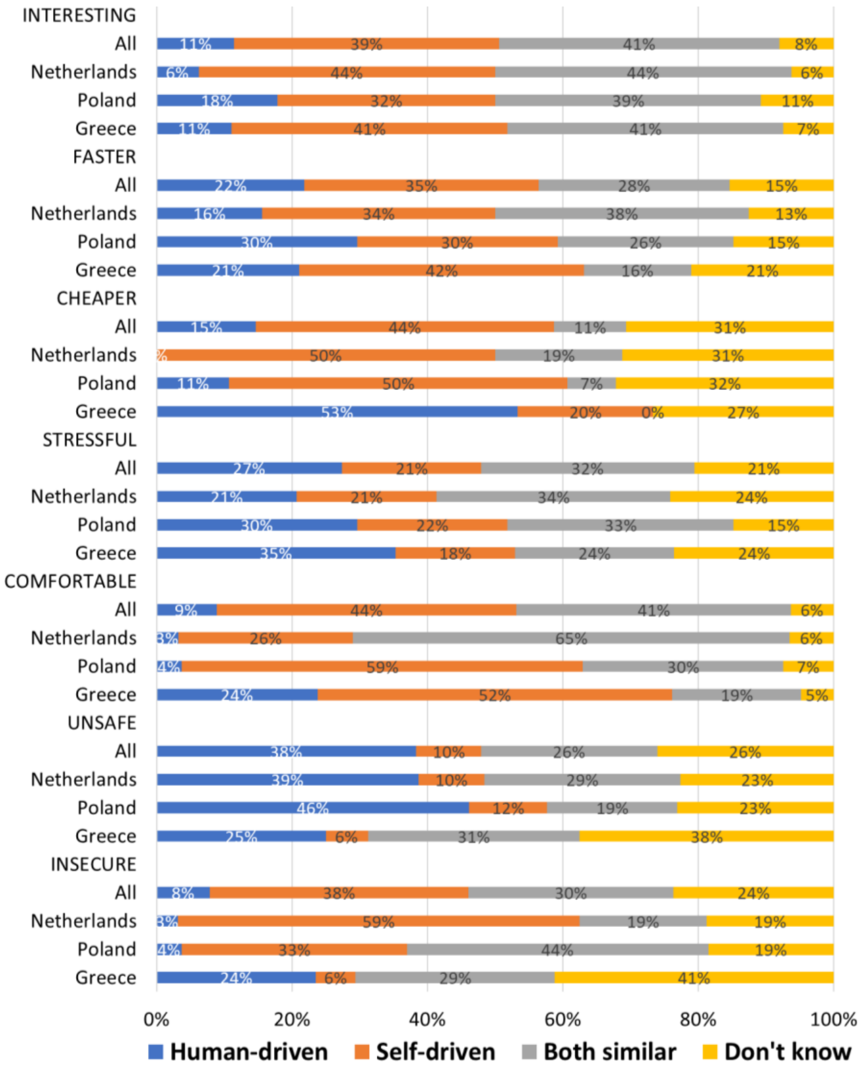


Figure 56. Comparison of self-driving and human-driven vehicles

4.9.5 Intention to use

Figure 57 compares the intentions to use self-driving cars and buses expressed after experiencing them in virtual reality and the previous intentions to use self-driving vehicles in general, expressed in the questionnaire answered before the event.

Overall, the intention to use self-driving vehicles increased markedly, from before the event (40% said they would use a self-driving vehicle) to after the event (58% said they would use a self-driving car and 70% said they would use a self-driving bus). The increase is higher in the Netherlands and Poland, as in Greece there was already a high proportion of positive intentions. In all countries, the stated propensity to use a self-driving bus is higher than the one to use a self-driving car. The increase in positive intentions comes mostly from the reduction of the number of participants who said they were unsure. The proportions who have negative intentions was residual before the event but remains residual (not eliminated).

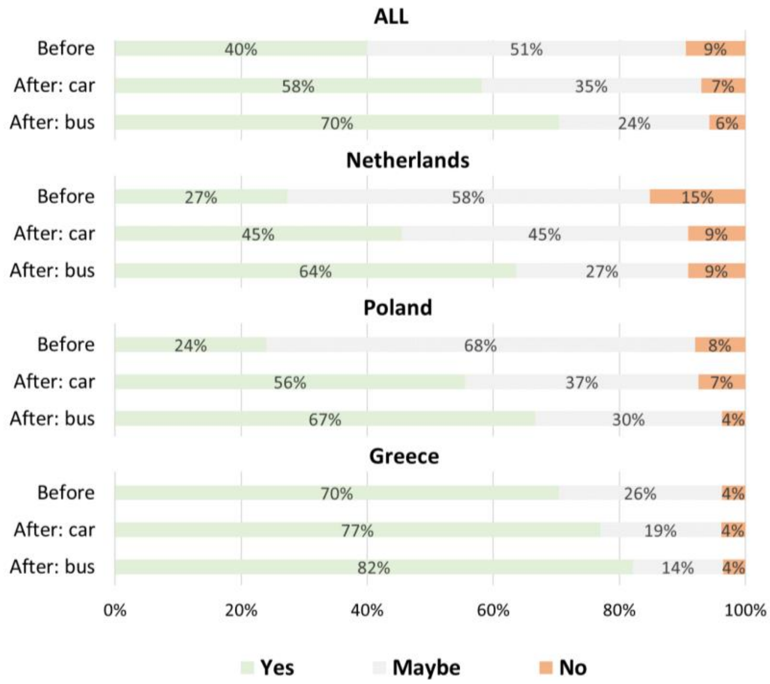


Figure 57. Intention to use self-driving vehicles before and after the experiment

4.9.6 Change in travel behaviour

Figure 58 shows participants' intentions to change travel behaviour after experiencing the self-driving car and bus in virtual reality. Overall, 46% and 51% said they would use the travel time for productive and leisure uses, respectively, if they could travel on a self-driving vehicle. The proportions for each county are in the same range as the proportions of participants reporting in the pre-event questionnaire that they would use travel time to work or for leisure uses such as watch videos (seen previously in Figure 40).

The majority in all countries said they would worry less about parking. One quarter of participants in all countries said they would travel by car more often, and 27% said they would travel by bus more often. 28% said they would travel more, regardless of mode.

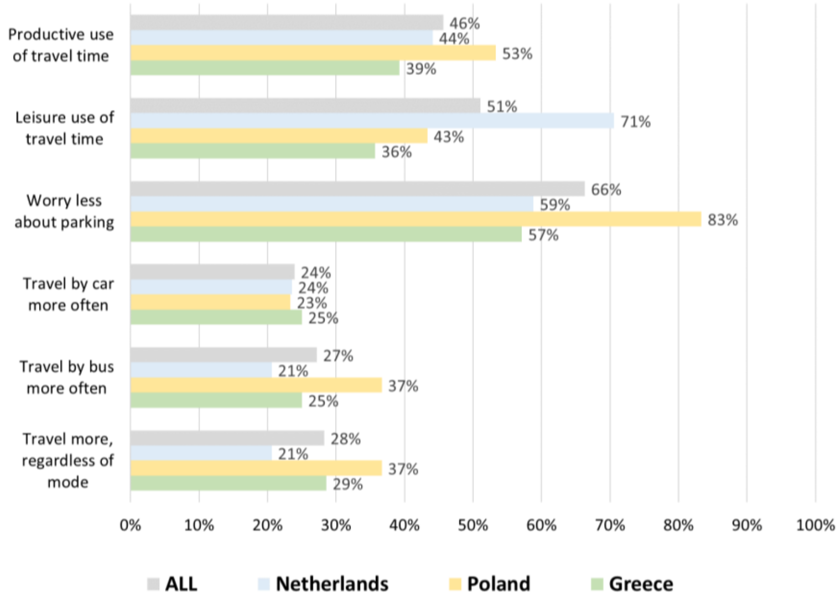


Figure 58. Intention to change travel behaviour

4.9.7 Relationships between opinions, intentions, choices, and participant characteristics

In this sub-section, we estimate how the participants' stated intentions to use self-driving cars and buses relate to their opinions about these vehicles, after experiencing them in virtual reality. We do this by comparing the intentions among participants who have a certain opinion and those who do not. The opinions examined are thinking that the self-driving vehicle is more interesting, slower, cheaper, more stressful, more comfortable, safer, and more insecure. We test whether the proportion of participants stating they will use the vehicle differs among the two groups of participants, using the chi-square test of proportions.

Table 31 shows the results. Intentions to use a self-driving car are significantly higher among those who think this vehicle is less stressful, more comfortable, and safer than a human-driven car. Intentions to use a self-driving bus are only significantly related to one opinion: thinking self-driving vehicles will be more secure.

Table 49. Proportion of sample intending to use vehicles, by opinion

	Intends to use vehicle	
	Car	Bus
All	54	67
Less interesting	49	66
More interesting	64	71
Faster	54	68
Slower	55	65
More expensive	54	68
Cheaper	55	67
Less stressful	60**	70
More stressful	27	53
Less comfortable	45	61
More comfortable	64*	77
Less safe	48	66
Safer	70**	71
More secure	56	73**
Insecure	43	55

Notes: Significance levels refer to the differences in intentions, or opinions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: ***%, **5%, *10

We now estimate how the stated opinions and intentions to use the vehicles relate to the participant characteristics and to the choices they make in the virtual reality game. We also estimate how the choices made in the game relate to participant characteristics.

To have reasonable sample sizes for each combination of opinions and participant groups, we reclassified the variables that measure participant characteristics as binary variables. The variables included in the analysis are:

- **Virtual reality choice** (initial choice): car vs. bus
- **Gender**: men vs. women
- **Age**: 18-34, 35-64, 65+
- **Education**: no university degree vs. university degree
- **Household composition**: no children in household vs. children in household

- **Disability affecting mobility*:*** no vs. yes
- **Situation regarding driving**: Can vs. cannot (because of no driving licence, no car, or a health problem)
- **Attitude towards driving*:*** Drives and enjoys it vs. does not drive or drives but does not enjoy it
- **Bus use:** no vs. yes
- **Awareness of self-driving vehicles**: aware but not following developments vs. not aware vs. aware and following developments
- **Previous intention to use self-driving vehicles** (expressed in the pre-event questionnaire): no vs. yes
- **Activity done first on the day** (for Netherlands participants only) demonstration vs. virtual reality

Other variables were tested but proved to always be insignificantly related to opinions and intentions. These include employment status, residence location (urban vs rural), frequency of travelling for shopping and leisure, and previous concerns with self-driving vehicles (as reported in the pre-event questionnaire). Results for these variables are not shown in the analysis that follows.

Table 32 shows the results for the self-driving car. As expected, the propensity to choose the car in the initial choice of the virtual reality game is significantly higher for participants who drive and enjoy doing it, and the intention to use a self-driving car after the virtual reality experiment is higher for those who already had that intention before the event. The older age group and participants in the Netherlands who joined the virtual reality experiment before seeing the real self-driving vehicles in the demonstration also have more positive intentions to buy a self-driving car.

The propensity to think self-driving cars are more interesting than human-driven ones is higher for those who chose the car in the game, those more aware of self-driving vehicles, had a previous intention to use them, and joined the virtual reality experiment before the demonstration.

The propensity to think self-driving cars are slower is higher among participants with a university degree, who cannot drive, use buses, had no previous intentions to use self-driving vehicles, and joined the virtual reality experiment before the demonstration.

The propensity to think self-driving cars are cheaper is higher among participants with a disability affecting mobility and those who use buses. “More stressful” is related to the 25-64 age group and those who use buses and “more comfortable” is related to university degrees and disability. “Safer” is only related to university degrees and “more insecure” only to the use of buses.

Table 50. Preferences and opinions about self-driving car, by sample segments (%)

	Car choice in game	Intends to use self-driving car in future	Opinion of self-driving car (vs. human-driven)						
			More Interesting	Slower	Cheaper	More stressful	More comfortable	Safer	More insecure
ALL	40	54	36	32	24	16	49	29	15
Car choice in game		59	57***	38	24	14	57	35	22
Bus choice in game		51	22	27	24	18	44	25	11
Man	40	52	35	25	23	15	48	29	15
Woman	42	56	37	37	23	19	49	28	14
Age:18-34	55	45	36	45	23	9	55	36	14
Age: 35-64	38	48	35	28	23	25**	48	25	18
Age: 65+	34	69*	38	24	24	10	45	28	10
No university degree	43	52	30	20	20	16	39	20	18
University degree	38	56	42	42**	27	17	58*	38*	13
No children in household	40	58	40	38*	27	18	52	32	12
Children in household	41	47	28	19	19	13	44	25	22
No disability	39	51	36	30	20	14	45	26	16
Disability	44	69	38	38	44**	25	69*	44	13
Can not drive	32	59	23	55***	32	9	45	27	5
Can drive	43	53	40	24	21	19	50	30	19
Does not drive or enjoy it	33	56	35	33	21	17	48	31	12
Drives and enjoy it	50*	53	38	30	28	15	50	28	20
Does not use bus	38	58	33	24	17	11	45	26	11
Uses bus	46	46	42	50**	42***	31**	58	38	27**
Not following or not aware	32	52	26	34	24	20	42	26	14
Aware and following	50	57	48**	29	24	12	57	33	17
No previous intention	43	43	29	38*	19	19	47	31	16
Previous intention to use	35	74***	47*	21	32	12	53	26	15
First: demonstration	18	35	24	35	29	18	41	35	24
First: virtual reality	41	53*	53*	12	18	6	59	29	6

Notes: Significance levels refer to the differences in preferences, intentions, or opinions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: ***%, **5%, *10%

Table 51 shows the results for the self-driving bus. The propensity to choose the bus in the initial choice of the virtual reality game is significantly higher for participants who do not drive or do not enjoy doing it and those not following developments or not aware of self-driving vehicles. Intention to use a self-driving bus is only related to one variable: not having children in the household.

The propensity to think self-driving buses are more interesting is higher among those who chose the car as their initial choice in the game and those who use buses, and lower among the older age group. Participants who use buses are also more likely to think self-driving buses will be slower and more stressful than human-driven ones. Those who are more aware of self-driving vehicles are also more likely to think they will be more stressful.

Participants with a disability and who drive and enjoy it are more likely to think self-driving buses will be more comfortable. Participants in the 65+ age group are less likely to think self-driving buses will be safer and more likely to think they will be more insecure. Those with previous intention to use a self-driving vehicle also think they are more insecure. There are no variables significant related to comparisons in terms of cost.

Table 51. Preferences and opinions about self-driving bus by sample segments (%)

	Bus choice in game	Intends to use self-driving car in future	Opinion of self-driving bus (vs. human-driven)						
			More Interesting	Slower	Cheaper	More stressful	More comfortable	Safer	More insecure
ALL	60	37	18	36	16	38	30	32	67
Car choice in game		41	27*	35	22	43	38	35	68
Bus choice in game		35	13	36	13	35	25	29	67
Man	60	38	19	42	15	31	31	31	65
Woman	58	37	16	28	16	47	28	30	70
Age:18-34	45	36	23	36	9	45	27	32	59
Age: 35-64	63	43	23	38	23	38	25	40	60
Age: 65+	66	31	7+	31	10	34	38	17+	83**
No university degree	57	41	16	27	23	30	27	34	64
University degree	63	33	21	44	10	46	33	29	71
No children in household	60	43*	20	38	18	38	33	27	68
Children in household	59	25	16	31	13	38	25	41	66
No disability	61	38	20	34	14	36	25	30	67
Disability	56	31	13	44	25	50	56**	38	69
Can not drive	68	23	23	50	14	45	23	27	77
Can drive	57	41	17	31	17	36	33	33	64
Does not drive or enjoy it	67*	42	21	37	19	42	21	27	69
Drives and enjoy it	50	30	15	35	13	33	43**	38	65
Does not use bus	62	32	14	29	17	32	30	32	70
Uses bus	54	50	31*	54**	15	54**	31	31	62
Not following or not aware	68*	38	18	36	18	28	28	26	62
Aware and following	50	36	19	36	14	50**	33	38	74
No previous intention	57	40	22	40	19	34	29	31	60
Previous intention to use	65	32	12	29	12	44	32	32	79*
First: demonstration	82	41	18	47	12	35	47	65	53
First: virtual reality	59	41	12	47	24	12	24	47	71

Note: Significance levels refer to the differences in preferences, opinions, or intentions between a group and its counterpart. The proportion of the group identified with stars is significantly higher than the counterpart group. Levels of significance: ***%, **5%, *10%. The proportion of the group identified with + is significantly lower than the counterpart group (at 10% level).

4.9.8 Relationships between virtual reality and vehicle demonstration

The previous section showed that the order of the events for the participants in the Netherlands, (who joined both virtual reality and the vehicle demonstration) is significantly related to some of the results of the virtual reality questionnaire. Previously, the chapter on the demonstration (Section 3.4.8) also showed that the order of events was related to the results of the demonstration questionnaire.

This section compares results of the two events, for questions that were identical to both: "likes" and "dislikes", reported feelings, comparisons between self-driving and human-driven vehicles, and intentions to use self-driving vehicles.

Participants were asked what they liked in one experience and disliked in the other. The main aspect participants liked in the virtual bus was the space inside the bus, mentioned by nine participants, i.e. 32% of the Netherlands sample. The main aspect they liked in the real bus was human interaction (four participants, i.e. 14%).

Figure 59 compares feelings participants reported for the two activities, focusing on the only vehicle common to both: a self-driving bus. In the demonstration (an experience of a real self-driving bus), higher proportions reported feeling surprised, in control, motivated and, to a lesser degree, safe). In the virtual reality experiment (an experience of a virtual self-driving bus), higher proportions reported feeling pleased.

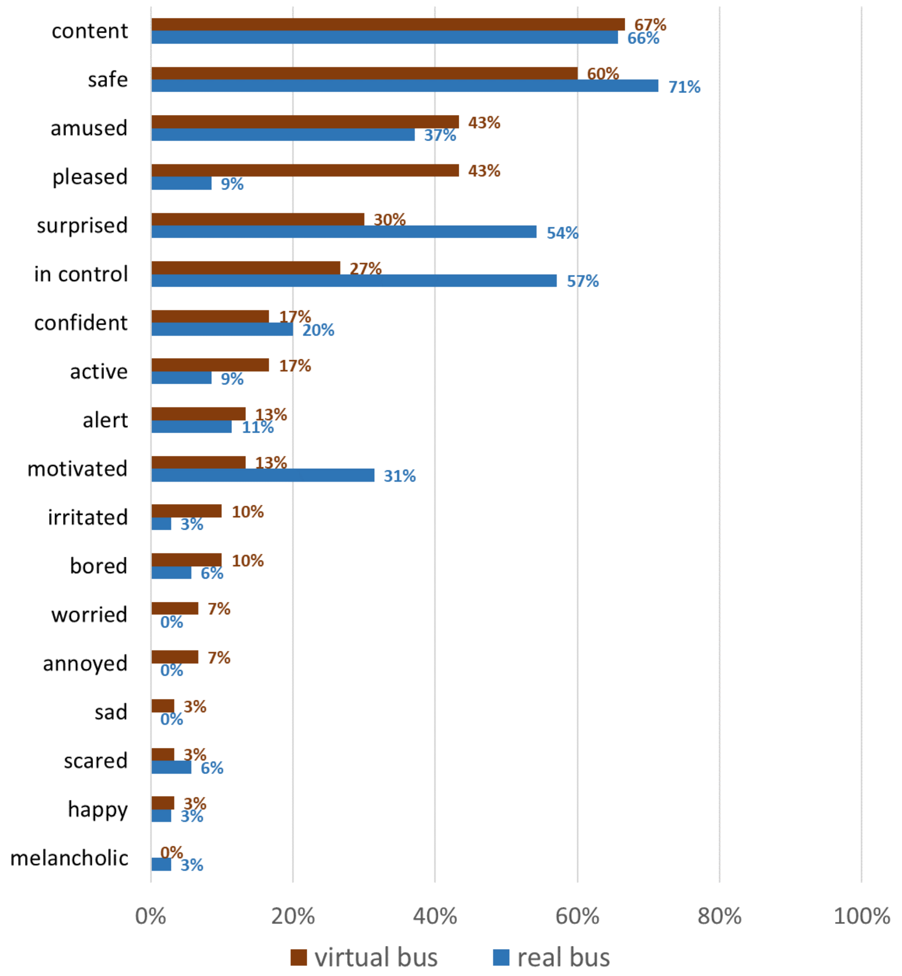


Figure 59. Virtual vs. real bus: feelings

Figure 60 compares the assessments of self-driving buses versus self-driven ones. The results are broadly similar. The main difference is that higher proportions thought that self-driving buses are faster when experiencing them in virtual reality. This result is as expected, since the virtual bus was designed to be faster than the virtual car, and the real self-driving bus moved slowly to reassure to participants that the vehicle was safe.

Higher proportions think the self-driving bus is more comfortable than a human-driven one when experiencing a self-driving bus, compared with experiencing it in virtual reality.

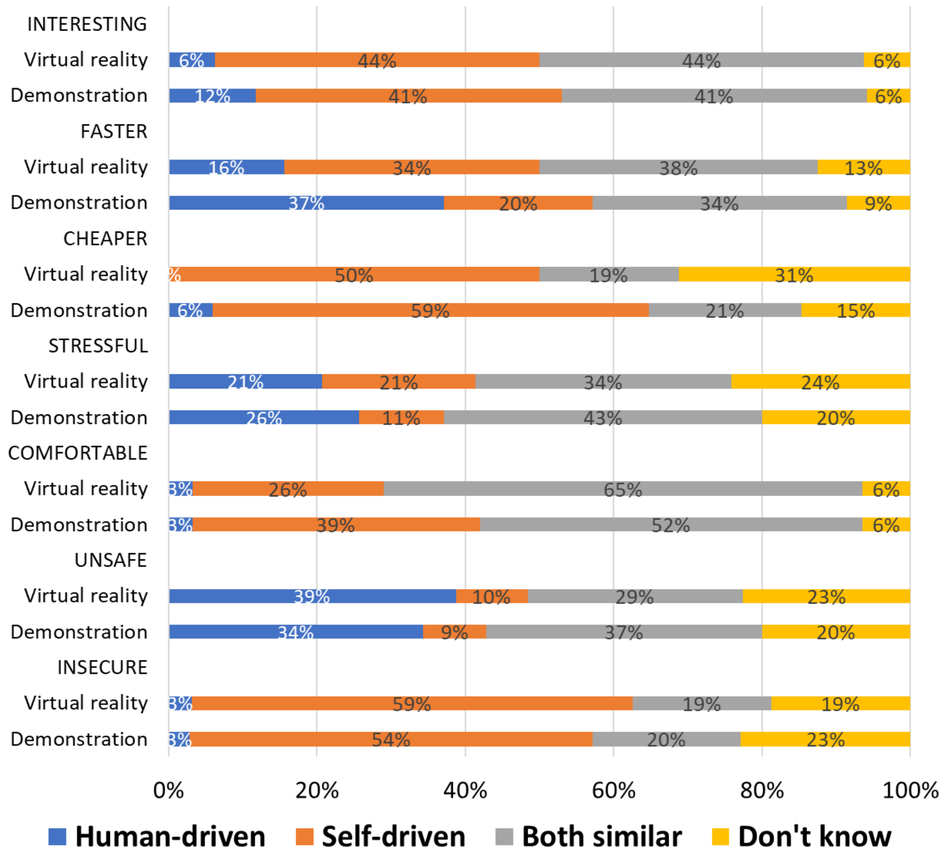


Figure 60. Virtual vs. real bus: vehicle comparison

Figure 61 compares intentions to use self-driving buses. Participants stated their intention before joining both events. They also stated their intention after the virtual reality and after the demonstration. In the last two cases, the results can be split according to sequence, i.e. which event participants joined first.

Positive intentions always grow, when compared with prior ones (i.e. before both events). Participation in the demonstration slightly reduce intentions because:

- Joining only the virtual reality produces slightly more positive intentions (71%) than joining only the demonstration (65%)
- Joining the virtual reality and then the demonstration produces more positive intentions (76%) than joining only the demonstration (65%)
- In contrast, joining the demonstration and then the virtual reality produces fewer positive intentions (56%) than joining only the virtual reality (71%)

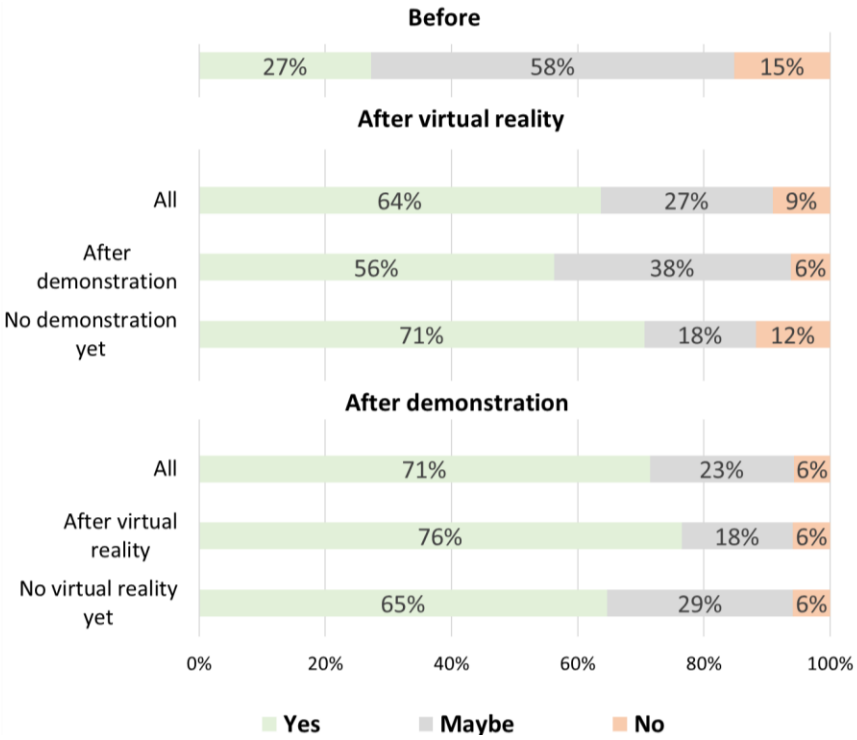


Figure 61. Virtual vs. real bus intentions to use bus

4.10 Group discussion results

4.10.1 Overview

24 group discussions were held, lasting about 20 minutes each, i.e., a total of eight hours of discussions. Twenty of the groups had four participants, four had three participants. Each discussion was structured into eight steps. At the start of each step, the moderator showed one image from the games. The images are described in sub-section 4.4.6 and shown in Appendix 6.

Notes were taken during the discussions on each participant intervention, also identifying their participant ID number. The discussion in all groups was translated into English by project partners in the three countries. ID numbers were then matched to the data on participant characteristics by researchers at University College London. Partners in the three countries did not have access to this file. This procedure ensured anonymity of participants. Two participant characteristics were retained for further analysis of the data from the discussion groups: gender and age.

The interventions of all participants were classified into a database of statements, identifying the main point made (standardized into general categories as the analysis proceeded) and also the vehicle they refer to, in the case of the discussions on external design, internal design, and view, as they were about comparisons of the two vehicles. Comments that applied to both vehicles or were more general (e.g. about the view, the road, or the overall realism of the scenarios) were coded separately. The left side of Table 52 shows statistics of the database of statements and the right side of Table 52 shows the total number of words. The discussions were longer in Poland, followed by Netherlands, and Greece. They focused more on the bus than on the car.

The translated noted from the discussion groups included a total of 15,361 words, i.e. an average of 179 words per participant. Table 53 shows the distribution of those words. The longest discussions were about the human assistant. In Poland there were also long discussions about the internal design of the bus and the unruly passengers with anti-social behaviour.

Table 52: Virtual reality post-experiment discussion – statements and words

Image		Statements			Words		
		Netherlands	Poland	Greece	Netherlands	Poland	Greece
1	External design	61	60	33	804	823	205
2	Internal design	35	89	30	522	1770	216
3	View	81	66	30	803	641	202
4	Car: slower than bus	40	38	23	662	522	230
4	Bus: crowded	30	41	23	487	667	142
6	Bus: Human assistant	50	71	34	1022	1118	212
7	Bus: Unruly passengers	27	49	22	377	1007	151
8	Bus: Empty	20	34	22	279	566	80
Final discussion		29	62	0	480	1373	0
Total car		93	111	39	1584	1958	376
Total bus		191	285	119	2973	5067	705
Total general		89	114	59	879	1462	357
Total		373	510	217	5436	8487	1438

Table 53: Virtual reality post-experiment discussion – words by participant

Image			Netherlands	Poland	Greece	Men	Women	18-34	35-64	65+
1	Car	External design	13	16	2	10	12	10	8	16
	Bus		10	9	3	8	6	5	10	5
2	Car	Internal design	9	15	4	10	10	5	12	10
	Bus		6	39	3	16	17	7	15	26
3	Car	View	1	2	0	1	1	0	1	1
	Bus		3	4	0	2	4	2	3	3
4	Car	Slower than bus	19	17	10	15	15	15	19	10
5	Bus	Crowded	14	22	6	11	19	10	13	21
6	Bus	Human assistant	30	37	10	25	28	24	28	26
7	Bus	Unruly passengers	11	34	7	17	16	11	19	17
8	Bus	Empty	8	19	4	8	13	9	10	12
General			36	69	16	41	41	29	43	47
All words per participant			**160**	**283**	**65**	**163**	**183**	**127**	**183**	**195**

Sub-sections 4.10.2 and 4.10.3 are an overview of all discussions about the car and the bus. The following eight sub-sections then analyse the results for each of the eight topics discussed. In these sections, we first show representative quotes from the participants' statements. We also use word clouds as a quick way to capture the main topics discussed. The word clouds show the 50 most common words in the discussion, after excluding the objects of discussion (e.g. "car", "bus") and words expressing an opinion (e.g., "think", "feel"). We then show the most common statements made, the proportion they represent in all statements, and the group who made that statement more frequently (if the difference with the frequencies for other groups are considerable), by country, gender, and age. We show only statements made at least five times.

4.10.2 Virtual car

The discussions about the virtual car, across all eight topics are synthesised in Figure 62. A large part of the discussions was about speed, especially the fact that the bus was moving faster than the car ("faster", "speed") and associated intentions to switch or not to the bus ("switch", "change" "wanted", "reason"). There were also discussions about how vehicle looked like ("vehicle", "design", "minimalistic") and how comfortable it was ("comfortable", "sit", "seats"), as well as comparisons both with the virtual bus and with real-life conventional cars ("compared", "different", "better", "driver", "driving"). The absence of other passengers was also noticed ("passengers", "people"). Participants also reflected on their experience ("experience", "curiosity").

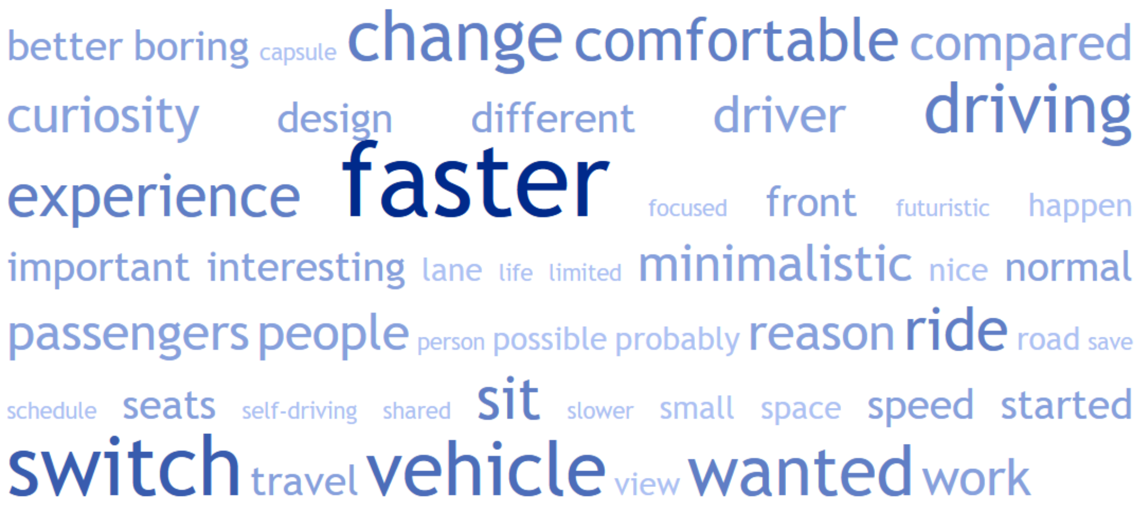


Figure 62. Word cloud of discussions about the virtual car

4.10.3 Virtual bus

The discussions about the virtual bus, across all eight topics, are synthesised in Figure 63. The main topics were about the other passengers ("passengers", "people", "person") and the human assistant ("assistant", "steward", "security"). Passengers also discussed how comfortable it was to use the bus ("seats", "sit", "stops") and what to do in case of unexpected events ("emergency", "situation", "someone"), and specific situations such as being alone in the bus at the end ("alone", "empty") Reasons to switch or not to the car were discussed ("switch", "change", "reason"), as well as comparisons with the virtual car and with real-life conventional buses ("difference", "driver").

Figure 63. Word cloud of discussions about the virtual bus

4.10.4 External design

"*The car looks from the 90s (Back To the Future)*" – Poland, Man, 18-34

"*It looks like a normal bus, but without driver. I miss the place where the driver sits in the normal bus.*" – Netherlands, Man, 18-34

Figure 64 shows the most common words used to talk about the vehicles' external design. Participants compared both virtual vehicles and each of them with their conventional counterparts ("better", "compared", "difference", "driver"). They also gave their opinions about the vehicles ("vehicle", "design", "beautiful", "clean", "comfortable", "futuristic", "modern", "nice", "normal", "regular", "seats") and how virtual reality portrayed them ("realistic").

Table 54 shows the most common statements. The car was perceived as futuristic (or "modern") and minimalistic (i.e. with few noticeable features), while the bus was perceived as familiar, i.e., similar to the conventional buses participants use or see in their regions, only without a steering wheel. Both vehicles were assessed as having a "sleek design". All these statements were more common among men.

Figure 64. Word cloud of discussions about the vehicles' external design

Table 54: Most common statements in discussions about the vehicles' external design

Statement	Frequency	% of discussions about vehicle(s)	Most common		
			Country	Gender	Age
CAR					
Futuristic	11	17%	Poland	Men	35-64 and 65+
Minimalistic	8	12%	Netherlands	Men	35-64 and 65+
BUS					
Familiar	24	38%	Poland	Men	35-64
Both					
Sleek design	7	28%	Greece	Men	18-34

4.10.5 Internal design

"Oddly enough, we sit facing each other [in the car]*, not just facing forward. Like in tour buses, around a table"* – Poland, Woman, 35-64

"A lot of standing places in the bus and just a few seats" – Netherlands, Man, 65+

Figure 65 shows the most common words used to talk about the vehicles' internal design. Participants assessed the quality of the vehicles ("nice", "clean", "pretty", "comfortable", "discomfort", "passengers", "people") and seating arrangements ("design", "arrangement", "placed", "seats", "sit", "small", "space", "spacious", "spaciousness"), including the fact that the car had seats in both directions ("backwards", "forward") and the bus had sideway seats in front of each other ("sideways", "front") . Participants noticed some aspects that were not realistic in the virtual reality, including the absence of some features (e.g., "lack", "missing", "minimalistic", "belts"). Participants also compared the two virtual self-driving vehicles, and each of these with their conventional counterparts in the real world ("different", "driver", "driving").

Table 55 shows the most common statements. The most frequent ones, for the car, were the seating arrangement (with some seats backwards to traffic) and the fact that the design was minimalistic, without features participants were expecting to find in a self-driving vehicle for passengers to use their time (e.g. devices). For the car, the most frequent statement was the lack of enough seats and the seating arrangement (with seats facing each other). A common statement for both vehicles was that they seemed comfortable. The statements about seating arrangement (both in the car and the bus) were more common among men.

Figure 65. Word cloud of discussions about the vehicles' internal design

Table 55: Most common statements in discussions about the vehicles' internal design

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
CAR					
Seats backwards to traffic	5	11%	Netherlands, Poland	Men	-
Minimalistic, no facilities	5	11%	Netherlands, Poland	-	35-64
BUS					
Few seats	10	14%	Poland	Women	-
Seats facing each other	6	8%	Poland	Men	35-64
BOTH					
Comfortable	9	24%	Greece, Poland	-	-

4.10.6 View

"It became darker outside very quickly" – Netherlands, Woman, 35-64

"*I was stressed that I was driving without a driver, I did not look around the sides (I did not see the factory, graffiti), I was even a little scared*", Poland, Woman, 35-64

"In the car, I looked little around, 40 years of driving experience causes one to look ahead of the road – Poland, Man, 65+

The discussions about the view from the vehicles (Figure 66) centred on whether participants looked outside or inside the vehicle and what they noticed outside ("around", "attention", "environment", "looked", "outside", "road", "street", "surroundings", "vehicle", "view"), compared with conventional vehicles ("driving"). Many talked about the changes ("changes", "different"), in land use ("urban", "city", "buildings"), traffic ("traffic") and time of day ("daytime", "lights", "night"). They also gave opinions about the scenes ("nice", "interesting", "boring"), identifying what they missed in them ("pedestrians", "people"), and assessing their realism ("realistic", "straight" (road)).

The most common statement was that participants looked mostly outside, not inside (Table 56). Other common statements were that they noticed the change in time of day and that the road was straight (with mentions that this was not realistic), and that the view was monotonous (i.e., not enough diversity in buildings and road infrastructure). All these statements were more common among the 35-64 group.

Figure 66. Word cloud of discussions about the view

Table 56: Most common statements in discussions about the view

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
BOTH					
Looked mostly outside, not inside	20	13%	Netherlands	Men	35-64
Noticed change in time of day	10	8%	Netherlands, Poland	-	35-64
Road was straight	10	7%	Netherlands	Men	-
Monotonous view	9	7%	Netherlands	-	35-64

4.10.7 Car slower than bus

"Seeing the faster bus, I thought about taking the bus; I wanted to go faster from the beginning and even wanted to go faster by car" – Poland, Woman, 35-64

"The b*us was faster but not as fast as in everyday life; the thought of changing to a bus for this reason did not come up*" – Poland, Woman, 18-34

"*Time is less important. Work could be done during the ride. If you are focused on your work, you don't notice it is faster or slower*" Netherlands, Woman, 35-64

The discussion about congestion affecting the car trip (Figure 67) focused on whether participants noticed that the bus was faster or not ("faster", "slower", "speed", "schedule", "started", "ride"), and whether that was a reason to switch to the bus ("switch", "change", "wanted", "reason", "transfer", "important"). Opinions were split between those who noticed and those who did not, and those who wanted to switch and those who did not (Table 57). Some of those who wanted to switch mentioned time as the most important consideration for them. Some of those who did not want to switch noted that they could use time spent in a self-driving car to work or other activities.

Figure 67. Word cloud of discussions about the car speed

Table 57: Most common statements in discussions about the car speed

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
Noticed and wanted to switch or switched to car	18	18%	Greece	-	18-34, 35-64
Noticed	17	17%	Netherlands	Men	35-64
Did not notice	15	15%	Poland, Greece	-	35-64, 65+
Noticed but did not want to switch	11	11%	Poland	-	35-64

4.10.8 Bus overcrowding

"I felt no change in emotions, I did not consider switching and did not switch when more passengers started to come in" - Greece, Woman, 35-64

"I was reminded of the pandemic and one coughing passenger gave me discomfort travel" - Poland, Man, 65+

"Switch due to crowds and because of that, little view. This is for me the moment to switch to the car". – Netherlands, Man, 35-64

As expected, discussions about overcrowding in the bus mentioned "passengers" and "people" (Figure 68) and the fact that more of them arrived in the bus ("appear", "arrive", "coming", "boarding"). Some participants were not affected by the situation ("secure"), mentioning this is what they usually experience ("normal"). Others did not like it ("annoyed", "bothered", "discomfort", "disturbing", "noisy", "unsafe"). Discussion on whether overcrowding is a reason to switch usually followed ("switch", "wanted", "reason"). Some mentioned that situation becomes different in a self-driving vehicle without anyone to control the crowds ("driver", "help").

Statistically, the most common statement was that overcrowded was not a problem, followed by not wanting to switch, and feeling uncomfortable and insecure (Table 58).

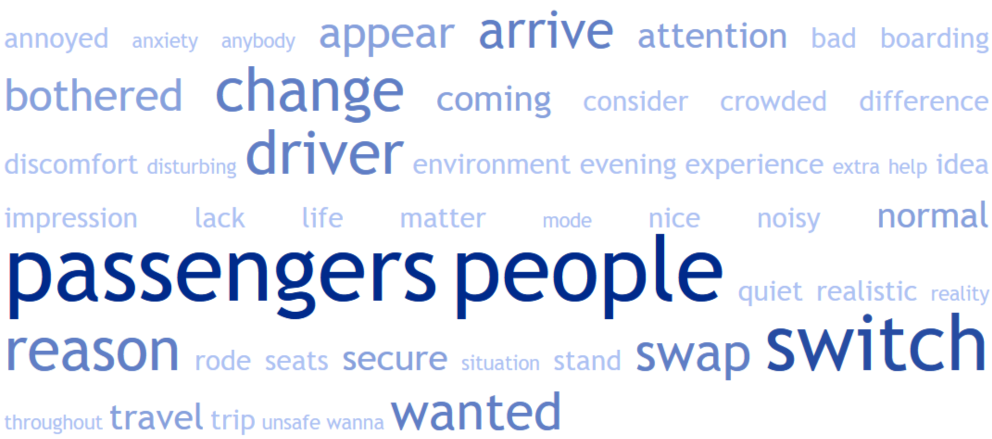


Figure 68. Word cloud of discussions about the bus overcrowding

Table 58: Most common statements in discussions about the bus overcrowding

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
No problem	27	29%	Poland	-	35-64
Noticed but did not want to switch	19	20%	Greece	Men	-
Felt uncomfortable or insecure	7	7%	Poland	-	-

4.10.9 Bus assistant

"A *steward is safe. When the steward was gone, I checked if there were cameras and if there was an emergency button. I couldn't see either*" – Netherlands, Woman, 35-64

"He *was a positive element, maybe he could help a person with a disability; he was unobtrusive, but he was there and it was important that he was there if he was needed by someone*" – Poland, Woman, 65+

"In my opinion it does not make sense, because it is supposed to be autonomous and yet instead of a driver there is an assistant" – Poland, Man, 18-34

There were lengthy discussions about the human assistant in the bus (Figure 69). The most common words were "assistant", "steward", and "person". The discussions were mainly about what could be the role, if any, of this assistant ("check", "control", "emergency", "happens", "help", "monitoring", "needed", "security", "situation", "someone", "something", "ticket"). The assistant could have some of the responsibilities now held by drivers ("driver"). Alternatives to ensure security were suggested ("button"). Participants noticed the assistant left ("disappeared") and noted their reactions ("feeling") or wishes to switch to the car ("reason", "switch").

The two most common statements (Table 59) present contrasting points of view: one is that the assistant offers security, and the other is that it was not a problem when the assistant left the virtual bus. The other common statements also show a mix of opinions, both in favour of having an assistant (who could play several roles) and opposed to it (on the basis that it is not necessary).

Figure 69. Word cloud of discussions about the bus assistant

Table 59: Most common statements in discussions about the bus assistant

Statement	Frequency	%of discussions about vehicle	Most common		
			Country	Gender	Age
Assistant offers security	17	11	-	Women	-
No problem when assistant left	17	11	Greece	-	-
Did not know what assistant was doing	11	7	Poland	-	35-64, 65+
Did not want to switch when assistant left	11	7	Netherlands	-	-
Can offer support	11	7	Greece	Men	65+
Assistant is unnecessary	10	6	Netherlands, Poland	Men	-
Can react to situations	10	6	Netherlands, Poland	Women	35-64
Can check tickets	8	5	Netherlands, Poland	Men	-
Monitoring is an alternative to ensure security	7	5	Netherlands, Poland	-	35-64
Assistant did nothing	7	5	Poland	Women	-
Noticed the assistant	7	5	Poland, Greece	-	18-34

4.10.10 Unruly bus passengers

"*They annoyed me, irritated me, I honestly thought I could have driven the car because of them*" - Poland, Man, 35-64

"*You can't even see if there is a driver, despite the punks on board. I did not have the feeling that I could approach the driver and ask for intervention*" - Poland, Man, 35-64

"*As in a normal bus. It is irrelevant to such situations that these are autonomous vehicles or not*" – Poland, Woman, 18-34

The discussion about the group of unruly bus passengers were also lengthy (Figure 70). Participants mentioned the group ("behaviour", "passengers", "people", "presence", "situation"). Some accepted the situation ("normal"), but others did not like it ("annoying", "anxiety", "bothered", "disturbing", "noise", "unsafe") and considered switching to the car ("change", "consider", "reason", "switch"). Some discussed the specific issues when this type of situations happens in a self-driving bus ("autonomous", "different", "drive", "driver"), and possible solutions to ensure security ("buttons", "cameras").

Statistically, statements that the situation was not a problem, or at least not a problem big enough to induce switching, were more common that those mentioning insecurity and annoyance (Table 60).

Figure 70. Word cloud of discussions about the unruly bus passengers

Table 60: Most common statements in discussions about the unruly bus passengers

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
No problem	13	13%	-	Men	18-34, 65+
Did not want to switch	9	9%	Netherlands	Men	35-64, 65+
Felt insecure	8	8%	Netherlands, Poland	Women	35-64, 65+
Annoying	8	8%	Netherlands, Greece	-	-

4.10.11 Empty bus

“T*he worst part was once everyone got off, it was the worst moment, because it was already dark*”- Poland, Woman, 35-64

“I*t was nice because it was empty, quiet, but it was strange because there was no driver. It was less comfortable than when there are more people*” – Poland, Woman, 35-64

“It *improved my mood, I am an introvert and do not necessarily like contact with people*” – Poland, Man, 35-64

Finally, the discussions about the empty bus (Figure 71) acknowledged the situation (“alone”, “empty”, “passengers”, “people”, “quiet”) and its effects on the participant. Some did not feel it was a problem ((does not) “matter”, (did not) “mind”, “nothing”). Others did perceive the situations as a problem (“anxiety”, “strange”, “unsafe”) and discussed how it differs from similar situations in human-driven buses (“driver”).

Statistically, the most commons statement was that it was not a problem (Table 61), followed by feeling insecure. Some participants said they prefer the bus when they are alone because they can have the bus all for themselves, sitting anywhere they want and not having to interact with other people.

Figure 71. Word cloud of discussions about the empty bus

Table 61: Most common statements in discussions about the empty bus

Statement	Frequency	% of discussions about vehicle	Most common		
			Country	Gender	Age
No problem	29	38%	Poland, Greece	-	35-64
Felt insecure	16	21%	Poland	Women	-
Better like this	12	16%	-	Men	35-64, 65+

4.11 Conclusions

This section collects the key conclusions from the virtual reality experiment, organised of terms of the five objectives stated in the introduction to the chapter.

The experiments captured a variety of data: choices made in a virtual reality game, physiological data, and results of a post-experiment questionnaire and group discussions. The experiments were done in three European countries, in sites with different geographic, economic, and social contexts. The sample was balanced in terms of gender and had an age distribution aligned with that of the populations of each site. However, it has a slight over-representation of people with university degrees. Participants had a good level of prior awareness of self-driving vehicles.

4.11.1 Perceptions, preferences, and reactions to self-driving vehicles

Table 62 shows the results of the experiment regarding perceptions, preferences and physiological reactions, comparing the two self-driving vehicles that the participants experienced: car and bus. Participants had general positive views about both vehicles. This has contributed to the improvement in attitudes and intentions regarding the vehicles. However, there were concerns about comfort, speed, and, in the bus, also about personal security.

Table 62. Conclusions of virtual reality : perceptions, preferences, and reactions

Car	• General positive feelings when using the virtual car • Intention to use self-driving cars increased after the experiment • Speed is a determinant of participant's attitudes regarding self-driving cars: being stuck in congestion is perceived to be a major deterrent • Stress and arousal, as measured by EEG, was identified as congestion got worse and night-time approached, in the virtual car scenario • Importance of the car internal design as part of perceived trip quality: amount of space, seat arrangement, and possibility to see the view are major determinants • Intention to use a self-driving car is significantly higher when self-driving cars are perceived to be less stressful, more comfortable, and safer than human driven ones.
Bus	• General positive feelings when using the virtual bus • Intention to use self-driving buses increased after the experiment • Slight tendency to choose to use the bus when faced with the option between the two vehicles, either at the start or during the virtual trip • In some cases, this choice was motivated by the fact that the bus was faster and cheaper, in the experiment • Importance of bus internal design as part of perceived trip quality: amount of space, seat arrangement, and possibility to see the view outside are major determinants • Opinions split about the need for a human assistant. Those who said an assistant is needed listed several possible roles, such as ensuring safety and security, but also ticket checking • Personal security is a concern, when passenger number or behaviour is unpredictable. This may be a reason for not travelling by self-driving bus. • Increase in stress and arousal, as measured by EEG, was identified when participants were faced with anti-social behaviour of other passengers • Stress and arousal also recorded when the bus had few passengers and it crossed through derelict industrial areas • Intention to use a self-driving bus is significantly higher when self-driving buses are perceived to be more secure (in terms of crime) than human driven ones.

Table 38 shows how participants compared self-driving and human-driven vehicles. Self-driving ones are expected to be more interesting, cheaper, more comfortable, and safer. To a lesser extent, they are also thought to be faster. However, they are more secure in terms of crime. There is a balance of views on which type of vehicles will be more stressful to use.

There is also uncertainty among part of the sample. None of the opinions reported in Table 38 were held by 50% of the sample. They were simply held by more participants that the ones who had the opposite view. However, there were also reasonable proportions thinking that both vehicles will be similar, or being undecided.

Table 63. Conclusions of virtual reality: comparison with human-driven vehicles

	Self-driving vehicles	Human-driven vehicles
Positive	• More interesting • Faster • Cheaper • More comfortable • Safer (accidents)	• More secure (crime)
Negative	• Less secure (crime)	• Less interesting • Slower • More expensive • Less comfortable • More dangerous (accidents)

4.11.2 Impacts of self-driving vehicles

Table 64 tabulates the conclusions of the experiment versus the nine Move2CCAM impact dimensions. Some impacts are positive (mobility, land use, safety). Deterioration of personal security is a major concern and can be a negative outcome of the deployment of self-driving vehicles. The impact on public health is uncertain. It could increase stress, especially among public transport users. The impact on the transport network is also uncertain: Congestion may increase if traffic levels increase. Equity may also be more difficult to achieve, as passengers with mobility restrictions may face challenges.

Table 64. Conclusions of demonstration: impacts

Mobility	• General positive feeling when using self-driving vehicles • Passenger satisfaction depends on vehicle comfort, speed, and personal security. • Self-driving vehicles are thought to be more interesting, cheaper, more comfortable, and safer than human-driven ones. • To some extent, they are also thought to be faster • Self-driving vehicles will allow for productive and leisure uses of travel time
Transport network	• Traffic levels can increase. 28% of participants said they would travel mode, regardless of the mode, if self-driving vehicles were available
Land use	• The view that participants can see from the vehicle window will be a determinant of passenger satisfaction and even of mode choice when vehicles are self-driving. “Looking around” was the main preference for using travel time. This may induce authorities to invest more in the aesthetical design of roads (e.g. green areas, attractive designs). • Most participants who used the car chose to send it back to the city centre at the end rather than parking it outside their homes. This suggests that parking needs in residential areas may decrease • The majority of participants also stated that they would worry less about parking, if they could use self-driving vehicles
Environment	• No information collected on this impact
Economy	• Half of sample said they would use travel time to work. This could improve productivity • At the same time, productivity may be negatively affected, if traffic levels increase and vehicles are stuck in congestion, causing delays to workers
Equity	• Concern that not having a human assistant in buses can reduce the accessibility of individuals with mobility restrictions
Public health	• Travel in self-driving cars and buses may increase stress, when passengers faced with unexpected situations, as revealed by EEG data • Balanced view on whether self-driving vehicles are more or less stressful than human-driven ones, as revealed by questionnaire data
Safety	• Self-driving vehicles are thought to be safer, in terms of accidents, than human-driven ones
Security	• Self-driving vehicles are thought to be less secure, in terms of crime, than human-driven ones • Strong concern among some people that self-driving buses can create situations when passengers fear about crime and anti-social behaviour from other passengers

4.11.3 Variations among sample

Table 65 shows the aspects in which conclusions differ the most from the sample average, in each country, gender, and age group. Greece and the 65+ age group show the most differences.

Table 65: Conclusions of virtual reality experiment: variations among sample

Country	
Netherlands	• Higher propensity to use bus, compared to car, as seen both initially and during the game • Lower propensity to think self-driving vehicles will be more comfortable • Higher propensity to think they will be more insecure
Poland	• Lengthier group discussion about the role of the human assistant and the presence of unruly passengers
Greece	• Higher propensity to "look around" while travelling, rather than using time to work • Higher propensity to park the car nearby rather than sending it back to the city centre • Higher propensity to think self-driving vehicles will be more expensive • Higher propensity to think self-driving vehicles will be more secure • Stronger intention to use self-driving vehicles
Gender	
Men	• Higher propensity to use bus, compared to car, as seen in the participants' choices to switch modes in the game
Women	• More situations where EEG shows increased stress/arousal when using the virtual car
Age	
18-34	• Lower propensity to "look around" while travelling
35-65	• More likely to report self-driving cars will be more stressful than human-driven ones, as stated in questionnaire
65+	• Higher propensity to use bus, compared to car, as seen in the participants' choices to not switch from bus to car during the game and to regret switching • Much higher propensity to park the car nearby rather than sending it back to the city centre • More situations where EEG shows increased stress/arousal when using the virtual car • More likely to report that self-driving buses will be more insecure than human-driven ones

4.11.4 Effectiveness of virtual reality method

Table 66 synthesises the positive and negative points that participants mentioned regarding the virtual reality experiment and the scenarios they experienced. On balance, the experiment was successful. Minor improvements could be made to the representation of the scenarios, especially those outside the vehicle, again confirming the conclusion that the view from the vehicle windows will be an important aspect in a transport system based on self-driving vehicles.

Table 66: Conclusions of virtual reality experiment: effectiveness of virtual reality method

Positive	• Most participants expressed positive feelings about their experience in both scenarios • Experiencing virtual reality improve people's attitudes and intentions regarding self-driving vehicles • The improve these attitudes and intentions even over and above the improvement caused by experiencing a real self-driving vehicle (in a demonstration) • The scenarios were perceived as realistic or very realistic by the majority of participants • Participants noticed almost all of the changes in trip attributes, both in the car and bus
Negative	• Participants thought the environment outside the vehicles could be more realistic (e.g. road less straight and with more pedestrians and cyclists)

4.11.5 Final remarks

This chapter showed that citizens have general positive views about self-driving vehicles and the experience of using them in virtual reality mitigate previous concerns and raise the intention of using the vehicles in the future. However, the experiment also raised concerns about the implications of self-driving vehicles for security in terms of crime. This was evident not only in the participants' opinions in the questionnaire and group discussions, but also in measured physiological reactions to specific situations inside the self-driving bus. Slow speed due to congestion is also a possible problem. Other concerns relate to how comfortable the vehicles will be. Overall, the virtual reality experiment was also successful as a method to study passenger's reactions and views about self-driving vehicles.

5. Pan-European survey

5.1 Overview

An online survey was implemented in eight European countries (Cyprus, France, Germany, Greece, The Netherlands, Poland, Spain, and United Kingdom), involving 7,941 citizens. The survey had six objectives:

- To assess citizens' current travel patterns across Europe.
- To assess citizens intentions, needs, and requirements regarding the purchase and use of self-driving vehicles.
- To capture perceptions about the possible impact of self-driving vehicles on several dimensions of the lives of individuals and on the regions where they lived. This used as a base the set of passenger and freight transport use cases created earlier in the project.
- To compare perceptions across countries, regions, age groups, and genders.
- To estimate the interrelationships between the different perceived impacts.
- To estimate the relationships between perceived impacts and demographics, current travel behaviour, and location.

A large international survey is needed because the possible impact of self-driving vehicles is still not fully understood. Previous studies have focused on specific impacts (e.g. safety, employment) but not on the full range of impacts that might arise at different levels (individual and regional) and on the inter-relations between those impacts. In addition, it is likely that the impacts will differ from country to country due to different economic, social, and cultural contexts.

While previous activities in the project, reported in previous chapters (e.g. demonstration of vehicles, virtual reality experiments) provided insights on impacts, they focused on specific experiences of using specific types of self-driving vehicles, using small samples of participants. A survey deployed widely across Europe was therefore needed to capture a wider range of vehicles and aspects beyond experiences, such as attitudes towards self-driving vehicles, intentions, and willingness to pay to use or buy these vehicles, possible changes in travel and online delivery ordering behaviour, and other ways in which self-driving vehicle will affect the individuals and their regions.

The survey includes several questions at the beginning to capture citizens' current travel patterns. While this is mostly to set the context for analyses of the possible impact of self-driving vehicles, it also provides useful information in itself, as it captures how citizens travel in a period that is both post-Covid but also when most of the travel behaviour adaptations to the post-Covid ways of living and working (e.g. flexible working patterns) are likely to have already taken place (as data was collected in 2024). This provides insights on wider transport and travel aspects, as most international travel behaviour surveys have captured either the pre-Covid period or the years immediately after Covid (2022-2023), when it was likely that citizens were still adjusting to new living and working circumstances.

The rest of this chapter is organised as follows.

- Section 5.2 describes the **methods** used in this survey.
- Section 5.3 and Section 5.4 describe the **characteristics** of participants and their individual behaviour (including travel, online delivery orders, and other behaviour).
- Section 5.5 describe participants' previous level of **awareness** of self-driving vehicles.

- Section 5.6 and 5.7 describe the results of the perceived **intentions** of citizens regarding using self-driving **passenger transport** vehicles and the **impacts** that may have in their **individual behaviour**. Section 5.8 then estimate statistical **models** of these intentions and impacts.
- Sections 5.9, 5.10, and 5.11 do parallel analyses for self-driving **freight vehicles**, including description of intentions and impacts and statistical models of both.
- Section 5.12 describe the participants' stated **needs and requirements** for using self-driving vehicles.
- Section 5.13 describe the participants' views on the **implementation timeline** of self-driving vehicles.
- Section 5.14 described the participants' perceived **wider impacts** of self-driving vehicles (in general) on several dimensions, at the regional (not individual) level. This section also estimates models of these wider impacts.
- Section 5.15 is a qualitative analysis of the answers that participants gave to open ended questions about **other impacts** not covered in other questions.
- Section 5.16 synthesises the **key results** of the survey, in terms of how the results address the six objectives described at the beginning of this overview.

5.2 Methods

5.2.1 Questionnaire

The questionnaire used was the same in all eight countries. It was designed in English and then translated into French, German, Spanish, Polish, Dutch, and Greek. Questions about monetary values were expressed in Euros, except in the United Kingdom (pound sterling) and Poland (złoty). All analyses of these questions were done in Euros. Values in pound sterling and Polish złoty were converted into Euros using the exchange rate in the day the data collection started in the respective countries.

Appendix 7 contains the English version of the questionnaire. The questionnaire was designed to be answered in around 15 minutes and it was structured into five parts as follows.

Part 1 of the questionnaire captured **demographic and other characteristics** of participants, including:

- Country
- Region, within country
- Age (in years)
- Gender
- Educational level
- Type of area where the participant lives (city or town centre, city or town not in centre, suburbs far from city or town centre, or village)
- Self-identified profile in terms of technology adoption, on a 5-point scale from "innovator" to "laggard")
- Self-identified confidence in using technologies in daily life, on a 5-point scale from "very confident" to "not confident"

Part 2 captures the participants' current **travel behaviour and travel context**, including:

- Ownership of a driving licence
- Number of private cars in household (capped at 10)
- Purpose and duration (capped at 120 minutes) of the most frequent trip

- Number of weekly trips per travel mode (capped at 40 per mode)
- Monthly travel expenditure, per travel mode (capped at €999)
- Ranking of factors affecting mode choice for the most frequent trip
- Frequency of receiving deliveries for online/phone orders
- Type of deliveries received
- Number of people in the household
- Number of children in the household (capped at 12) and frequency of trips to escort them
- Employment situation
- Health issues hindering mobility (participant and family members)

Part 3 captures intentions and potential impacts of self-driving vehicle use cases on **individual behaviour**.

Participants were first introduced to self-driving vehicles and asked if they were aware of them. Then they were asked to imagine that 50% of vehicles in their area are self-driving. They were then presented with two passenger use cases and one freight use case, selected randomly from a set of three passenger use cases (taxi, private car, or public bus) and two freight use cases (private delivery/pick-up robot or delivery drones), all co-created by citizens and organisation in previous project activities. Each of the three passenger use cases was presented to two thirds of the sample. Each of the two freight use cases was presented to half of the sample.

For passenger transport use cases, participants were then asked:

- Likelihood of buying the product or using the service provided, by trip purpose, on a 5-point scale from “highly unlikely” to “highly likely”
- Expected change in travel time of the most frequent trip (expressed by moving a slider, on a scale between -120 and +120 minutes)
- Expected change on number of weekly trips (expressed by moving a slider on a scale between -20 and +20 trips)
- Expected change on parking needs, on a 5-point scale (reduced significantly (50% reduction or more); reduced (up to 50% reduction); no change; increase (up to 50% increase); and increase significantly (50% increase or more)
- Expected change on residential location, on a 5-point scale (relocate to a rural area, relocate to suburbs, no change, relocate closer to the city centre, relocate to city centre)
- Number of current trips substituted with the self-driving vehicle, by current mode, on a 5-point scale (none of them (0%), few of them (up to 33%), about half of them (33-66%), most of them (66-99%), all of them (100%)
- Purposes of trips using self-driving vehicles
- Willingness to pay to buy the vehicle (capped at €99,999) or to use it (capped at €999)
- In the case of self-driving car only, the type of car participant would buy, if any
- In the case of self-driving taxi only, the willingness to share the ride with strangers

For freight transport use cases, participants were asked:

- Likelihood of using the product or service provided, on the same 5-point scale as above
- Expected change in number of delivery orders and number of trips (expressed by moving sliders on a scale between -20 and +20)
- Expected change on parking needs, on the same 5-point scale as for passenger use cases above
- Expected change on delivery costs, on the same 5-point scale
- Substitution of deliveries currently made by other modes, on the same 5-point scale as for passenger use cases

- Usefulness of the service for the organisation the participant works for (if they are working)

Part 4 captures participants' **needs and requirements** related to self-driving vehicles. This including questions on:

- Rank of preferred self-driving vehicle type (overall and for commuting trips), choosing from a wide range of vehicles, i.e. not limited to the specific use cases analysed in the previous parts of the questionnaire.
- Perception about when the different types of self-vehicle will be implemented in their region (five choices from 2030 to 2050, or never)
- Activities the participant would engage with during travel in self-driving vehicles

Part 5 captures the **wider impacts** of self-driving vehicles on several indicators of the nine Move2CCAM impact dimensions, as below

Table 67. Indicators of wider impact

Dimension	Number of indicators	Indicators
Mobility	8	• Citizens' number of trips • Citizens' travel time • Travel costs for citizens' trips • Ownership of conventional private vehicles • Ownership of self-driving vehicles • Usage of self-driving shared services (public transport, car clubs) • Citizens' number of trips for shopping • Delivery costs
Transport network	2	• Number of vehicles on the network • Traffic congestion
Land use	4	• Number of people who live in rural areas • Number of people who live in the city centres • Demand for parking spaces in the city centres • Demand for redesigned transport infrastructure
Environment	3	• Transport sector's emissions • Demand for electricity to charge self-driving vehicles • Noise pollution
Economy	4	• Economic growth • Investments • Job losses • New skills requirements
Equity	5	• Accessibility of general population • Accessibility of people with special mobility needs • Accessibility of older people • Accessibility of families with children • Employment opportunities
Public health	3	• Stress related to travelling • Access to health care • Emergency response
Safety	4	• Number of traffic accidents • Number of traffic fatalities • Number of traffic violations and tickets • Number of harassment events while travelling
Security	2	• Number of cyber-attacks related to the transport sector

5.2.2 Participant sampling and recruitment

The target sample was 1,000 in each country except in Cyprus, where the target was 500 because of the small population (below 1 million), compared with the other countries. In Cyprus, residents in the districts north of the Green Line were not sampled. A sample of 1,000 per country was deemed to be necessary to derive precise results, and to ensure that the sample is representative of gender, age, and regions inside the country.

Participants were recruited through market research companies, which recruited participants from their panels. Only individuals aged 18 or above were recruited. In each country, quotas were imposed on sex, age groups (18-34, 35-64, 65+) and regions (using the NUTS1 classification). Regional quotas did not apply in Cyprus, as the whole country is a NUTS1 region. Participants who stated that they did not know their region did not proceed with the questionnaire.

5.2.3 Ethics

The study received ethical approval from the Bartlett School of Environment, Energy and Resources at University College of London (ID: 20231120_EI_ST_ETH_ Move2CCAM).

Participants were provided with an information sheet (in the local language) before they were asked to agree to take part in the survey. This sheet provided answers to the following questions:

- Why have I been chosen?
- Do I have to take part?
- What will happen if I take part?
- Will I be recorded and how will the recorded media be used?
- What are the benefits of taking part?
- What are the possible disadvantages and risks of taking part?
- What if something goes wrong? [including contact details]
- Will my taking part in this project be kept confidential?
- What will happen to the results of the research project?
- Who is organising and funding the research?

Participants then gave they consent by confirming (by ticking a box) that they understand what the research involves and what is expected of them. This was detailed as a series of ten statements. Participants had to agree with all of them.

The information sheet and consent form are not included in this report, as they were included as appendix to a previous report of this project (Deliverable 3.3).

5.2.4 Survey administration

Data was collected during January-May 2024. Pilot surveys with 50-100 participants were ran in each of the eight countries, to test the questions. Minor corrections to the questionnaire were made after the first pilot (in the United Kingdom) and country-specific minor corrections on dataset formats were applied after the pilots in the other countries.

5.3 Participant characteristics

Figure 72 shows the populations of the eight countries surveyed and the respective sample sizes. The countries cover all broad regions of Europe (North, South, West, East) and differ in size, from 0.9 million (Cyprus) to 83 million (Germany). The results in this chapter relative to the whole sample did not weight data for each country. The target sample size for each country was achieved in Greece and Cyprus and surpassed in all other countries. The overall sample size was 7,941.

The eight countries also differ in terms of income per capita, with four different groups: Netherlands and Germany having the highest income (in the €60,000-70,000/year interval), followed by France and the United Kingdom (55,000 to 60,000), then Cyprus and Spain (45,00 to 50,000), and finally Greece and Poland (40,000-45,000). This grouping is relevant to understand some of the patterns found in the results of this chapter.

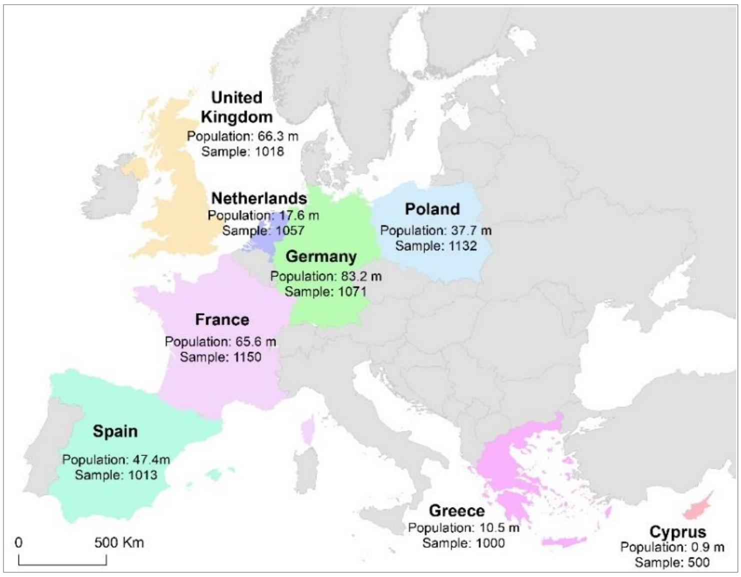


Figure 72. Countries surveyed: population and sample sizes

As mentioned, quotas were imposed based on regions in each country (based on NUTS1 regions). There regions are also used as units of analysis in this chapter. It should be kept in mind that the regions surveyed are heterogeneous, even within the same country. Two of the main differences between regions are population density and income per capita. Figure 73 and Figure 74 show these two variables, using data from Eurostat. There are clear divides between different parts of some countries, such as Germany (West vs. East). In addition, in most countries, the capital city is denser and richer than other regions. This is evident for example in the cases of London, Paris, Madrid, Berlin, and Athens. These differences are used in the following sections to explain the patterns found in the results. In addition, regional population density and income per capita were specified as new variables and attached to the data on all participants living in each region. These variables were used as predictors of several impacts reported by participants, in statistical models.

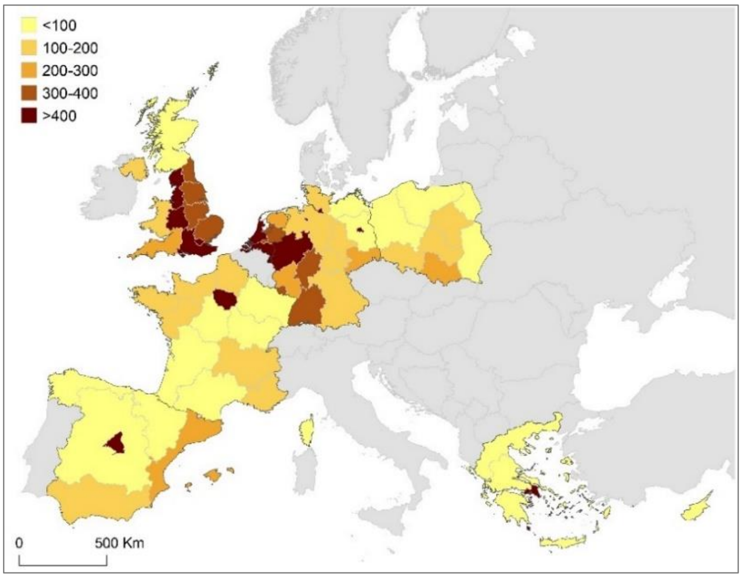


Figure 73. Regions in the countries surveyed: population density (people/km^2)

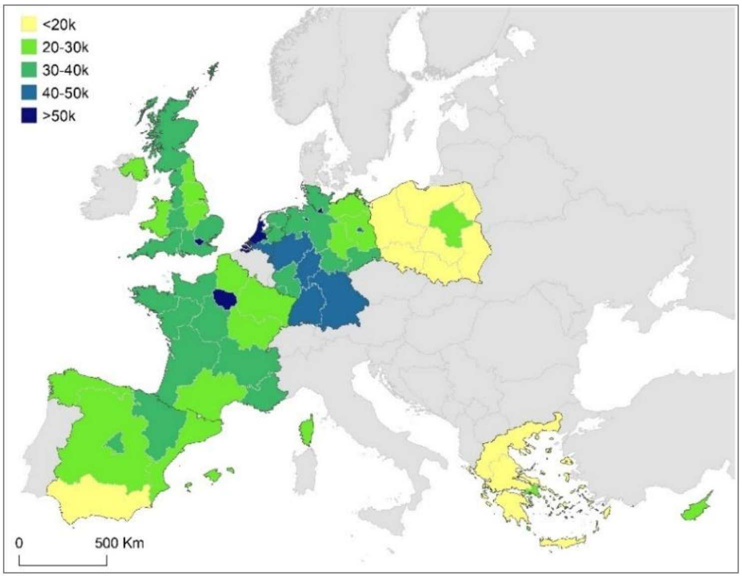
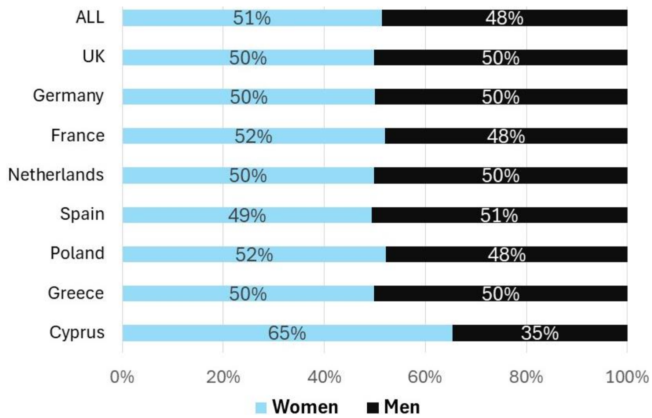


Figure 74. Regions in the countries surveyed: gross domestic product per capita (€/year)

While in Poland provinces are a more commonly used regional unit than NUTS 1 regions, we decided to use NUTS1 regions to be consistent with other countries.

5.3.1 Gender and age

Figure 75 shows the gender distribution of the overall sample and of the samples by country. Table 68 shows how those distributions match with the respective population distributions. The samples are balanced in terms of gender in almost countries (around 50-50% men vs. women) and the proportions of men and women match those in the populations. The exception is Cyprus, where women are almost two thirds of the sample but 51% of the population.



Note: Excludes participants indicating "other" (11 individuals, i.e. 0.14% of the sample) or not providing gender information (3 individuals, i.e. 0.04% of the sample).

Figure 75. Sample gender distribution

Table 68. Gender distribution: sample % vs. population %

	Women		Men	
	Population	Sample	Population	Sample
UK	51	50	49	50
Germany	51	50	49	50
France	52	52	48	48
Netherlands	50	50	50	50
Spain	51	49	49	51
Poland	52	52	48	48
Greece	51	50	50	49
Cyprus	51	65	49	35

Around half (52%) of the overall sample is aged 35-64 years. 20% are in the 18-34 group, and 20% in the 65+ group (Figure 76). The sample man age is 46.5 years (Table 69). The Cyprus sample is very imbalanced, as it includes only 2% of participants aged 65+ (i.e., only 9 people). This results in a mean sample age (38.1 years) which is much lower than in other countries. As seen in Table 69, the Cyprus sample has a much lower proportion of people aged 65+ (2%) than in the population (27%) and much higher proportions of people in the 18-34 and 35-64 (25% and 48% respectively) in the sample, than in the population (38% and 60% respectively). The 65+ age group represents a lower proportion in the sample than in the population in Greece (13% in sample, 27% in population) and Spain (17% in sample, 27% in population).

Figure 76. Sample age distribution

Table 69. Sample mean age

	Mean age (years)
ALL	46.5
UK	48.1
Germany	47.2
France	49.7
Netherlands	47.7
Spain	46.6
Poland	46.8
Greece	43.3
Cyprus	38.1

Table 70. Age distribution: sample % vs. population %

	18-34		35-64		65+	
	Population	Sample	Population	Sample	Population	Sample
UK	28	28	49	49	23	23
Germany	32	33	48	47	20	20
France	22	23	54	51	24	26
Netherlands	27	29	48	47	25	24
Spain	21	23	52	61	27	17
Poland	25	28	52	48	23	24
Greece	24	31	50	56	27	13
Cyprus	25	38	48	60	27	2

The imbalance of the sample in Cyprus results from the difficulty in recruiting participants in general, and older participants in particular, due to the relatively small population of the country. While this imbalance has little effect on results aggregated for the overall sample (as Cyprus represents only 1/15 of the sample), all cross-country comparisons are affected. As seen in the rest of the report, Cyprus is often an outlier in the distribution of variables. This may be due, in part, to the specific geographic context of the country or to land use, economic, social, and cultural specificities. However, some of the differences between Cyprus and other countries may also be partly explained by the fact that the Cyprus sample is unbalanced in terms of age (and gender); it is in effect an 18-64 sample, with a great overrepresentation of women. Given the large age and gender imbalances, weighting the Cyprus data is not an effective solution. As such, readers are reminded that differences between Cyprus and other country are not only explained by differences in the population but also by differences in the sample.

While the Greek and Spanish samples also have some underrepresentation of the 65+ group, weighting was not applied to be consistent with the approach used in the other countries.

5.3.2 Regional distribution

Figure 77 and Figure 78 show the proportions that each region represents in the population and in the sample of each country (Cyprus is not shown as it is a single NUTS 1 region). The proportions match very closely in almost all cases. This means that the samples accurately represent the regional distribution of the population inside each country.

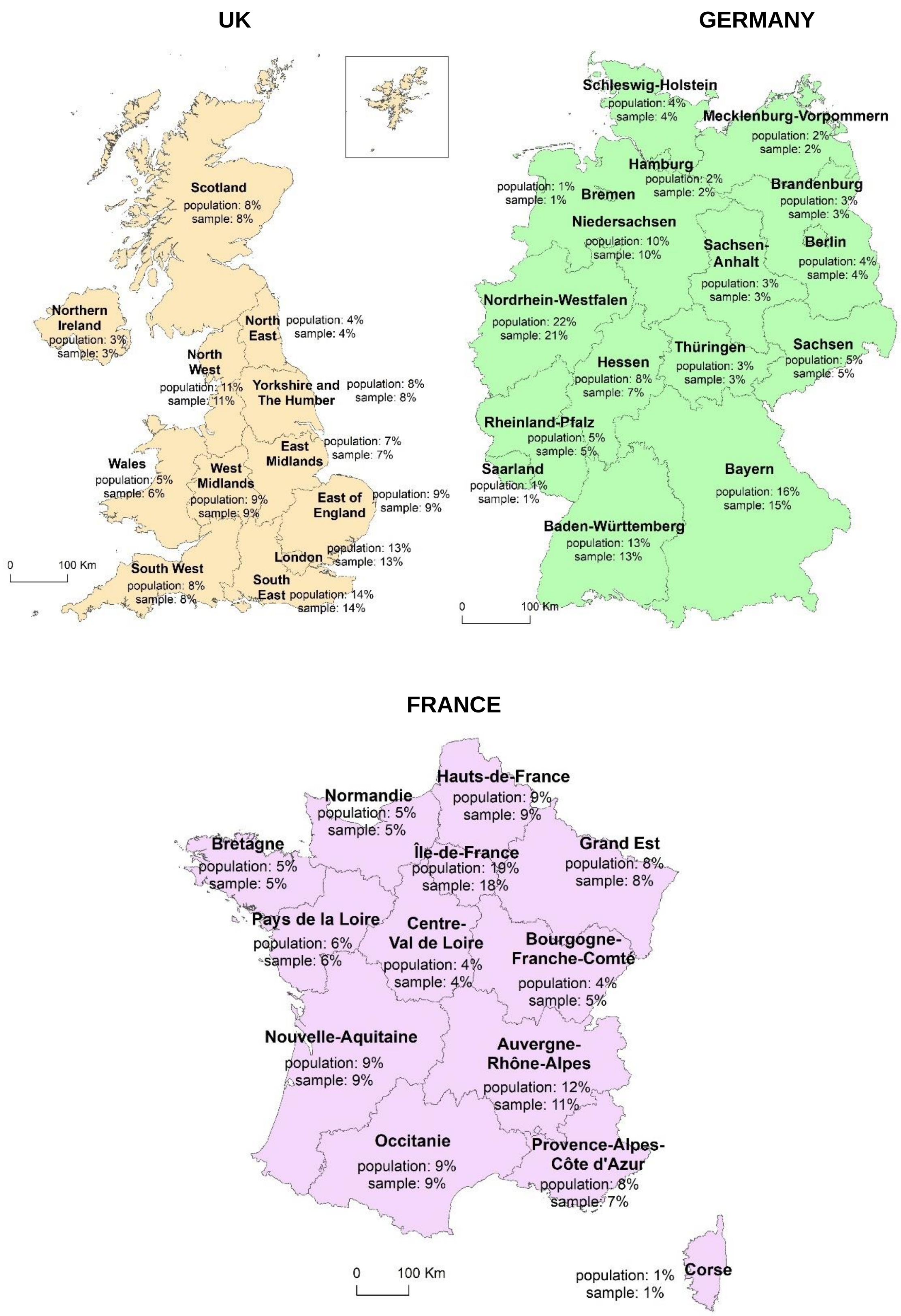


Figure 77. Regions surveyed: population and sample (as % of country) – UK, Germany, France

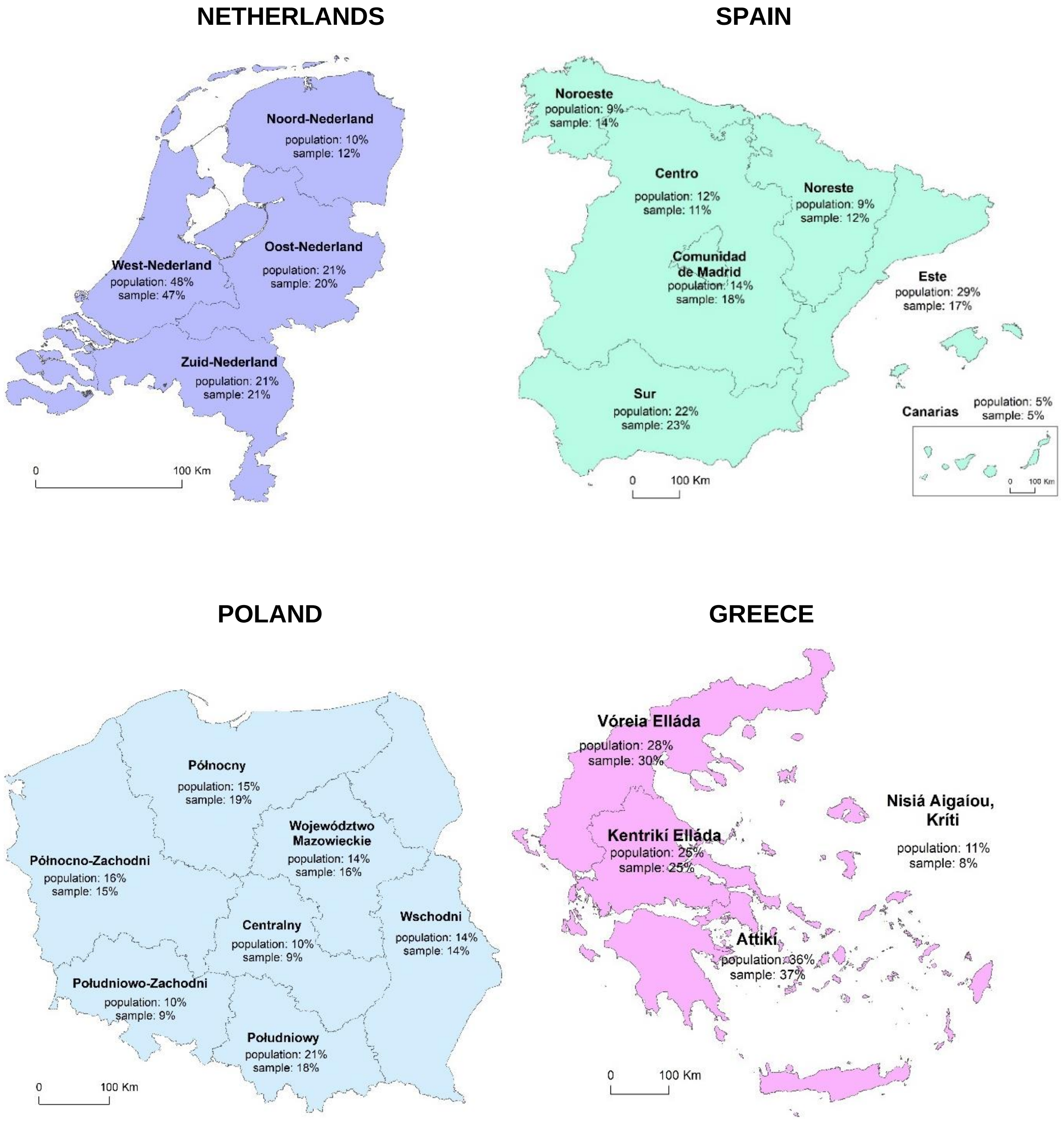


Figure 78. Regions surveyed: population and sample (as % of country) – Netherlands, Spain, Poland, Greece

5.3.3 Other characteristics

More than half of the sample (55%) has a university degree (31%) or a higher degree such as a Master's degree or PhD (22%) (Figure 79). While these numbers are high, they are not a major overrepresentation. Statistics from Eurostat show that the proportion of population with a university degree in most countries is only 5-10% higher than in our sample[3]. The exceptions are Greece and Cyprus, where the sample has a great overrepresentation of individuals with a university degree.

About two thirds of the sample is currently working (50% full-time and 14% part-time). 21% is retired. (Figure 80). The French sample has more retired individuals (31%) while the Cyprus sample has more workers (83%), compared with the other countries.

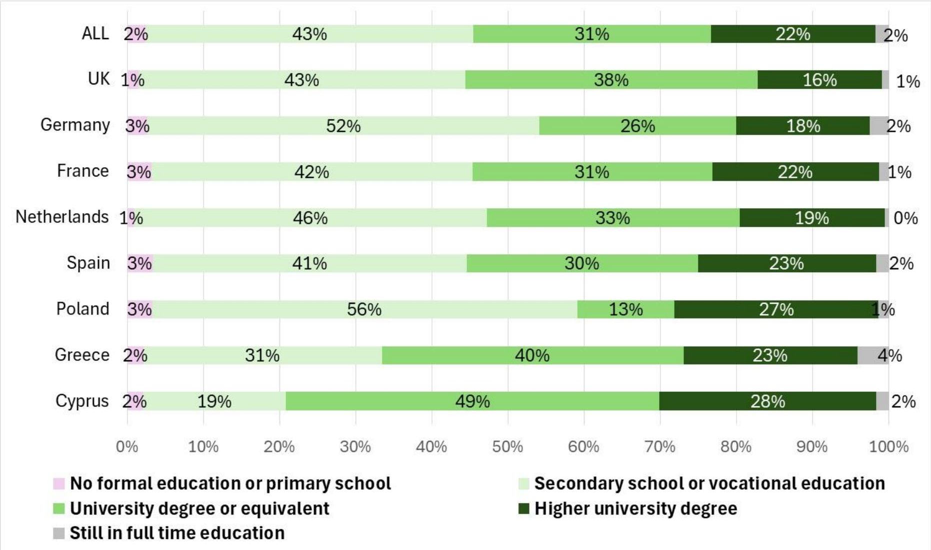


Figure 79. Sample composition by country: education

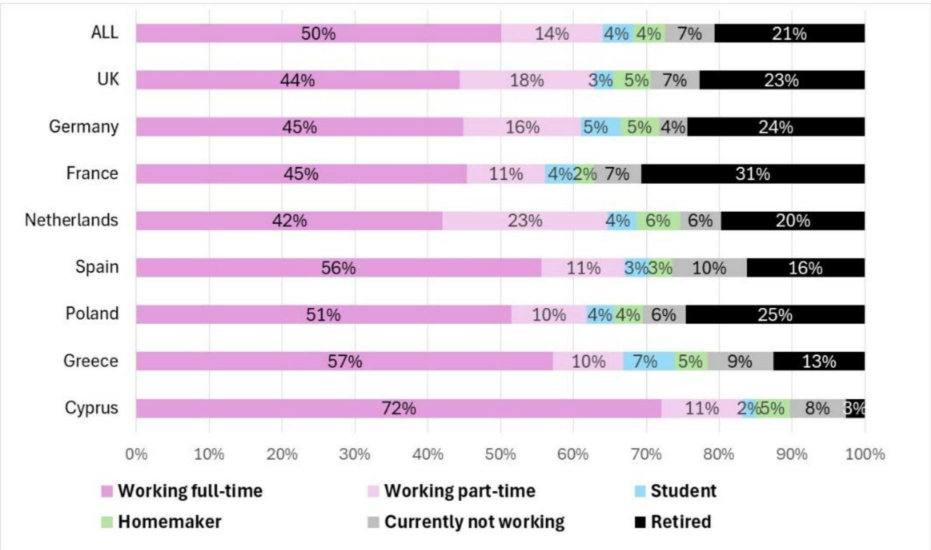


Figure 80. Sample composition by country: employment

[3] See https://www.euronews.com/next/2024/06/15/which-countries-are-home-to-the-most-educated-people-in-europe

17% of the sample lives alone (Figure 81) and 63% live in a household with no children (Figure 82). Households tend to be smaller and have fewer children in Germany and France and larger and with more children in Spain, Greece, and Cyprus.

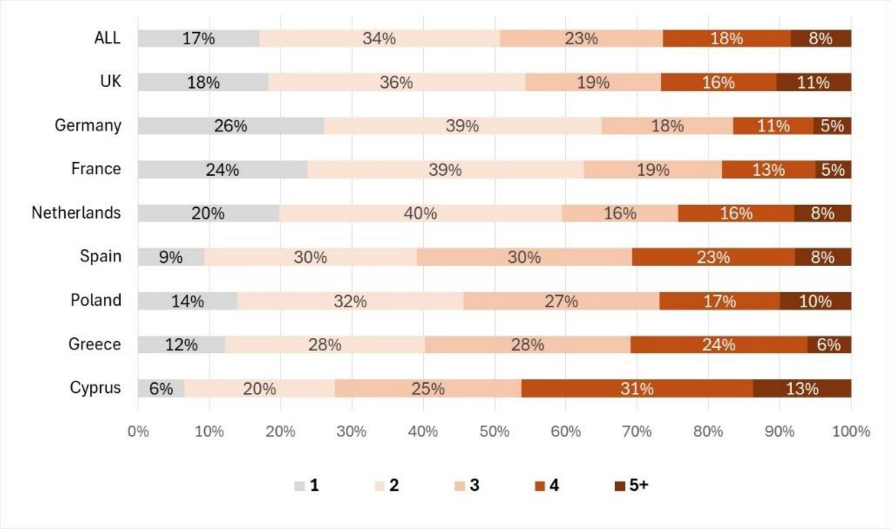


Figure 81. Sample composition by country: number of people in household

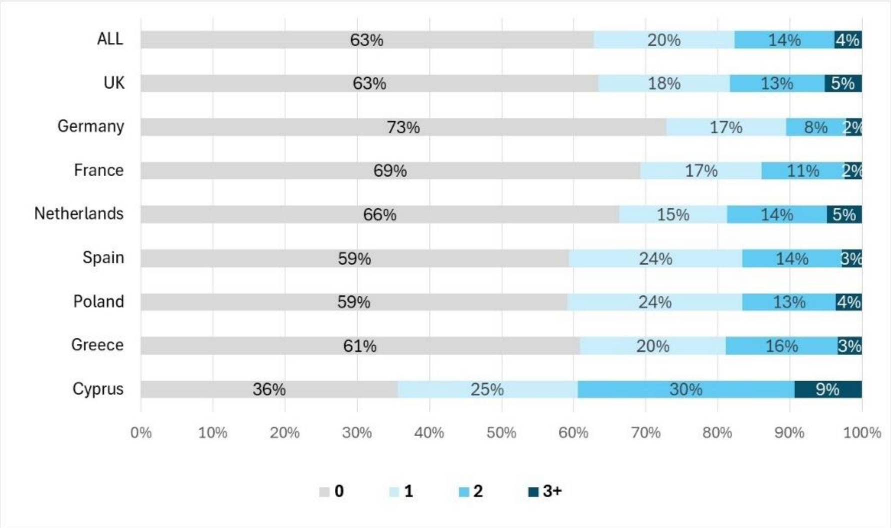


Figure 82. Sample composition by country: number of children in household

14% and 15% of the sample reported a health issue affecting their mobility or the mobility of a family member, respectively. These proportions are smaller in Spain, Greece, and Cyprus (Figure 83).

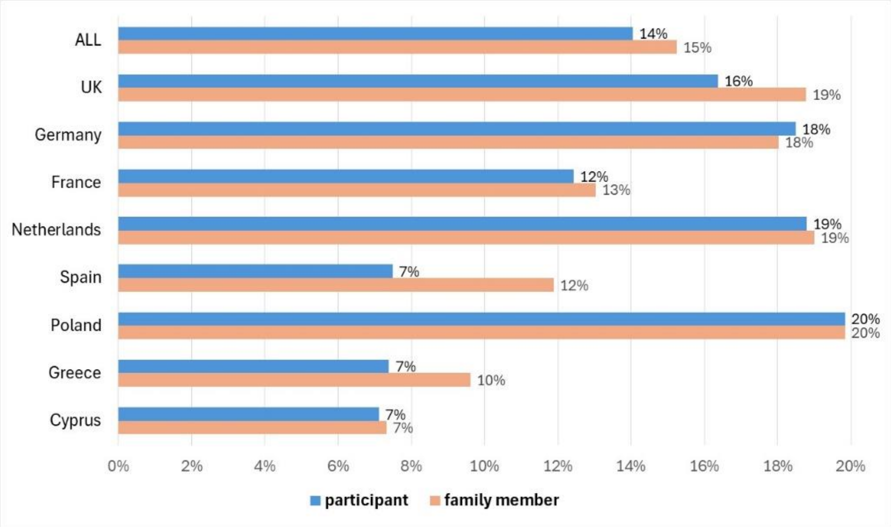


Figure 83. Sample composition: health issue affecting mobility, by country

About a third of the sample lives in a city or town centre and another third lives in a city or town but not in the centre. 20% live in a village (Figure 84). The sample in Greece has higher proportions of people living in the city centre (59%). The samples in France and Netherlands have higher proportions of people living in villages (around 30%).

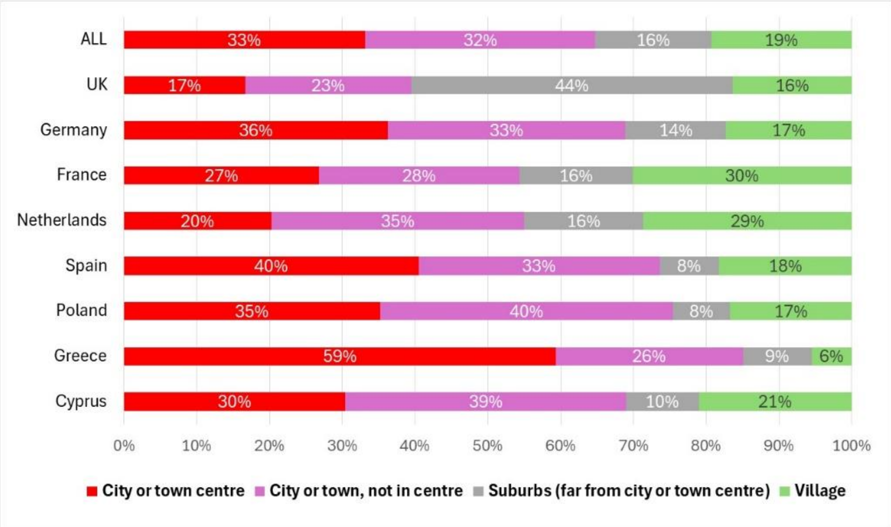


Figure 84. Sample composition by country: residence area type

5.3.4 Attitudes towards technology

Most people assessed their adoption of technologies and innovations in one of the middle points (2-4) in the 5-point scale, i.e. “early adopter”, “early majority”, or “late majority” (Figure 85). Only 15% self-assessed as “innovator” and only 8% as “laggard”. However, the large majority of participants tend to be either very confident (35%) or somehow confident (41%) in using technologies and innovations (Figure 86). Participants in Greece and Cyprus had much higher proportions of people self-assessing as “innovators” (30% and 37% respectively) and of people stating they are very confident in the use of technologies (51% and 55% respectively), compared with the overall sample.

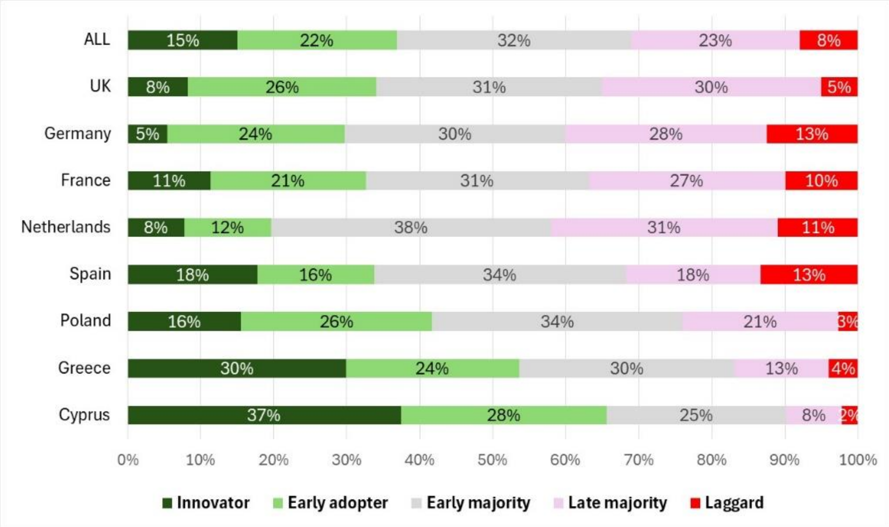


Figure 85. Self-assessed adoption of technologies and innovations, by country

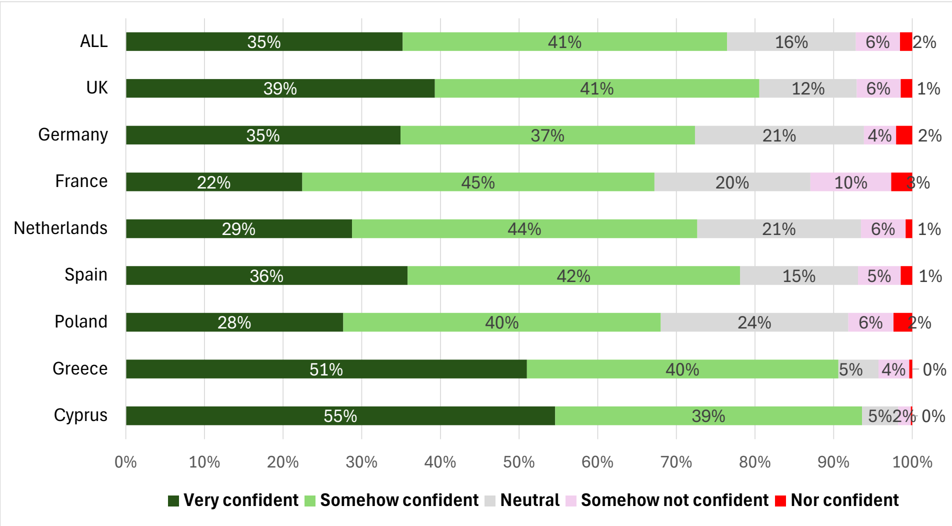


Figure 86. Confidence in using technologies and innovations in daily life, by country

5.4 Current individual behaviour

The results of this section, on current individual travel and online ordering behaviour, and the results in subsequent sections, are disaggregated by country, by age and gender.

5.4.1 Driving licence and car ownership

87% of the overall sample has a driving license (Figure 87) and only 11% lives in a household with no cars (Figure 88). Almost all of the Cyprus sample has a driving licence (98%) and lives in a household with at least one car (99%). In addition, 58% of the Cyprus sample has 2 cars and another 23% have 3 or more cars in the household. Car ownership also tends to be higher in Greece than in the overall sample. Poland has a considerably lower proportion of driving licence ownership (77%) and of people living in 0-car households (18%) than other countries.

Women and the 18-34 age group are less likely to own a driving licence than men and older age groups. However, the 65+ age group is more likely to live in a zero-car household than other age groups, and the 18-34 group is more likely to live in households with 2 or 3+ cars.

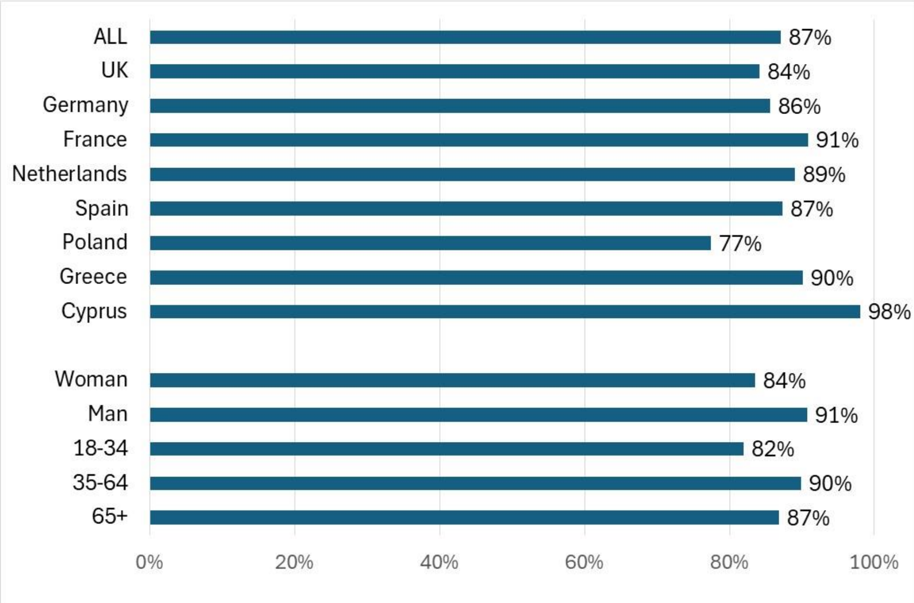


Figure 87. Driving licence, by country, gender, and age

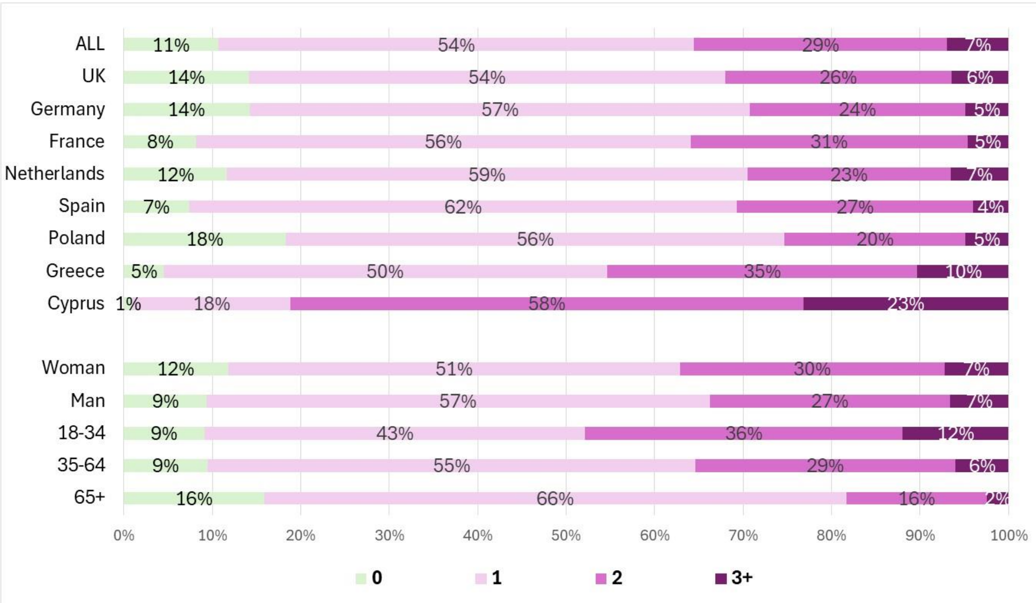


Figure 88. Number of private cars in the household, by country, gender, and age

5.4.2 Frequency and characteristics of passenger trips

Figure 89 shows the purpose of the most frequent trip that participants make. The most frequent purpose is work (45%). Trips to work are even more frequent in Cyprus (76%) and Greece (55%). Across the whole sample, 19% of the trips are for shopping. The number is higher in the United Kingdom (30%) and Poland (28%). 12% of the trips are to meet friends and family. The number is higher in Germany (21%). Other trip purposes are less frequent.

There are only minor differences between trip purposes of men and women and between the 18-34 and 35-64 age group. The 65+ plus is much less likely to indicate work trips (7%, vs. 45% in the whole sample) and more likely to indicate all other purposes such as shopping (34% vs. 19%), meeting friends and family (19% vs. 12%), leisure (15% vs. 9%), and personal businesses

(16% vs. 8%). The majority of the most frequent trips for the two younger age groups (18-34 and 35-64), are to go to work.

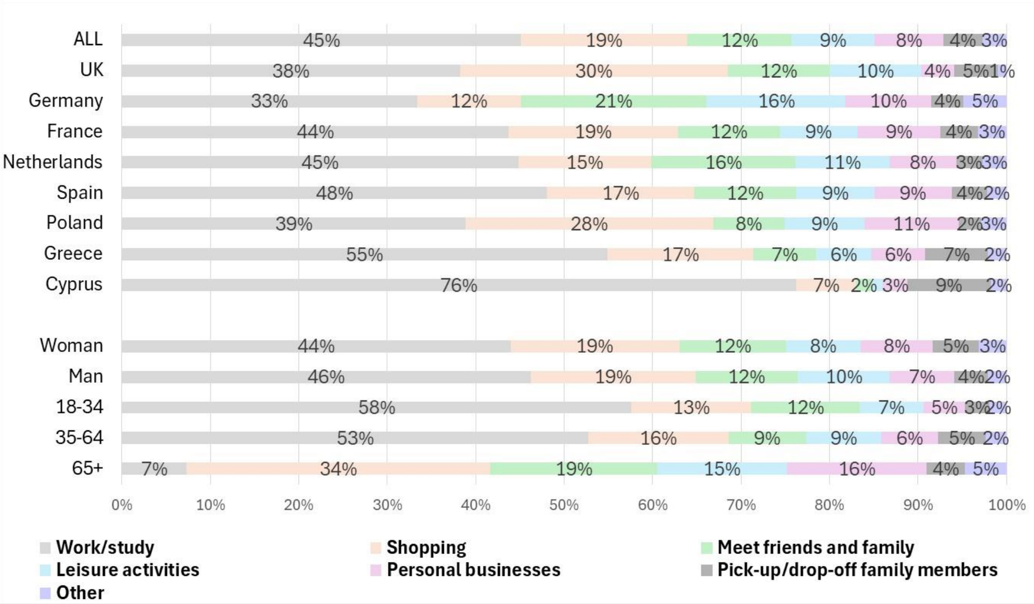


Figure 89. Purpose of most frequent trip, by country, gender, and age

Figure 90 shows the statistical distribution of the duration of the most frequent trip (in minutes) across the whole sample. Table 68 shows the mean trip duration by country, gender, and age. The overall mean duration is 30.2 minutes, with most trips being under 40 minutes. Less than 10% of the trips are less than 10 minutes. There is little variation across countries, genders, and age groups in terms of trip duration.

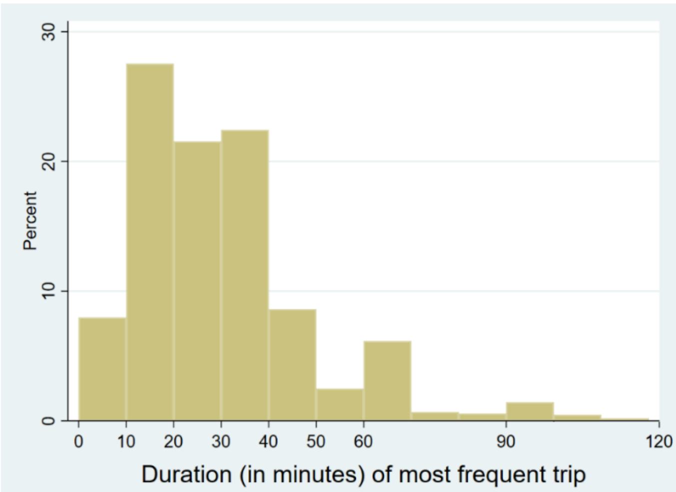


Figure 90. Duration of most frequent trip

Table 71. Mean trip duration of most frequent trip, by country, gender, and age

	Mean trip duration (minutes)
ALL	30.2
UK	29.9
Germany	34.0
France	27.8
Netherlands	33.9
Spain	27.7
Poland	30.5
Greece	28.6
Cyprus	28.1
Women	29.6
Men	30.7
18-34	30.2
35-64	29.6
65+	31.9

Note: Excludes participants with number of trips above the 95% percentile of the distribution (equal to 50 trips)

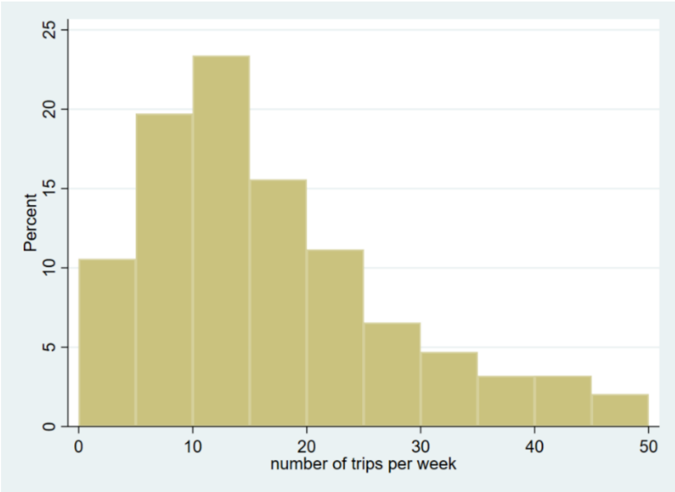
Figure 91 shows the statistical distribution of the number of trips per week across the whole sample. Table 72 shows the mean number of trips per mode, country, gender, and age. Both exclude participants with a number of trips deemed to be unrealistic. These are identified as participants for whom the sum of all trips, across all modes, is above the 95% percentile of the statistical distribution of that sum, which is equal to 50 trips.

The overall mean number of trips per week is 16.1 (Table 72), with the most frequent number being between 10 and 15 (Figure 90). About half of the trips (8.1) are by car (Table 72). More than half of the car trips (4.7) are trips where the participant is driving alone. Bus trips (1/2 per week) are more frequent than rail trips (0.8 per week), and walking (4.4 trips) is much more frequent than cycling (1.1).

There is not much variation in the overall mean number of trips across countries, genders, and age groups (Table 72). However, the mean number of trips per mode shows considerable variation. Participants in Cyprus make almost twice as many trips by car than the overall sample (15.9 vs. 8.1), half of walking trips (2.2 vs. 4.4), and very few trips by all other modes. Participants in Greece make more trips by car, but also more trips by walking, compared with the overall sample. In the Netherlands, cycling trips are more frequent and car and bus trips less frequent. In Poland, bus trips are more frequent. In Spain, bus and walking trips are more frequent, and cycling trips less frequent. Apart from Cyprus, Germany and the United Kingdom have the lowest mean number of walking and cycling trips, respectively.

Men and women make about the same number of trips by private car. The 18-34 and 35-64 age groups also make comparable mean number of trips by private car. However, men and the 35-64 group make more trips driving alone and women and the 18-34 group make more private car trips as passenger (with other person driving). The 65+ group makes much fewer trips by car (5.6) than other groups (8.5-8.9).

These results are reflected in the proportions that each mode represents in the number of trips, shown in Figure 92, which shows that Cyprus is more car-oriented and the Netherlands more cycling-oriented than other countries and that the 65+ group relies more on walking and less on car compared with other age groups.



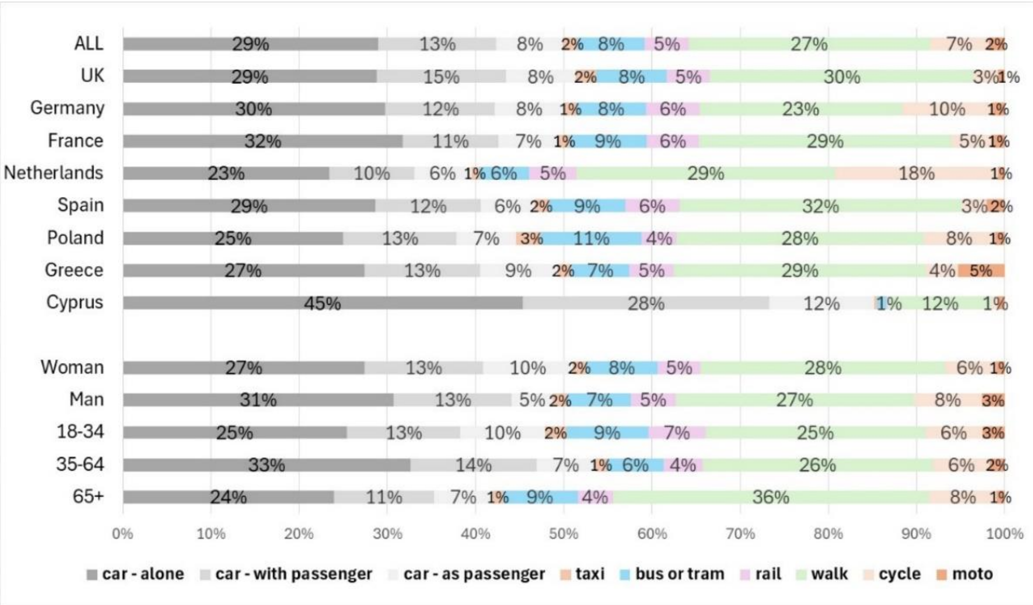
Note: Excludes participants with number of trips above the 95% percentile of the distribution (equal to 50 trips)

Figure 91. Number of trips per week

Table 72. Mean number of weekly trips, per mode, country, gender, and age

	car				*bus*	*rail*	*taxi*	*walk*	*cycle*	*moto*	*all*
	alone	*with passenger*	*passen-ger*	*all*							
ALL	4.7	2.2	1.2	8.1	1.2	0.8	0.3	4.4	1.1	0.3	16.1
UK	4.3	2.2	1.2	7.7	1.2	0.7	0.4	4.5	0.4	0.1	14.9
Germany	4.4	1.8	1.2	7.4	1.2	0.9	0.2	3.4	1.5	0.2	14.7
France	4.5	1.5	1	7	1.2	0.8	0.2	4	0.7	0.2	14.1
Netherlands	3.6	1.5	1	6.1	0.9	0.8	0.1	4.5	2.8	0.1	15.2
Spain	5.1	2.1	1.1	8.3	1.5	1.1	0.3	5.7	0.5	0.4	17.9
Poland	4.1	2.1	1.1	7.3	1.9	0.7	0.5	4.6	1.3	0.2	16.6
Greece	5.2	2.5	1.7	9.4	1.3	1	0.3	5.4	0.7	1	18.9
Cyprus	8.5	5.2	2.2	15.9	0.2	0	0.1	2.2	0.1	0.2	18.7
Women	4.4	2.2	1.7	8.3	1.3	0.8	0.3	4.5	0.9	0.2	16.2
Men	5	2.2	0.8	8	1.2	0.8	0.3	4.4	1.2	0.4	16.1
18-34	4.5	2.3	1.7	8.5	1.6	1.2	0.4	4.4	1.1	0.5	17.7
35-64	5.4	2.4	1.1	8.9	1.1	0.7	0.2	4.3	1.1	0.3	16.5
65+	3.2	1.5	0.9	5.6	1.1	0.5	0.1	4.7	1	0.1	13.2

Note: Excludes participants with number of trips, across all modes, above the 95% percentile of the distribution (equal to 50 trips)



Note: Excludes participants with number of trips, across all modes, above the 95% percentile of the distribution (equal to 50 trips)

Figure 92. Travel modes, by country, gender, and age (% of trips)

18% of the sample participants escort children to school or after-school activities once a day and another 19% several times a day (Figure 93). This is a total of 37%, a number almost identical to the proportion of participants reporting the live in a household with children (as previously seen in Figure 81).

The propensity to escort children is higher in Spain and Greece, and much higher in Cyprus, than in other countries. Women are also more likely to escort children several times a day (23%) than men are (13%), and the 65+ group is less likely to escort children several times a day but more likely to escort them less regularly (few times per week) than younger age groups.

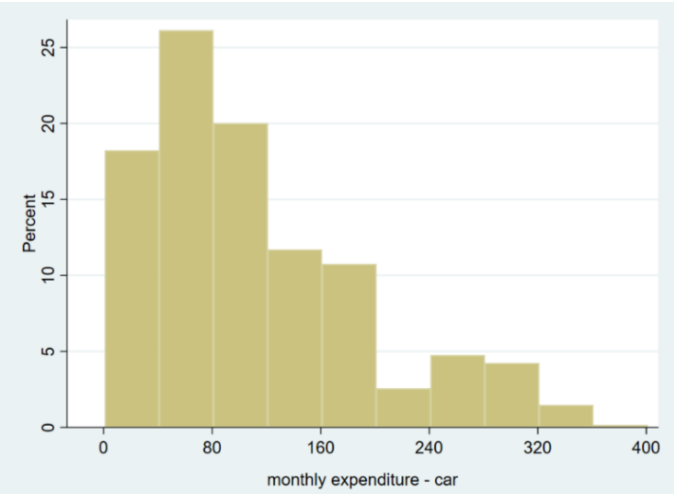
Figure 93. Frequency (per week) of escorting children, by country, gender, and age

5.4.3 Travel costs

The histograms in Figure 94, Figure 95, and Figure 96 show the statistical distribution of the monthly costs per mode in the overall sample and Table 73 shows that participants spend an average of €115 in car travel, €36 in taxis, and €25 on public transport. Expenditures on car travel are higher in Cyprus (€166) and Netherlands (€142). In the latter case, this may be due to the high cost per trip (including fuel, parking, and other expenses), rather than the number of trips per month, which, as shown previously (Table 72) is lower in the Netherlands than all other seven countries. Expenditures on public transport are lower in Spain, Poland, and Greece than other countries. Again, this is likely to reflect lower public transport fares rather than number of trips per month, as these are the three countries where participants reported more trips by public transport (bus and train), as shown in Table 72. Women spend about the same as men. Participants aged 65+ spend much on all three modes than younger age groups.

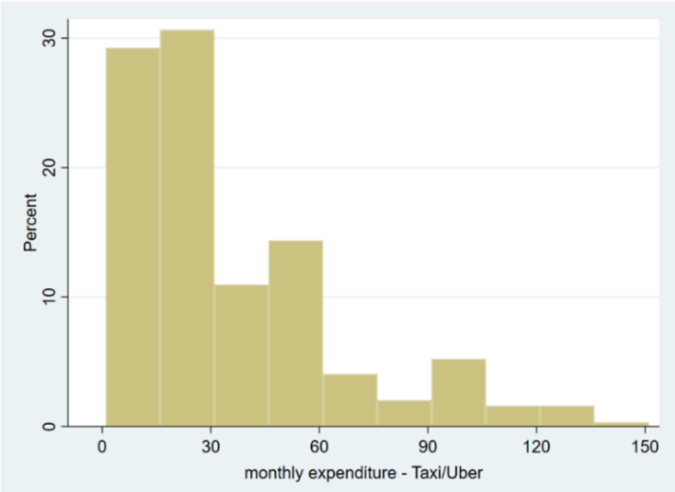
Table 73 shows the mean monthly travel cost per mode, country, gender, and age. Both exclude participants who indicated costs deemed to be unrealistic. These are identified as participants for whom the cost, for a given mode, is above the 95% percentile of the distribution. These percentiles are equal to €400 (car), €150 (taxi), and €100 (public transport). Original answers were in local currency. The values provided by participants in the United Kingdom and Poland were converted into Euro. It should be noted that the values are monthly and reflect not only the number of trips per mode but also the cost per trip.

The histograms show that most participants spend less than €120 on car travel and less than €30 on taxis or public transport. However, there are also a few participants stating much higher values.



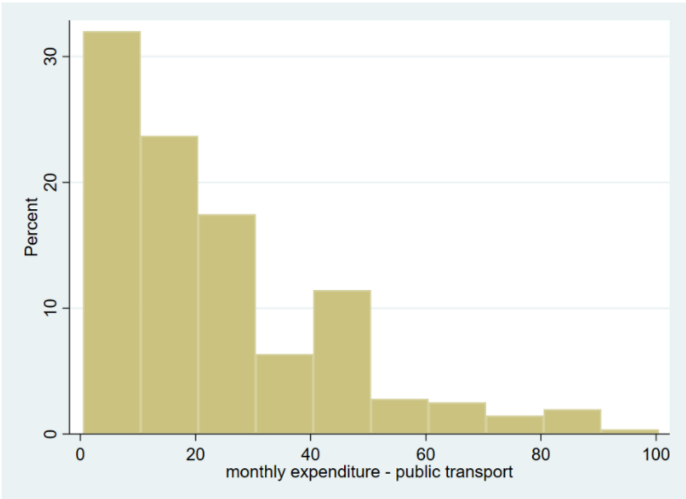
Note: Excludes participants with monthly travel cost above the 95% percentiles of the distribution (equal to €400).

Figure 94. Monthly travel expenditure – car (€)



Note: Excludes participants with monthly travel cost above the 95% percentiles of the distribution (equal to €150).

Figure 95. Monthly travel expenditure – taxi (€)



Note: Excludes participants with monthly travel cost above the 95% percentiles of the distribution (equal to €100).

Figure 96. Monthly travel expenditure – public transport (€)

Table 73 shows that participants spend an average of €115 in car travel, €36 in taxis, and €25 on public transport. Expenditures on car travel are higher in Cyprus (€166) and Netherlands (€142). In the latter case, this may be due to the high cost per trip (including fuel, parking, and other expenses), rather than the number of trips per month, which, as shown previously (Table 72) is lower in the Netherlands than all other seven countries. Expenditures on public transport are lower in Spain, Poland, and Greece than other countries. Again, this is likely to reflect lower public transport fares rather than number of trips per month, as these are the three countries where participants reported more trips by public transport (bus and train), as shown in Table 72. Women spend about the same as men. Participants aged 65+ spend much on all three modes than younger age groups.

Table 73. Mean monthly travel cost, per mode, country, gender, and age (€)

	Car	Taxi	Public transport
ALL	115	36	25
UK	111	46	31
Germany	117	40	35
France	99	44	32
Netherlands	142	42	31
Spain	107	40	19
Poland	92	25	16
Greece	113	25	17
Cyprus	166	26	23
Women	113	36	25
Men	116	35	25
18-34	125	39	27
35-64	120	35	26
65+	85	22	17

Note: Car travel cost includes all expenses (e.g. fuel, maintenance, and parking fees and fines). Results exclude participants with monthly travel cost above the 95% percentiles of the distribution (equal to €400 (car), €150 (taxi), and €100 (public transport)).

Finally, Figure 97 shows the factor ranked as the most important in participants' choice of travel mode. Overall, the main factor is travel time (ranked as the most important by 37% of participants), followed by convenience and comfort (22%) and travel cost (20%). No other factor was mentioned by more than 10% of participants. In Germany, convenience and comfort was the most frequent factor (28%). In Greece, convenience and comfort was ranked as the most important factor by only 16% (compared with 22% in the overall sample) and in Cyprus, travel cost was ranked as most important factor by only 10% (compared with 20% overall). Age is inversely related to ranking travel time and travel cost as the most important factor, and directly related to ranking convenience and comfort, and reliability, as the most important.

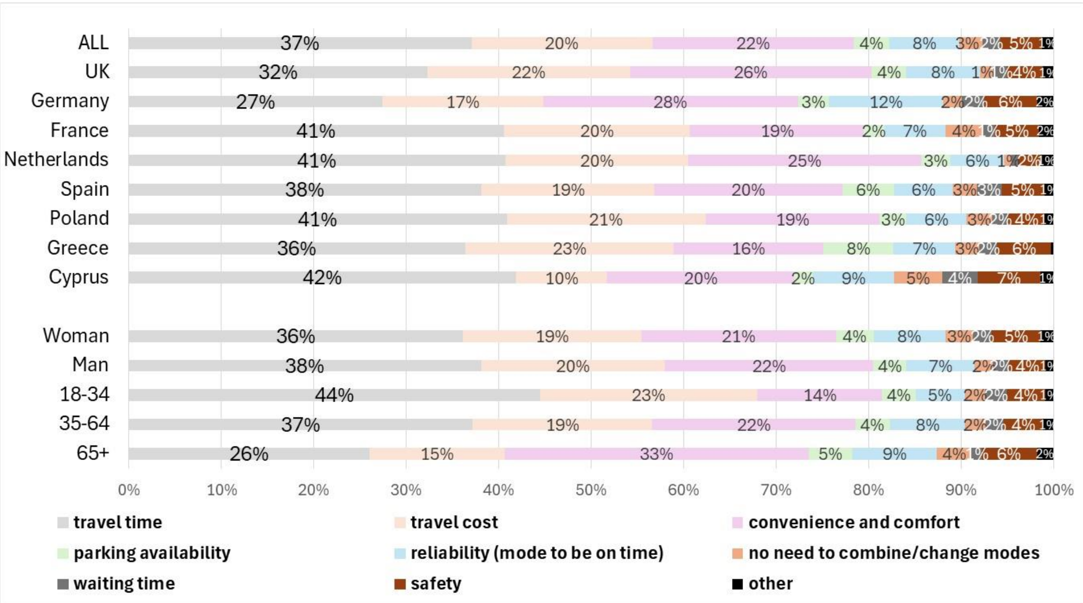


Figure 97. Main factor affecting mode choice, by country, gender, and age

5.4.4 Frequency and characteristics of delivery orders

We now turn on individual behaviour regarding ordering deliveries online or by phone. As shown in Figure 98, about half of the sample (48%) receives deliveries a few times per month. 16% receives deliveries at least a few times per week. This number is considerably higher in the United Kingdom. 37% receive deliveries few times per year or never. This number is higher in France and Poland. Women and men tend to receive deliveries with almost the same frequency. Age tends to be inversely related with the frequency of receiving deliveries. The most frequent type of deliveries is clothes (Figure 99).

Figure 98. Frequency of making delivery orders, by country, gender, and age

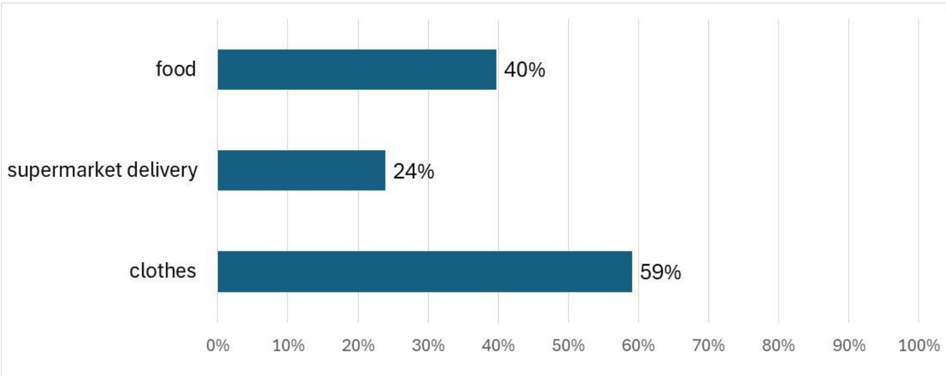


Figure 99. Type of deliveries received

5.5 Awareness of self-driving vehicles

Half of the sample have only listened about self-driving vehicles (Figure 100). 23% are aware and only 6% are well aware. 21% were not aware of self-driving vehicles. Levels of awareness tend to be higher in the United Kingdom, with half of the sample stating there are aware or well aware. In Germany, Poland, and Cyprus, the proportions of participants stating they were aware or well-aware of self-driving vehicles is lower than in other countries. In Poland and Cyprus this is accompanied by a higher proportion of participants stating they were not aware. In Germany, it is accompanied by a higher proportion of participants stating there have only listened to self-driving vehicles. Levels of awareness tend to be higher for men than for women. The proportion of participants stating they are aware or well aware is inversely related to age.

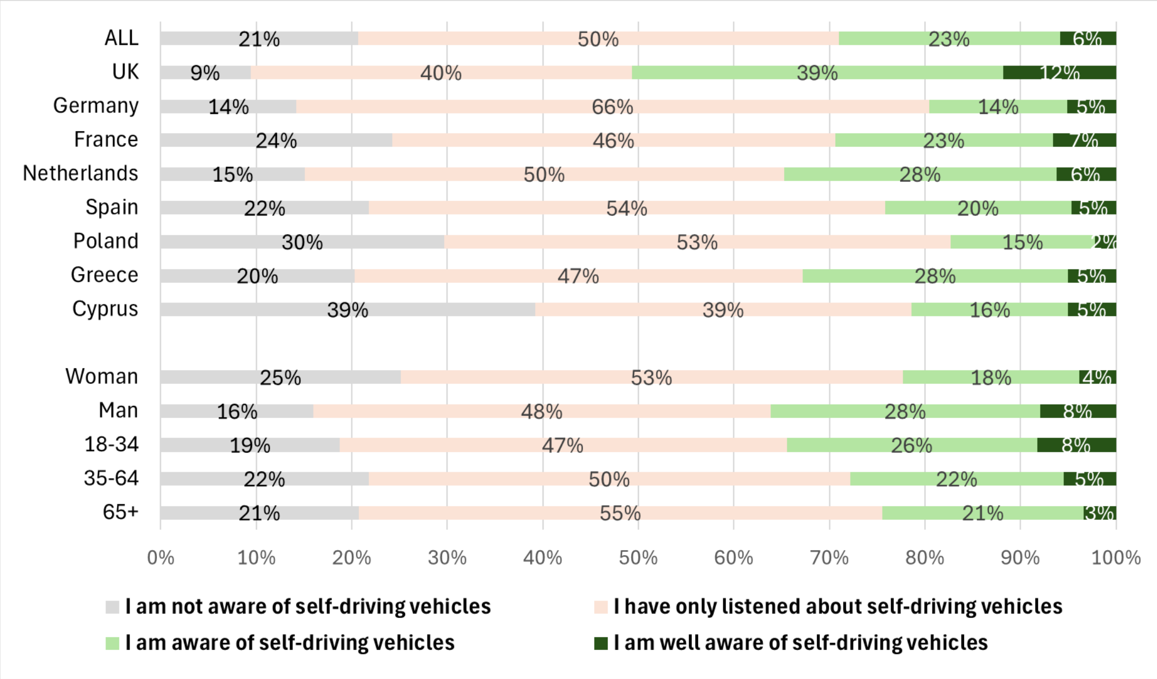


Figure 100. Level of awareness of self-driving vehicles, by country, gender, and age

The results also vary by region. The maps in Figure 101 (proportion not aware of self-driving vehicles) and Figure 102 (proportion aware or well aware) show that while levels of awareness are uniformly high across the United Kingdom and low across Poland, in other countries there are variations. For example, in Germany, levels of awareness are lower in the former East Germany, and in Greece they are lower in the islands. In Spain, levels of awareness are higher in Madrid.

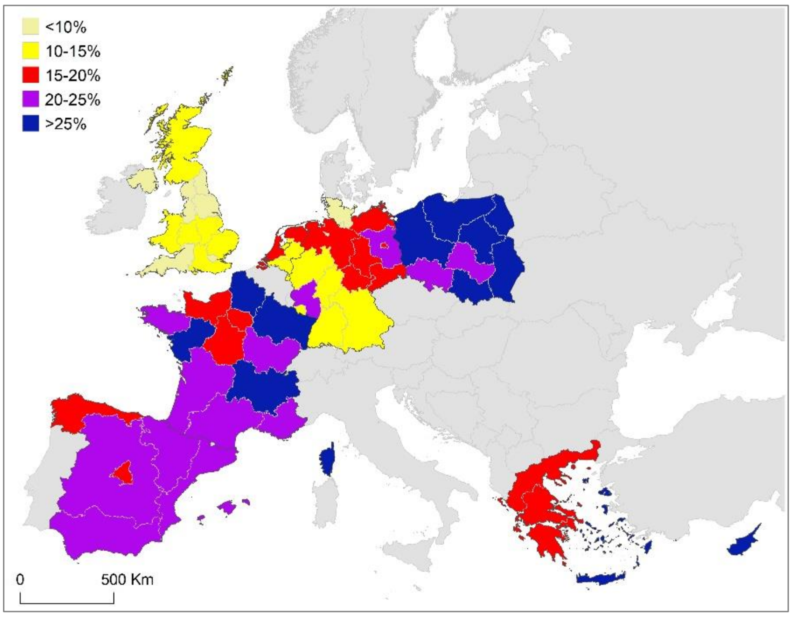


Figure 101. Proportion of participants not aware of self-driving vehicles, by region

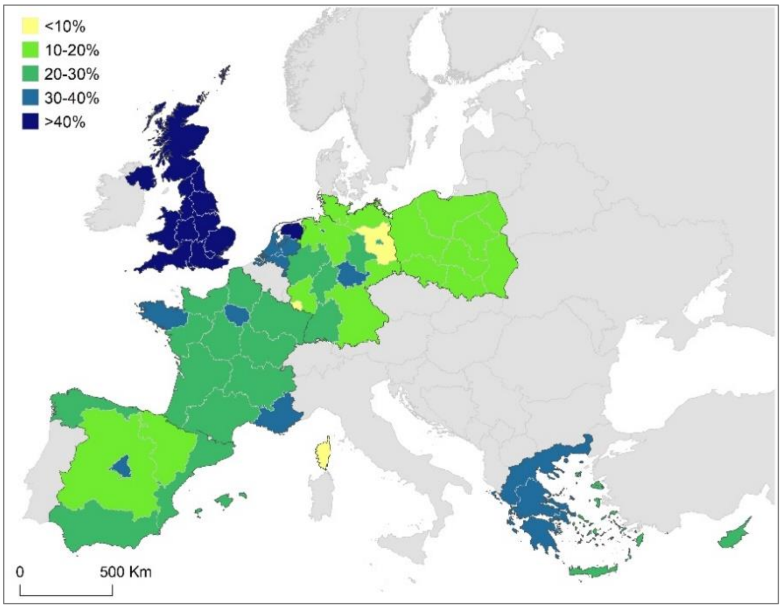


Figure 102. Proportion of participants aware or well aware of self-driving vehicles, by region

5.6 Intentions regarding self-driving passenger transport vehicles

5.6.1 Passenger transport use cases presented to survey participants

The survey considered three passenger transport use cases based on self-driving vehicles: private car (Figure 103), taxi (Figure 104) and bus (bus). These use cases were selected from a wider set co-created by citizens and organisations in previous activities of the project. The use cases are defined in terms of four characteristics: availability, procedure before the trip (i.e., waiting), procedure after the trip (i.e., what to do with the vehicle), and sharing the trip with others (or not). Each participant was presented (randomly) with two of these three use cases.

Figure 103. Self-driving private car

Figure 104. Self-driving taxi

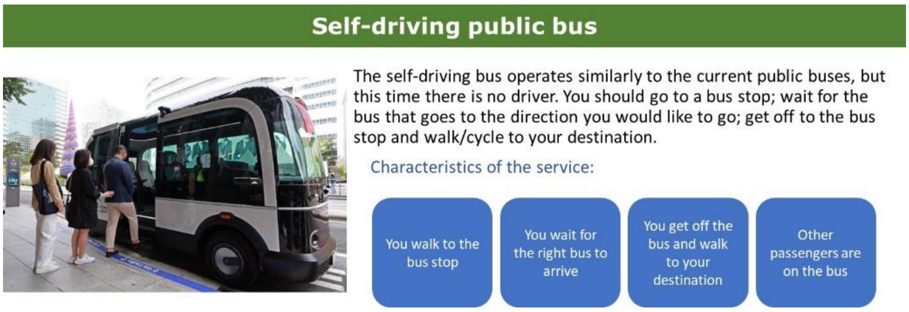


Figure 105. Self-driving bus

5.6.2 Likelihood of buying or using self-driving passenger vehicles

Table 74 shows the correlations between the various stated likelihoods. The number of observations (N) (in this and subsequent correlation tables in this report) differs from correlation to correlation as each participant only expressed likelihood for two of the three vehicles. Spearman correlations were used as variables are expressed on an ordinal scale (a 5-point scale)[4]. In this and subsequent correlation analyses, we describe correlations according to the following labels: 0-0.19: “very weak”, 0.2-0.39: “weak”, 0.40-0.59: “moderate”, 0.6-0.79: “strong” and 0.8-1: very strong”[2].

All correlations as positive, as expected. For a given purpose, someone who is likely to use one vehicle also tends to be likely to use another. Likewise, for a given vehicle, someone likely to use the vehicle for one purpose is also likely to use it for another purpose. There are strong correlations between almost all likelihoods, i.e. between buying a car and using it (for all three purposes); between each of the three purposes, for a given vehicle; and between car and taxi, for a given purpose. The only moderate correlations are between likelihoods of using bus and the other two vehicles. Given these results, some of the analyses in this and subsequent sections will not be disaggregated for all likelihoods.

[4] Swinscow, T D V. (1997) *Statistics at Square One*. BMJ Publishing Group., https://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one, Chapter 11

Table 74. Correlation between likelihoods of buying/using passenger vehicles

Likelihood A	Likelihood B	N	Spearman correlation
car (buy)	car (use - commuting)	5299	0.68
car (buy)	car (use - non-commuting)	5299	0.69
car (buy)	car (escort children)	2019	0.62
car (use - commuting)	car (use - non-commuting)	5299	0.79
car (use - commuting)	car (escort children)	2019	0.75
car (use - non-commuting)	car (escort children)	2019	0.74
taxi (use - commuting)	taxi (use - non-commuting)	5268	0.72
taxi (use - commuting)	taxi (escort children)	1911	0.65
taxi (use - non-commuting)	taxi (escort children)	1911	0.61
bus (use - commuting)	bus (use - non-commuting)	5315	0.75
bus (use - commuting)	bus (escort children)	1986	0.65
bus (use - non-commuting)	bus (escort children)	1986	0.67
car (use - commuting)	taxi (use - commuting)	2626	0.60
car (use - commuting)	bus (use - commuting)	2673	0.48
taxi (use - commuting)	bus (use - commuting)	2642	0.59
car (use - non-commuting)	taxi (use - non-commuting)	2626	0.59
car (use - non-commuting)	bus (use - non-commuting)	2673	0.42
taxi (use - non-commuting)	bus (use - non-commuting)	2642	0.58
car (escort children)	taxi (escort children)	972	0.59
car (escort children)	bus (escort children)	1047	0.43
taxi (escort children)	bus (escort children)	939	0.52

Note: N=number of observations. It differs from correlation to correlation as each participant answered questions for two types of vehicle only.

Figure 106 shows participants' intentions regarding buying the self-driving car and using the car, taxi, or bus for different trip purposes (commuting, non-commuting, and escort children). Around one quarter of the sample stated they were likely or very likely to buy the self-driving car, with another quarter being neutral and half stating they were unlikely or very unlikely. Participants were in general more receptive to the idea of using the private car for the trip purposes shown, rather than buying the car. They were also more receptive of using the car, followed by the bus and the taxi, for a given purpose. For a given vehicle, likelihood was in generally higher for trips to escort children, followed by non-commuting and commuting trips. This was especially the case for trips by car.

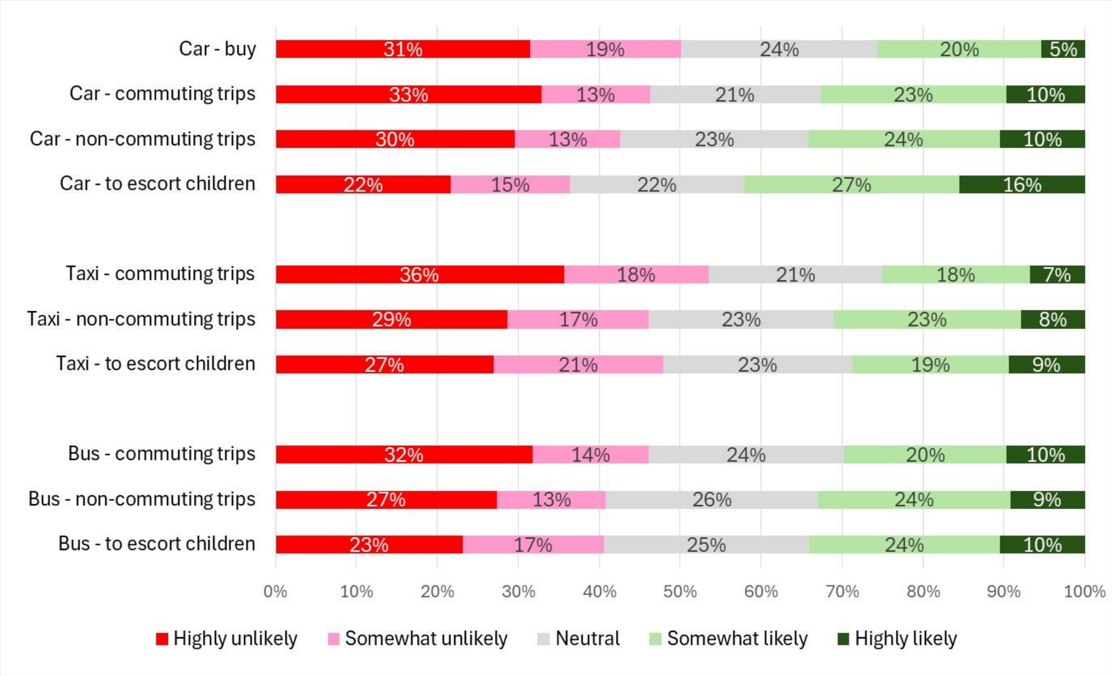


Figure 106. Likelihood of buying or using self-driving passenger vehicles

Table 75 shows the mean values of an indicator of likelihood of buying or using the various vehicles, overall, and by country, gender, and age. The 5-point likelihood scale was converted into a numerical one, assuming values -2 (highly unlikely), -1, 0, 1, and 2 (highly likely). The assumption is that participants perceive the original scale as a linear one, i.e. moves from one point to the next one always correspond to the same increase in likelihood. The mean likelihood is almost always negative, i.e. there is a stronger tendency for being unlikely to buy or use self-driving vehicles than to being likely. The only exception is to use a self-driving vehicle to escort children, with a mean likelihood of zero (i.e. participants are, on average, neutral).

The mean likelihood of buying a self-driving car is -0.51 (on the -2 to +2 scale), i.e. the average participant has a likelihood roughly between “neutral” and “somewhat unlikely”. Participants in Spain, Poland, and Cyprus have slightly less negative intentions. The likelihood decreases with age. Using a self-driving car for commuting or non-commuting has a less negative mean likelihood score than the one for buying the car. This is driven mostly by the positive likelihoods of participants in Greece and Cyprus. Participants are in general less likely to use a self-driving taxi than a self-driving car for a given purpose, overall and in almost all countries. They are almost as likely to use a self-driving bus and a self-driving car for commuting or non-commuting trips but are less likely to use the bus for escorting children. Across almost all cases, the stated likelihoods are inversely related with age but do not differ much between men and women.

Table 75. Mean likelihood of buying or using self-driving passenger vehicle, by country, gender, and age

	Car				Taxi			Bus		
	buy	commute	non-commute	escort children	commute	non-commute	escort children	commute	non-commute	escort children
All	-0.51	-0.37	-0.27	0.00	-0.57	-0.36	-0.37	-0.38	-0.26	-0.19
UK	-0.52	-0.48	-0.40	0.07	-0.64	-0.39	-0.34	-0.52	-0.38	-0.29
Germany	-0.55	-0.45	-0.42	0.11	-0.75	-0.57	-0.11	-0.50	-0.39	-0.11
France	-0.65	-0.69	-0.46	0.00	-0.96	-0.61	-0.36	-0.74	-0.45	-0.08
Netherlands	-0.65	-0.48	-0.42	-0.21	-0.68	-0.62	-0.62	-0.48	-0.44	-0.34
Spain	-0.38	-0.37	-0.18	-0.08	-0.51	-0.25	-0.38	-0.22	-0.03	-0.10
Poland	-0.54	-0.42	-0.25	0.08	-0.35	-0.14	-0.13	-0.22	-0.04	-0.03
Greece	-0.33	0.16	0.10	0.08	-0.17	-0.02	-0.35	0.06	0.01	-0.18
Cyprus	-0.30	0.10	0.04	-0.09	-0.35	-0.11	-0.71	-0.45	-0.43	-0.47
Women	-0.54	-0.38	-0.30	-0.08	-0.60	-0.38	-0.48	-0.39	-0.28	-0.30
Men	-0.47	-0.35	-0.24	0.09	-0.55	-0.34	-0.21	-0.37	-0.24	-0.05
18-34	-0.14	0.09	0.12	0.14	-0.21	0.01	-0.24	-0.08	0.00	-0.08
35-64	-0.46	-0.29	-0.23	-0.06	-0.52	-0.34	-0.43	-0.35	-0.28	-0.26
65+	-1.16	-1.25	-0.98	-0.74	-1.20	-0.91	-0.83	-0.94	-0.59	0.00

Notes: Scale from -2 to +2. Assumes that 1-point increases on the 5-point ordinal scale shown to participants correspond to the same increase in likelihood. Cyprus sample is 18-64 only and is not gender-balanced.

The results for the likelihood of buying a self-driving private car are shown in more detail in Figure 107. The results for the likelihoods of using the car, taxi, and bus for the three trip purposes are not shown as they reveal roughly similar country, age, and gender differences as the one for buying the car (which is consistent with the strong correlation between likelihoods as presented earlier in this section).

The results in Figure 107 show nuances that are not discernible when looking only at mean values in the table above. For example, while mean likelihoods are higher in Spain, Greece, and Cyprus than in other countries, as shown in the table, in Spain this is because of both higher proportions of participants stating they are somewhat or highly likely to buy the car and lower proportions of participants stating they are somewhat or highly unlikely. In Greece and Cyprus, it is because of the latter only. In these two countries there are also higher than average proportions of participants saying they are neutral. In the United Kingdom, while there are higher than average proportion of participants saying they are likely to buy the car, opinions are more polarised, i.e. there are also high proportions of participants saying they are unlikely, and relatively few participants saying they are neutral.

It is also worth noting the large differences in likelihoods across age groups (with likelihood generally decreasing with age). Almost three quarters (73%) of participants aged 65+ stated they are somewhat or highly unlikely to buy the car. Only 9% said they are somewhat likely and only 2% said they are highly likely.

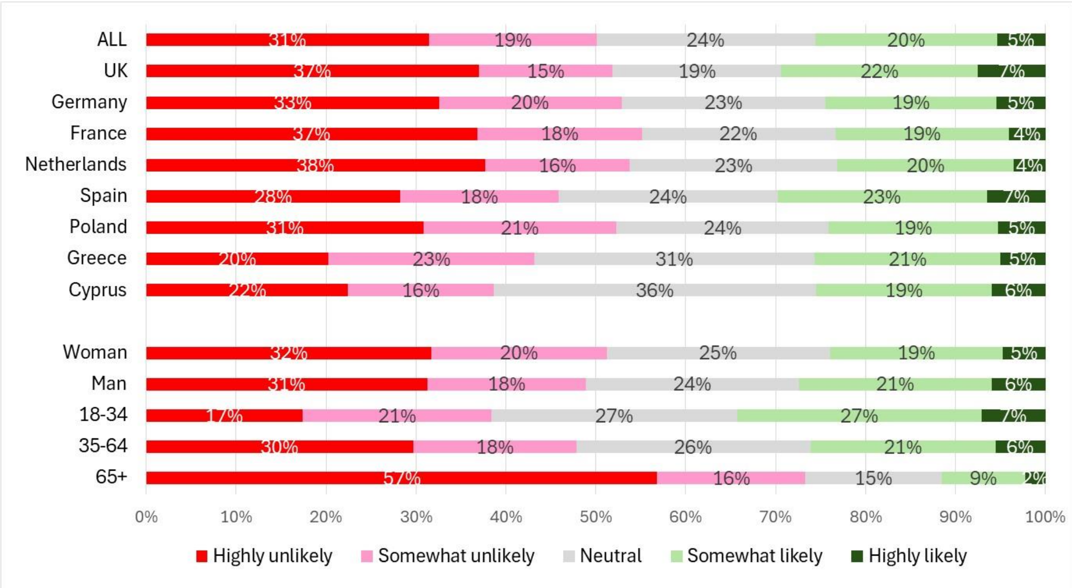
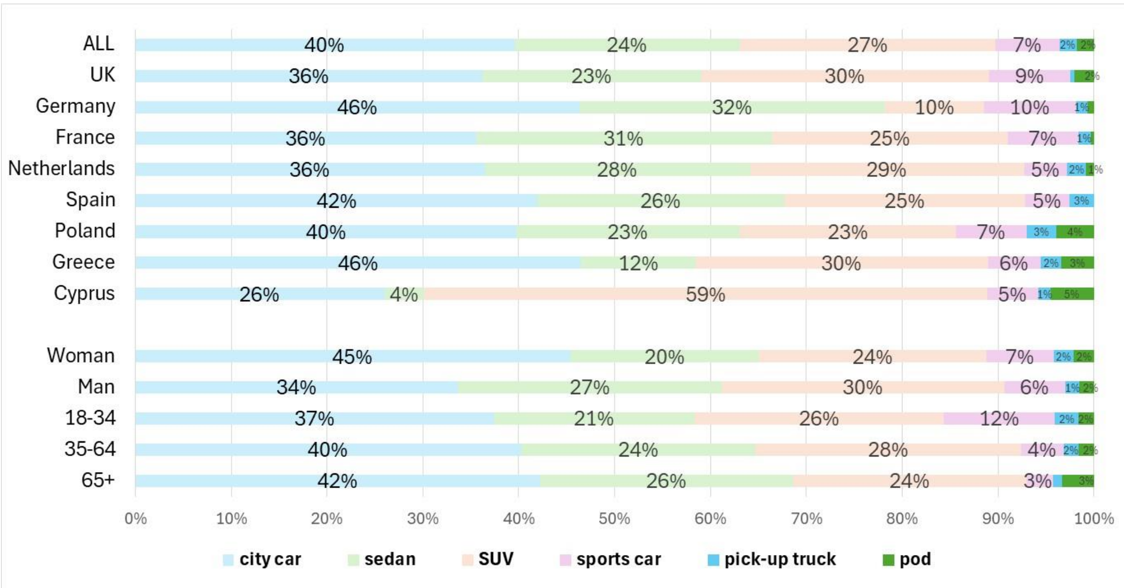


Figure 107. Likelihood of buying self-driving private car, by country, gender, and age

Among people planning to buy a self-driving car, the most popular car type is a city car (40%), followed by SUV (27%) and sedan (24%). However, in Cyprus, the majority (59%) preferred a SUV. Women were more likely to prefer a city car (45%) than men were (34%), and men more likely to prefer a sedan or SUV.



Note: Includes only participants who said they want to buy a self-driving private car (an option provided in the same question)

Figure 108. Type of self-driving car participant would buy, by country, gender, and age

The following maps show regional variations in the proportions of participants who stated they are (somewhat or highly) likely to buy the car and use the three vehicles. We only show maps of likelihoods for using vehicles for commuting trips. Maps for non-commuting trips and trips escorting children are not shown, as the respective likelihoods are correlated to the ones for commuting, as shown earlier in this section.

The proportion of participants likely to buy the self-driving car (Figure 89) varies in all countries. Most countries have regions with high proportions. Lower proportions are found in some parts of the former East Germany, all regions in East Poland, and Corsica (France). As seen in previous maps in this chapter (Sections 5.3.2 and 5.5), these are all regions with lower population densities, income per capita, and previous awareness of self-driving vehicles, compared with other regions in the same country. However, the Greek islands, which also have lower population density and income per capita than the rest of Greece, have higher proportions of participants likely to buy the self-driving vehicle. This could be because of higher levels of awareness of this type of vehicles, as shown previously in Section 5.5.

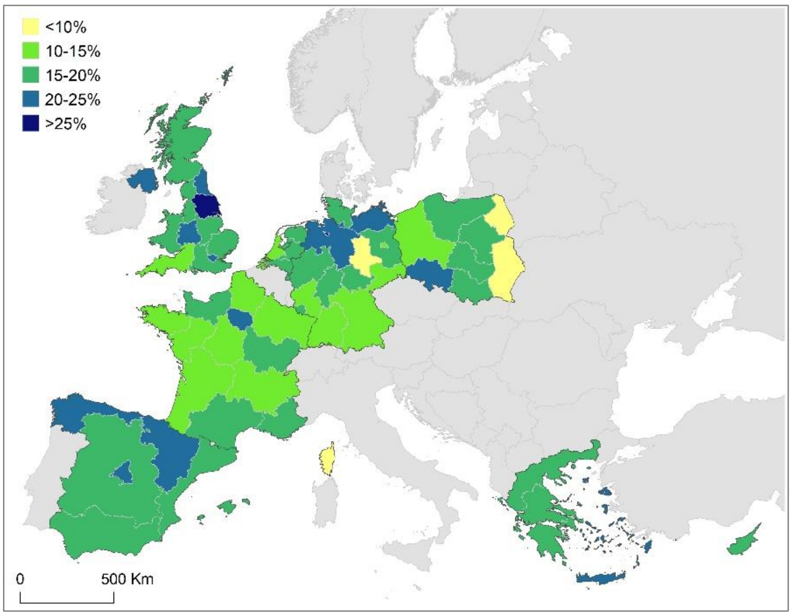


Figure 109. Proportion of participants likely to buy self-driving private car, by region

The maps of the proportions of participants likely to use the vehicles use the same classification scheme and the same legend colours are the map above. This makes it clear that the proportions of participants likely to use the self-driving car for commuting (Figure 110) are generally higher than the proportions likely to buy a car as seen above. The highest proportions of participants likely to use the self-driving car are found in the United Kingdom (both in London but also some of the lower-income regions such as Wales and the North East), in North Germany, and the whole of Greece and Cyprus.

The proportions of participants likely to use taxi for commuting (Figure 111) are generally lower than the ones for the private car.

The maps for the case of the public bus (Figure 112) shows a different regional pattern than the one for the private car. The highest proportions are found across most of Spain, Poland, Greece, and some parts of the United Kingdom (again, both London and some lower-income regions such as Wales, Cornwall, and the Northeast).

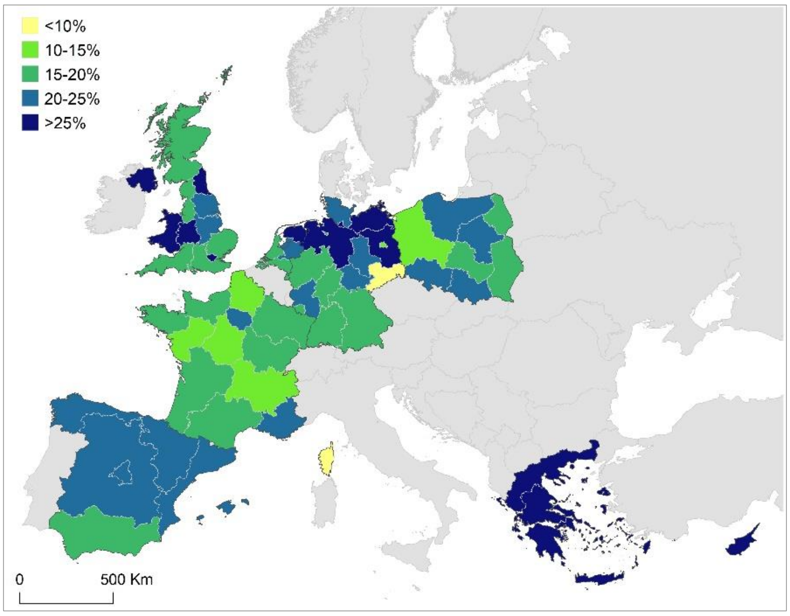


Figure 110. Proportion of participants likely to use self-driving private car for commuting, by region

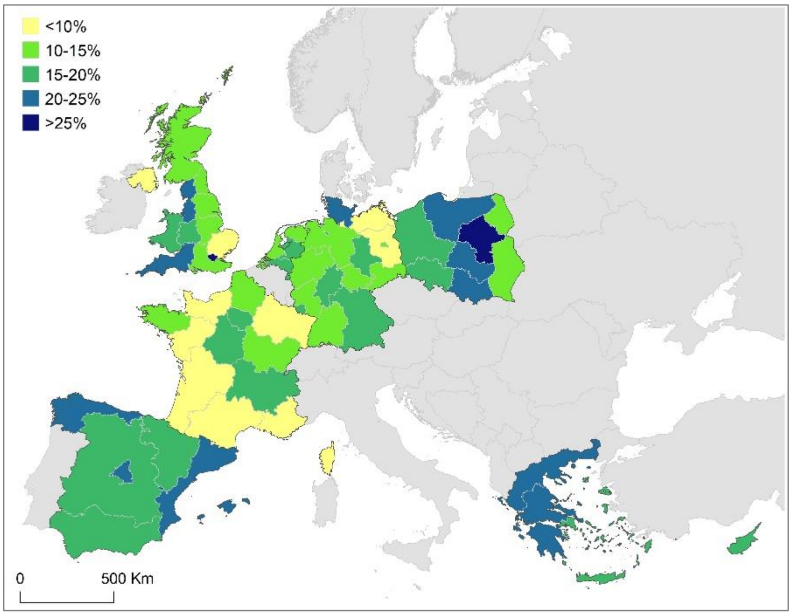


Figure 111. Proportion of participants likely to use self-driving taxi for commuting, by region

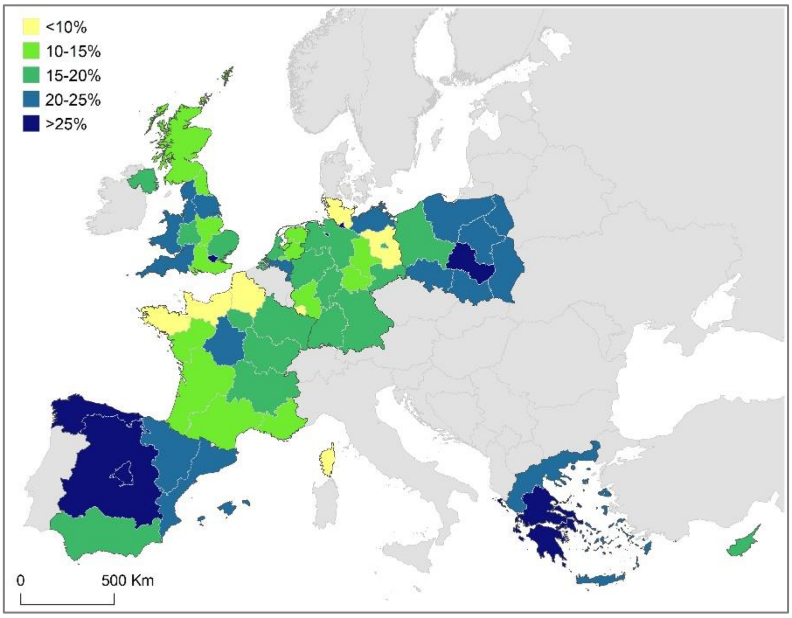


Figure 112. Proportion of participants likely to use self-driving public bus for commuting, by region

While map comparison gives some hints on the possible factors explaining likelihood of buying or using self-driving vehicles, this approach does not control for other factors. Later in this chapter (Section 5.8), we estimate statistical models relating likelihood with other variables, including the perceived impact that self-driving vehicles will have on individuals (which will be the focus of Section 5.5).

5.6.3 Willingness to pay for buying or using self-driving passenger vehicles

Table 76 shows the correlations between the various willingness to pay values. Pearson correlations were used as all variables are continuous. All correlations are positive, as expected. There are only very weak correlations between the willingness to buy and use a car or between willingness to use a car and a taxi. The correlation between willingness to pay to use taxi and bus are higher, but still moderate (0.46). Willingness to pay to use car and bus are almost completely independent (correlation close to zero). Given these results, the analysis that follows is separate for the four types of willingness to pay.

Table 77 shows the correlations between willingness to pay and respective likelihoods (analysed in the last section). Only likelihoods for commuting trips are considered, as likelihoods for other trip purposes are correlated with these, as seen before. Spearman correlations are used as likelihoods are ordinal variables and willingness to pay are continuous variables. All correlations are positive, as expected. However, the correlations are weak or very weak. This suggests the analysis of willingness to pay is justified, as it provides information not provided in the analysis of likelihoods.

Table 76. Correlation between willingness to pay values

Willingness to pay A	Willingness to pay B	N	Pearson correlation
car (buy)	car (use)	3100	0.18
car (use)	taxi (use)	2626	0.13
car (use)	bus (use)	2673	-0.003
taxi (use)	bus (use)	2642	0.46

Note: N=number of observations. It differs from correlation to correlation as each participant answered questions for two types of vehicle only.

Table 77. Correlation between likelihoods and willingness to pay

Likelihood	Willingness to pay	N	Spearman correlation
car (buy)	car (buy)	3100	0.15
car (use – commuting)	car (use)	2626	0.22
taxi (use - commuting)	taxi (use)	2673	0.08
bus (use - commuting)	bus (use)	2642	0.02

The histograms in Figure 113 to Figure 116 show the statistical distribution of willingness to pay to buy the self-driving car and use the three vehicles. Table 78 shows mean willingness to pay per country, gender, and age. Both exclude participants who indicated values deemed to be unrealistic, identified as the ones above the 95% percentile of each distribution. These percentiles are equal to €50,000 (buy car), €350/month (use car) €25 (3-km taxi ride), and €30 (1-way bus ticket). Participants stating a willingness to pay of zero were also excluded.

The willingness to pay to buy a car (Figure 113) follows a distribution peaking at €25,000-30,000 and with mean equal to €24,276 (Table 78). There are more participants indicating a value below €25,000 than above €35,000. The willingness to pay question reminded participants that the average current value of an electric sedan is around €30,000. The results suggest that either:

- people are willing to pay less for a self-driving vehicle than a conventional one, or
- they think in terms of smaller, cheaper types of private car (in fact, the most common private car participants said they would but are “city car”, as previously shown in Figure 108).

Willingness to pay to use (i.e. operate and maintain) a self-driving private car has an overall mean of €100/month (Table 78). This is lower than what they currently spend on car travel (€115), as seen previously in Table 73. Most values of willingness to pay to use a self-driving car are below the mean, although participants indicated a range of values up to €350 (Figure 114).

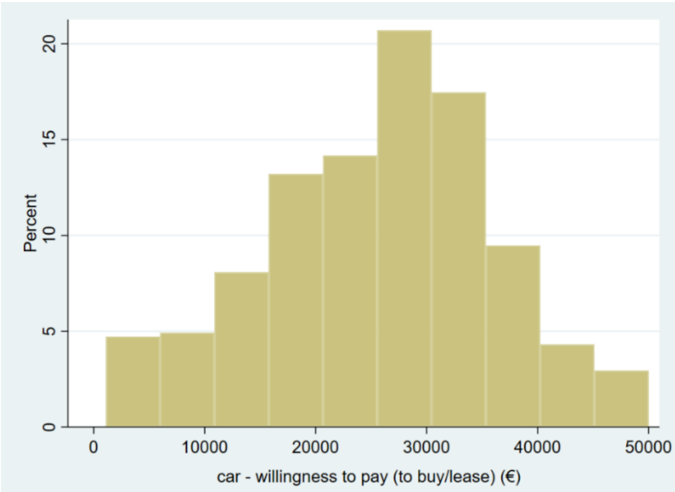
The mean willingness to pay to use a self-driving taxi is €7.6 (Table 78). However, the frequent values were between €2.5 and €5 (Figure 115). The mean willingness to pay for a 1-way bus ticket (to an unspecified location) is €5.6 (Table 78), but more than 60% of participants indicated a value below €3.5 (Figure 116). As reference, survey participants currently spend a monthly average of €36 on taxis and €25 on public transport, as seen previously in Table 73.

Willingness to pay is usually related to ability to pay so it is expected that countries with higher income per capita have higher average willingness to pay. Indeed, willingness to pay values tend be lowest in Greece and Poland, the two countries with the lowest income per capita (Table 78). The countries with the highest income per capita (Netherlands and Germany) have the highest willingness to pay to use car or bus, but the United Kingdom has the highest willingness to pay to buy a car or use a taxi.

Men have higher willingness to pay to buy or use car but lower willingness to pay to use a taxi than women have. The values to use bus are not much different between genders. The results for the car could reflect higher income or stronger preference for car travel among men. The results for taxi could reflect a stronger preference to use taxi (e.g. in comparison with bus) among women, which could be related to personal security or other concerns.

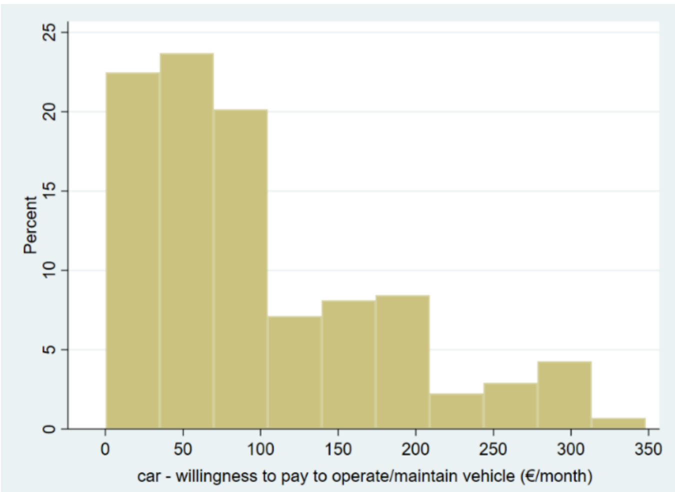
The 35-64 group has the highest willingness to pay to buy a self-driving car but the 18-34 age group has the highest willingness to pay to use a car, taxi, or bus. These results are likely to reflect income differences and associated travel mode choices. The 35-64 group tends to have higher income, which means higher ability to pay and thus higher car ownership (as seen previously in Figure 88), while the younger age group is more likely to currently use taxis or buses (as seen previously in Table 72). The younger age group may also be more likely to accept shared use of self-driving cars, rather than buying their own car for personal use, which would explain their below-average willingness to buy but higher-than-average willingness to use a car.

Later in this chapter (Section 5.8), we estimate statistical models relating willingness to pay with other variables.



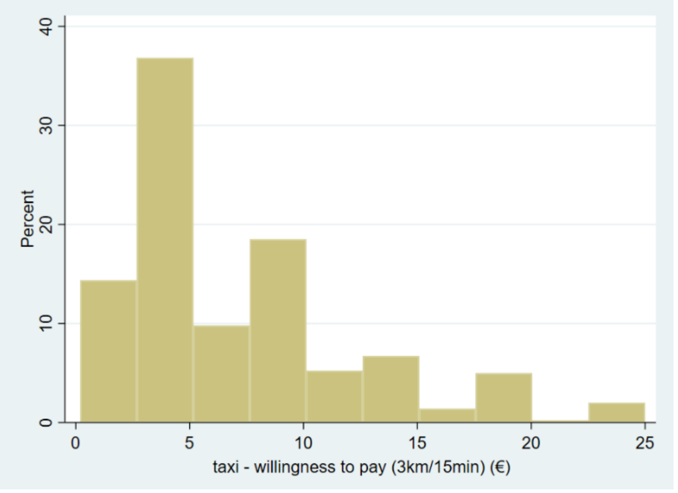
Note: Excludes participants with willingness to pay of zero or above the 95% percentile (equal to €50,000).

Figure 113. Willingness to pay to buy or lease a self-driving private car (€)



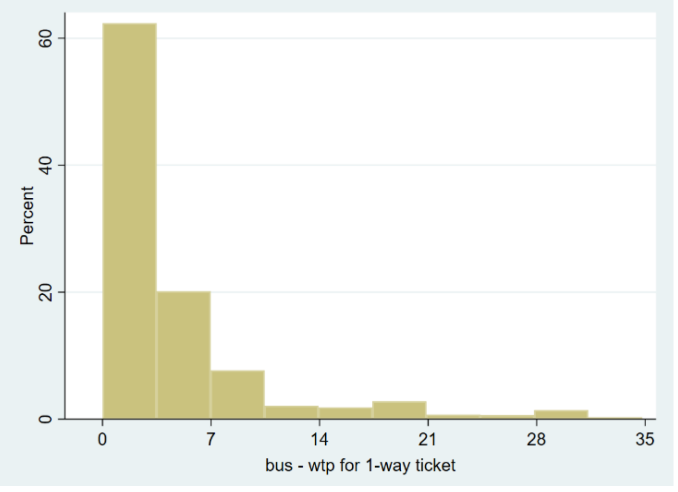
Note: Excludes participants with willingness to pay of zero or above the 95% percentile (equal to €350).

Figure 114. Willingness to pay to use self-driving private car (€/month)



Note: Excludes participants with willingness to pay of zero or above the 95% percentile (equal to €25).

Figure 115. Willingness to pay to use self-driving taxi (€/3km or 15 minute-trip)



Note: Excludes participants with willingness to pay of zero or above the 95% percentile (equal to €35).

Figure 116. Willingness to pay to use self-driving bus (€/1-way ticket)

Table 78. Mean willingness to pay to buy/use self-driving vehicle (€), by country, gender, and age

	car		taxi	bus
	buy or lease	operate and maintain, per month	3km trip	1-way trip
All	24,276	100	7.6	4.8
UK	26,451	109	10.5	5.9
Germany	25,275	110	8.7	6.3
France	23,255	92	7.8	5.7
Netherlands	25,643	119	8.9	6.3
Spain	26,383	93	8.6	4.9
Poland	20,968	80	4.4	2.7
Greece	22,838	96	6.0	3.0
Cyprus	23,780	124	6.5	3.6
Women	23,526	98	8.1	4.6
Men	25,023	103	7.1	5.0
18-34	23,845	110	8.5	5.6
35-64	24,796	102	7.3	4.5
65+	23,358	76	7.1	4.3

5.6.4 Willingness to share trips

In the case of the self-driving taxi only, participants were asked if they were willing to share the vehicle with strangers. Only about half said they would (Figure 117). Participants in the United Kingdom had, by far, the lowest willingness to share (37%). Men were more willing to share than women, and the 35-64 age group were more willing to share than younger and older groups.

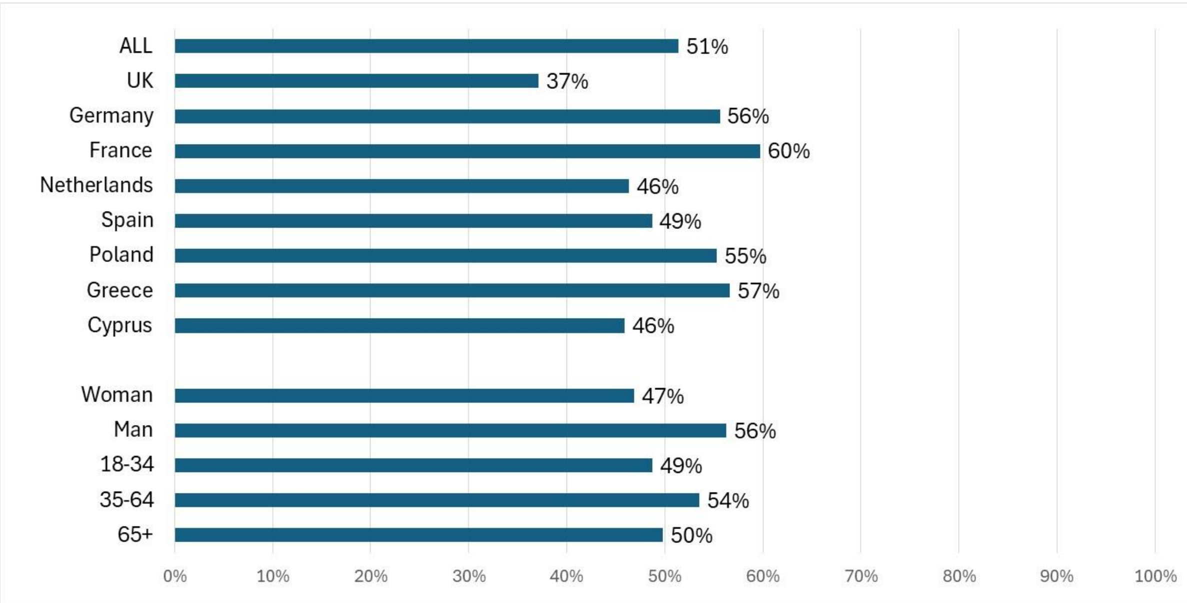


Figure 117. Willingness to share self-driving taxi with strangers, by country, gender, and age

5.7 Impacts of self-driving passenger transport vehicles on individual behaviour

5.7.1 Overview

This section reports the results of participants' stated impacts of self-driving passenger vehicles on individual behaviour. Sub-section 5.7.2 analyses correlations between the impacts. The following sections focus on the various impacts: travel time (5.7.3), number of trips (5.7.4), travel mode substitution (5.7.5), parking needs (5.7.6), and residence location (5.7.7). The analyses are split only by country, gender, and age, but in the following section (5.8) we estimate models of each impact, to identify how they relate with a broader range of variables.

Impacts on **travel time** and **number of trips** are expressed on a continuous scale. In these cases, we analyse the statistical distribution, across the whole sample, of the impacts of the three types of vehicles, and the average impact, overall and by country, gender, and age.

Impact on **travel mode substitutio**n is on a 5-point ordinal scale. We analyse the distribution of participant answers on the 5-point scale, comparing substitution between modes across the whole sample. We also estimate average substitution rates across countries, genders, and age groups.

Impacts on **parking needs** and **residence location** are expressed on 5-point ordinal scales. In these cases, we analyse:

- The distribution of participant answers on the 5-point scale, comparing the three vehicles across the whole sample
- The average impacts across the whole sample and disaggregated by country, gender, and age. The 5-point scale was converted into a numerical one, assuming values from -2 to +2. Again, the assumption is that participants perceive the original scale as a linear one, i.e. moves from one point to the next one always correspond to the same increase in impact
- The distribution of participant answers on the original 5-point scale for each vehicle, disaggregated by country, gender, and age.

5.7.2 Correlations between impacts

Table 76 shows the correlations between the various impacts of a given vehicle, and the correlations between the impacts of different vehicles. The correlations are very week to moderate. As such, separate analyses are conducted for all impacts in the sub-sections that follow. All correlations are positive i.e. changes in travel time, number of trips, parking needs, and residence re-location towards more central areas tend to move all in the same direction.

Table 79. Correlation between impacts of self-driving passenger vehicles on individual behaviour

Impact A	Impact B	N	Correlation	Type
Travel time (car)	Number of trips (car)	5299	0.45	Pearsons
Travel time (car)	Parking needs (car)	5299	0.18	Spearman
Travel time (car)	Residence location (car)	5299	0.15	Spearman
Number of trips (car)	Parking needs (car)	5299	0.20	Spearman
Number of trips (car)	Residence location (car)	5299	0.17	Spearman
Parking needs (car)	Residence location (car)	5299	0.35	Spearman
Travel time (taxi)	Number of trips (taxi)	5268	0.36	Pearsons
Travel time (taxi)	Parking needs (taxi)	5268	0.10	Spearman
Travel time (taxi)	Residence location (taxi)	5268	0.09	Spearman
Number of trips (taxi)	Parking needs (taxi)	5268	0.14	Spearman
Number of trips (taxi)	Residence location (taxi)	5268	0.14	Spearman
Parking needs (taxi)	Residence location (taxi)	5268	0.32	Spearman
Travel time (bus)	Number of trips (bus)	5315	0.53	Pearsons
Travel time (bus)	Parking needs (bus)	5315	0.11	Spearman
Travel time (bus)	Residence location (bus)	5315	0.16	Spearman
Number of trips (bus)	Parking needs (bus)	5315	0.13	Spearman
Number of trips (bus)	Residence location (bus)	5315	0.20	Spearman
Parking needs (bus)	Residence location (bus)	5315	0.39	Spearman
Travel time (car)	Travel time (taxi)	2626	0.53	Pearsons
Travel time (car)	Travel time (bus)	2673	0.45	Pearsons
Travel time (taxi)	Travel time (bus)	2642	0.52	Pearsons
Number of trips (car)	Number of trips (taxi)	2626	0.47	Pearsons
Number of trips (car)	Number of trips (bus)	2673	0.44	Pearsons
Number of trips (taxi)	Number of trips (bus)	2642	0.53	Pearsons
Parking needs (car)	Parking needs (taxi)	2626	0.40	Spearman
Parking needs (car)	Parking needs (bus)	2673	0.30	Spearman
Parking needs (taxi)	Parking needs (bus)	2642	0.50	Spearman
Residence location (car)	Residence location (taxi)	2626	0.49	Spearman
Residence location (car)	Residence location (bus)	2673	0.37	Spearman
Residence location (taxi)	Residence location (bus)	2642	0.38	Spearman

Note: N=number of observations. It differs from correlation to correlation as each participant answered questions for two types of vehicle only.

5.7.3 Impact on travel time

Figure 118 to Figure 120 show the statistical distribution, across the whole sample, of the impact of the three self-driving vehicles on the travel time (in minutes) of the most frequent trip that participants currently make. Table 80 shows the average impact by country, gender, and age.

The impacts follow almost normal distributions, centred around a clear peak slightly above zero. Most values are between -20 and +40 minutes. On average, self-driving cars, taxis, and buses would increase travel time by 2.2, 3.8, and 1.5 minutes, respectively. These represent relative increases of 7%, 13% and 5%, considering that the current mean trip duration is 30 minutes as seen before in Table 71.

On average, almost all sub-sets of the data believe the availability of self-driving cars and taxis will increase the travel time of their most frequent trip. The exceptions are Cyprus and people aged 65+, who, on average, believe that travel time would decrease. Self-driving taxis tend to be associated with slightly higher increases in travel time than self-driving cars. Self-driving buses are also believed to lead to (small) travel time increases, overall, but not in all countries. Again, people aged 65+ believe that travel time would decrease with the availability of self-driving buses.

In Cyprus and Greece, buses are believed to lead to a considerably higher increase in bus travel time, compared with other counties, or to the other two vehicles.

For all three vehicles, men believe travel time increases will be larger than women do, and age is inversely related to change in travel time: younger age groups believe their travel time will increase more than older ones do.

In general, there is a tendency among survey participants to think that travel time will increase, although this increase is small, on average. This tendency could be explained by three hypotheses:

- Participants may believe that congestion will increase – however, as will be seen later in Section 5.14.3 of this report, the average perception among survey participants is that congestion will remain almost the same as now.
- They may believe that self-driving vehicles will be slower than human-driven ones (for example, because it will be more difficult to travel above the speed limit, or because of other safety or other features of the vehicles.
- They may be planning to travel longer distances due to increased perceived convenience or another quality of self-driving vehicles. Their most frequent trip would then require a longer travel time. The fact that people believe that self-driving cars and taxis would increase travel time to a larger extent than self-driving bus also supports this hypothesis, as these modes are private and allow for more flexibility to make longer trips.

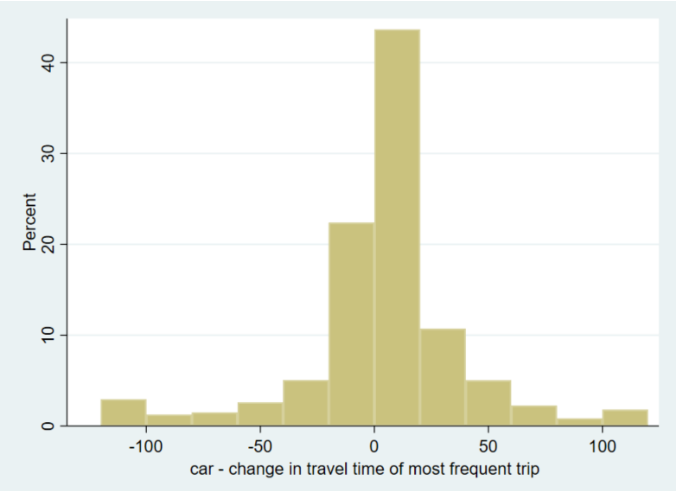


Figure 118. Impact of self-driving car on individual travel time

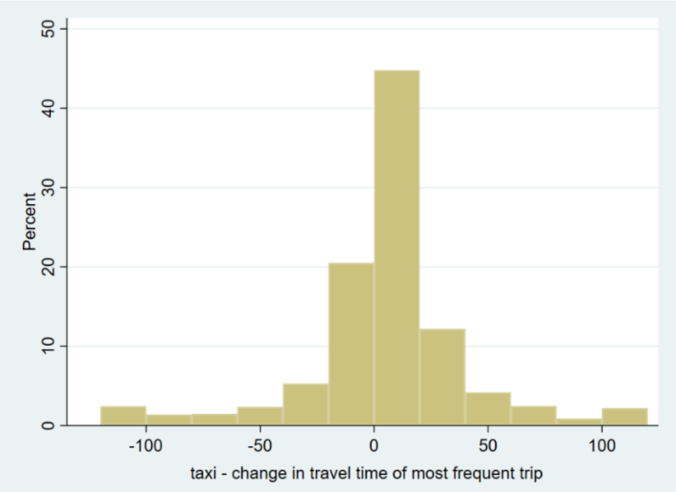


Figure 119. Impact of self-driving taxi on individual travel time

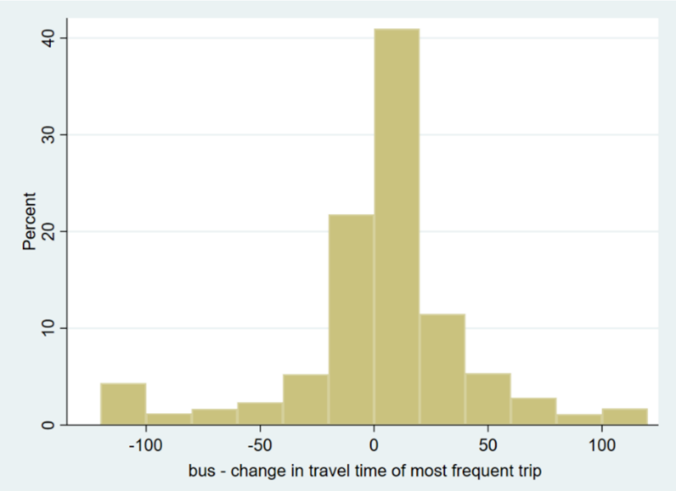


Figure 120. Impact of self-driving bus on individual travel time

Table 80. Average impact of self-driving passenger vehicles on travel time (minutes) of most frequent trip, by country, gender, and age

	Car	Taxi	Bus
All	2.2	3.8	1.5
UK	3.4	4.6	-1.8
Germany	5.6	5.9	2.3
France	1.3	3.4	-2.0
Netherlands	1.5	6.7	0.9
Spain	1.6	1.5	1.9
Poland	1.4	2.9	-0.3
Greece	2.6	3.1	7.3
Cyprus	-0.8	1.0	6.6
Women	0.9	2.6	0.7
Men	3.7	5.1	2.2
18-34	7.3	6.5	6.7
35-64	1.1	3.2	0.8
65+	-2.3	1.8	-4.3

Notes: Values in minutes. Cyprus sample is 18-64 only and is not gender-balanced.

5.7.4 Impact on number of trips

Figure 121 to Figure 123 show the statistical distribution, across the whole sample, of the impact of the three self-driving vehicles on the number of trips that participants make per week. Table 81 shows the average impact by country, gender, and age. Again, the impacts follow almost normal distributions, centred around a clear peak slightly above zero. Most values are between -5 and +5 trips. On average, self-driving cars, taxis, and buses would increase number of weekly trips by 1.4, 0.9, and 0.6 trips, respectively. These are modest relative increases of 9%, 6%, and 4%, respectively, considering that the currently average number of trips survey participants make is 16.1, as seen before in Table 72.

Almost all average impacts are positive, although small in magnitude. However, the 65+ age group believes, on average, that the three self-driving vehicles would decrease the number of trips that they make. While it is expected that the flexibility provided by self-driving vehicles could be linked to more trips, a reduction of trips is also plausible. For example, travel flexibility may allow individuals to travel to new destinations which are difficult to access now (for example, city centres, for people living in rural areas), and where more than one activity could be performed, without the need to make multiple trips to several destinations. There could also be a concern with the cost of the new modes, which could lead to an intention to reduce trips. In the case of the 65+ group, concerns with aspects of the vehicle (e.g. safety, need to rely on technology) could also explain expected trip reduction.

Most mean impacts are small in magnitude. They tend to be higher in the four countries with lower income per capita (Spain, Poland, Greece, and Cyprus), and lower in the four countries with higher income per capita. In particular, the richest country (Netherlands) has, by far, the lowest expected increase in number of trips (close to zero).

Age is inversely related to change in number of trips: younger age groups believe the number will increase more than older ones do.

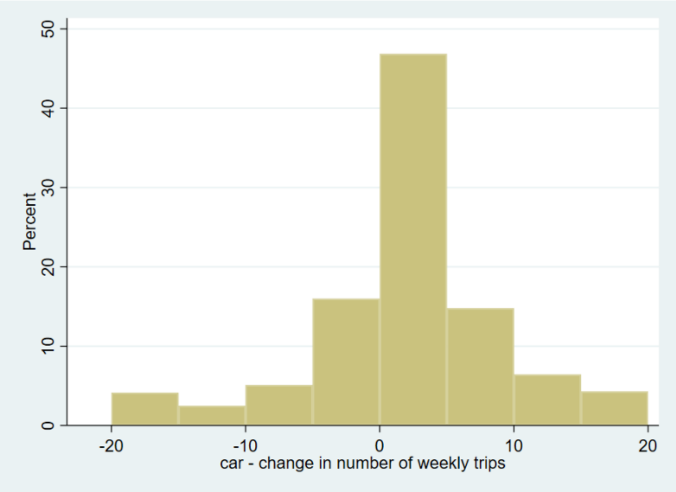


Figure 121. Impact of self-driving cars on number of trips

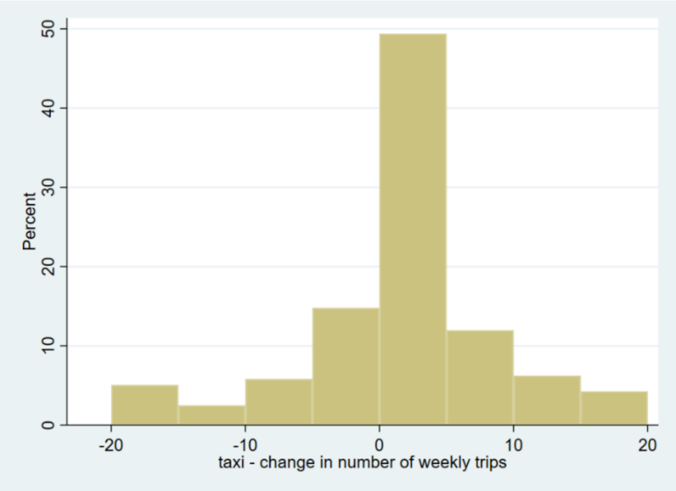


Figure 122. Impact of self-driving taxis on number of trips

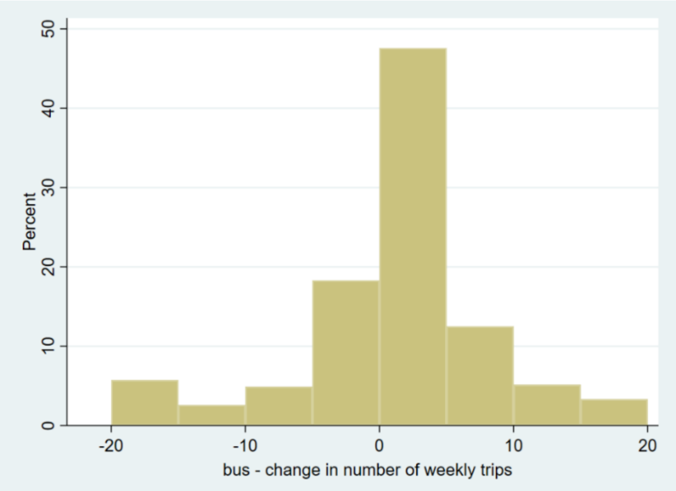


Figure 123. Impact of self-driving buses on number of trips

Table 81. Average impact of self-driving passenger vehicles on number of trips, by country, gender, and age

	car	taxi	bus
All	1.3	0.9	0.6
UK	1.0	0.3	-0.6
Germany	1.3	0.6	0.2
France	1.1	0.3	-0.2
Netherlands	0.3	0.2	-0.2
Spain	1.8	1.3	1.2
Poland	2.0	2.0	1.3
Greece	1.9	1.5	1.7
Cyprus	1.5	1.4	1.9
Women	1.2	0.9	0.6
Men	1.5	1.0	0.5
18-34	2.6	2.1	1.5
35-64	1.3	0.9	0.5
65+	-0.4	-0.5	-0.8

Notes: Cyprus sample is 18-64 only and is not gender-balanced.

5.7.5 Impact on travel mode substitution

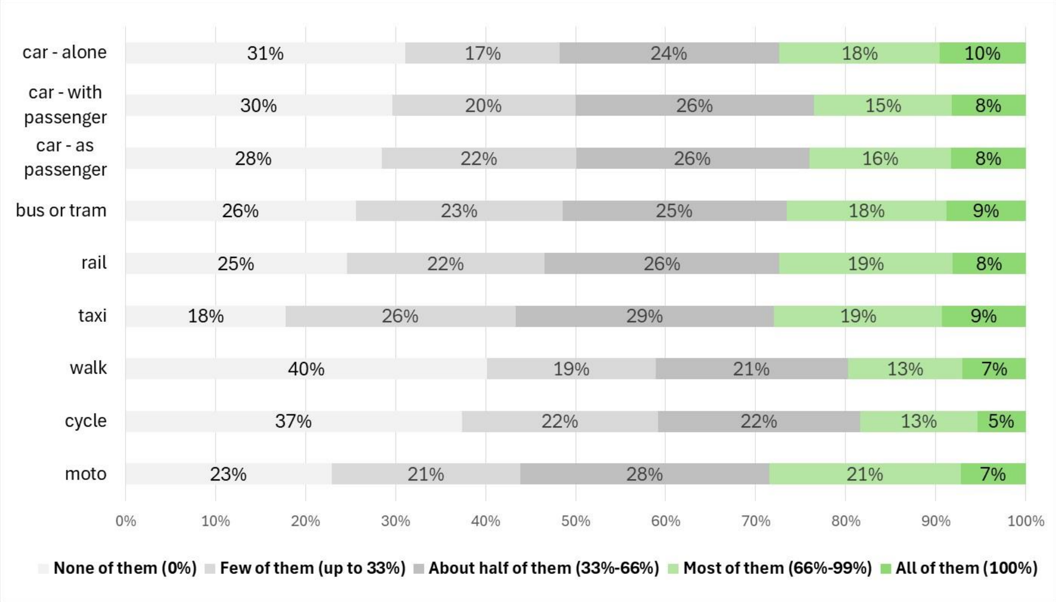
Participants were asked about the proportion of their weekly trips they would substitute with a self-driving private car, taxi, or bus. The question was asked for each of the current travel modes. Answers were on a 5-point scale, from “none of them (0%)” to all of them (100%). The figures below show the distribution of the answers for the self-driving car (Figure 124), taxi (Figure 125) and bus (Figure 126), across the whole sample. The charts show results only for participants who currently make at least one trip per week by a given mode. As an example of how to read the charts, in Figure 124, 10% of participants stated that they would substitute all the trips they currently make by car, driving alone, with trips by a self-driving car (right-side of the first bar of the chart). 31% stated that they would not substitute any of the trips they currently make by car driving alone with trips by a self-driving car (left-side of the first bar).

As shown in Figure 124, considerably higher proportions of participants said they would not substitute any walking or cycling trips (40% and 37% respectively), compared with those who said they would not substitute trips currently made by other modes (between 18% and 31%). The proportions stating they would replace all or most of the trips (i.e. the green bars in the chart) are also lower for walking and cycling (and fairly similar for all other current modes).

The self-driving taxi would replace slightly less car trips (alone, driving with passenger, or riding as passenger) than the self-driving car, but about the same proportion of trips by other current modes (Figure 125). Only 9% said they would replace all of their current trips made by taxi with trips by self-driving taxi.

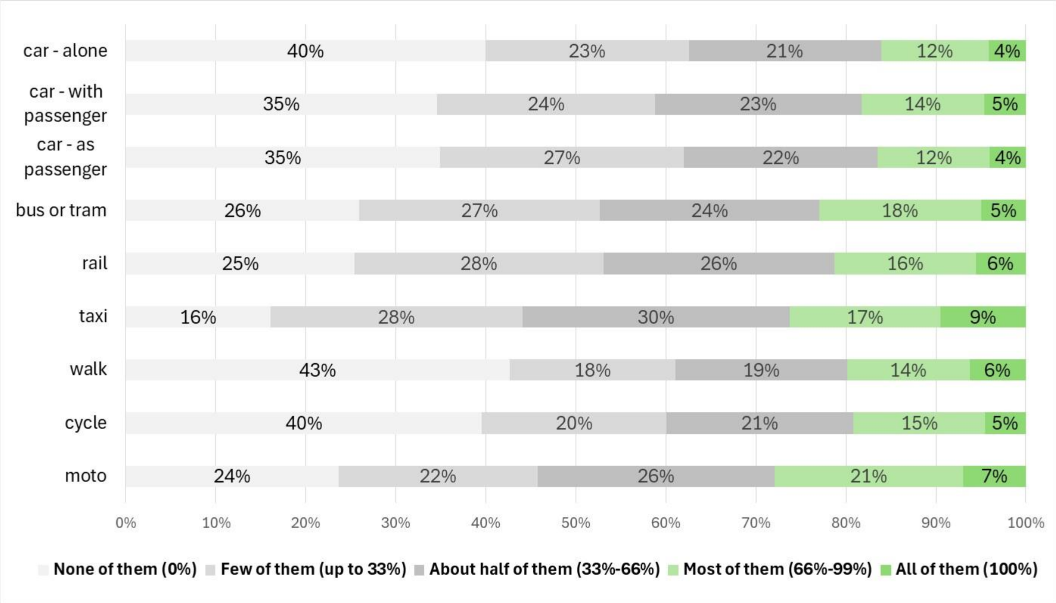
The self-driving bus would replace similar proportions of trips as the self-driving taxi, for each mode (Figure 126). The self-driving taxi would replace slightly less car trips (alone, driving with passenger, or riding as passenger) than the self-driving car, but about the same proportion of trips by other current modes. Only 10% said they would replace all of their current trips made by bus or tram with trips by self-driving bus.

Overall, there is little evidence that self-driving vehicles would contribute to a substitution of trips by private modes (e.g. car) to public transport. Only 17% would substitute most or all of their current car trips driving alone with trips by self-driving bus (Figure 126). In contrast, 27% would substitute most or all of their bus trips with self-driving car (Figure 124).



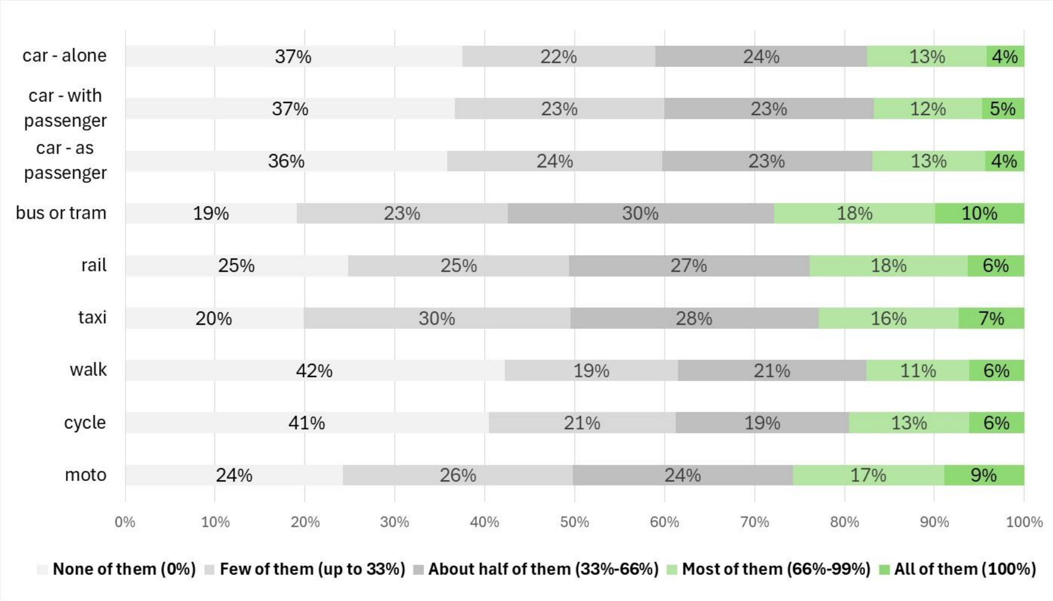
Note: results for a mode include only participants who currently make at least one trip per week using that mode

Figure 124. Trips that self-driving car would substitute, by current travel mode



Note: results for a mode include only participants who currently make at least one trip per week using that mode

Figure 125. Trips that self-driving taxi would substitute, by current travel mode



Note: results for a mode include only participants who currently make at least one trip per week using that mode

Figure 126. Trips that self-driving bus would substitute, by current travel mode

The following tables quantify trip substitution in terms of percentage of current trips, by each mode, substituted with self-driving vehicles. This was estimated by multiplying the number of trips each participant makes by each mode with the mid-point of the interval indicated for substitution. For example, someone who makes 10 trips per month by car driving alone and indicating they would substitute "most of them (66%-99%)" with a given self-driving vehicle, would substitute an estimated number of 10 * 82% = 8.2 trips. The values were then aggregated for the whole sample to estimate a percentage of substituted trips, i.e., the total number of trips substituted with self-driving vehicle as a percentage of the total number of trips current made by each of the current modes. A similar aggregation was then made for countries, genders, and age groups.

The following tables show the results for each of the three self-driving vehicles. It should be noted the totals across the three vehicles can be above 100%, for a given mode, as no restrictions were made to participant answers (e.g. one could say they would substitute all their trips by mode with each of the three self-driving vehicles presented). Besides, using the middle point of the interval produces only an approximation of the real proportion participants would substitute.

As shown in Table 82, self-driving would substitute an estimated percentage of 37%-39% of trips currently made by car (driving alone, with passenger, or as passenger). It would substitute slightly higher percentages (39%-43%) of trips currently made by other motorised modes. It would also substitute 31%. of trips currently made by walking and cycling – this signals a possible reduction in the amount of active travel people engage in, with possible impacts on public health.

The proportions of substituted trips tend to be higher in Poland and Spain. Men and women would substitute roughly the same trips. Substitution rates are inversely related with age.

In all cases, self-driving taxis and buses would substitute smaller proportions of trips currently made by other modes (Table 83 and Table 84). Self-driving taxis and buses would substitute 43% of trips currently made by taxi and bus/tram.

Self-driving buses would substitute 30% of trips currently made by car (Table 84). In contrast, self-driving cars would substitute 39% of trips currently made by bus or tram.

Table 82. Proportion of trips by other modes substituted by self-driving car, by country, gender, and age

	car - alone	car - with passenger	car - as passenger	bus or tram	rail	taxi	walk	cycle	moto
ALL	39%	37%	38%	39%	40%	43%	31%	31%	42%
UK	37%	34%	36%	32%	36%	50%	24%	32%	49%
Germany	39%	39%	40%	42%	44%	50%	30%	33%	42%
France	37%	35%	36%	41%	44%	45%	31%	31%	43%
Netherlands	35%	32%	36%	39%	39%	46%	22%	22%	44%
Spain	47%	44%	43%	42%	44%	42%	44%	36%	42%
Poland	50%	47%	44%	41%	40%	36%	42%	40%	54%
Greece	34%	34%	35%	37%	35%	40%	26%	30%	34%
Cyprus	31%	30%	29%	47%	43%	42%	22%	26%	34%
Women	38%	37%	36%	38%	40%	43%	31%	31%	40%
Men	40%	37%	41%	41%	41%	43%	31%	31%	43%
18-34	47%	45%	45%	46%	48%	48%	39%	40%	49%
35-64	39%	37%	36%	38%	37%	41%	29%	29%	38%
65+	26%	25%	25%	28%	28%	30%	25%	20%	21%

Table 83. Proportion of trips by other modes substituted by self-driving taxi, by country, gender, and age

	car - alone	car - with passenger	car - as passenger	bus or tram	rail	taxi	walk	cycle	moto
ALL	28%	31%	29%	36%	36%	43%	30%	30%	41%
UK	26%	28%	25%	28%	30%	48%	22%	29%	43%
Germany	29%	32%	27%	38%	41%	48%	28%	28%	36%
France	26%	28%	32%	39%	39%	52%	28%	31%	43%
Netherlands	24%	24%	28%	31%	29%	49%	23%	22%	49%
Spain	33%	39%	35%	42%	43%	34%	47%	40%	46%
Poland	41%	48%	39%	39%	39%	37%	42%	39%	50%
Greece	23%	25%	28%	33%	29%	39%	23%	33%	32%
Cyprus	19%	19%	20%	39%	37%	39%	15%	27%	29%
Women	27%	31%	28%	35%	35%	41%	31%	29%	40%
Men	29%	32%	32%	37%	37%	44%	29%	31%	41%
18-34	37%	39%	36%	44%	41%	49%	38%	39%	46%
35-64	28%	30%	28%	35%	35%	42%	27%	28%	37%
65+	15%	20%	19%	24%	23%	24%	26%	21%	33%

Table 84. Proportion of trips by other modes substituted by self-driving bus, by country, gender, and age

	car - alone	car - with passenger	car - as passenger	bus or tram	rail	taxi	walk	cycle	moto
ALL	30%	30%	30%	43%	38%	39%	29%	30%	39%
UK	25%	25%	27%	40%	29%	35%	22%	28%	49%
Germany	29%	30%	29%	45%	41%	48%	25%	26%	40%
France	28%	28%	30%	43%	41%	44%	28%	29%	39%
Netherlands	28%	25%	27%	40%	32%	38%	22%	25%	52%
Spain	38%	39%	38%	48%	45%	40%	43%	38%	41%
Poland	43%	44%	41%	45%	44%	35%	42%	38%	42%
Greece	28%	27%	29%	40%	34%	38%	25%	33%	32%
Cyprus	19%	17%	17%	30%	33%	33%	12%	23%	22%
Women	29%	29%	28%	42%	37%	37%	29%	28%	39%
Men	32%	31%	34%	44%	39%	40%	29%	32%	39%
18-34	38%	37%	35%	47%	41%	42%	35%	37%	44%
35-64	30%	29%	29%	42%	39%	40%	27%	29%	37%
65+	19%	21%	23%	38%	27%	21%	24%	19%	22%

5.7.6 Impact on parking needs

Impact on parking needs was expressed by participants on a 5-point scale from “reduced significantly (50% reduction or more) to “increase significantly” (50% increase or more). Almost equal proportions of participants think their parking needs will increase (19%) and decrease (18%) with the implementation of the self-driving car (Figure 127). Opinions are similar in the case of the self-driving taxi and bus. In both cases, the proportion of people who think their parking needs will decrease is higher than the proportion who think they will increase: 17% think the taxi will increase parking needs and 26% think it will decrease. The numbers for the self-driving bus are 14% and 25%, respectively.

This tendency can be quantified by converting the 5-point ordinal scale into a numerical scale from -2 to +2. Table 85 shows the average impact on this scale. Overall, the impact of the self-driving car is almost neutral (-0.02). The impacts of the self-driving taxi and bus are negative (-0.17 and 0.20 respectively).

These results suggest that the self-driving use cases based on private ownership and use (i.e. the car) is not generally perceived to lead to a change in parking needs. This could be because people believe that a possible increase in efficiency in parking (because vehicles can keep moving even when not in use) will be compensated by an increase in car ownership. There is also a slight tendency for people to perceive that use cases based on private use (taxi) or public use (bus) lead to some reduction in parking needs. This could be related to an associated perception that the development of these modes could reduce car ownership.

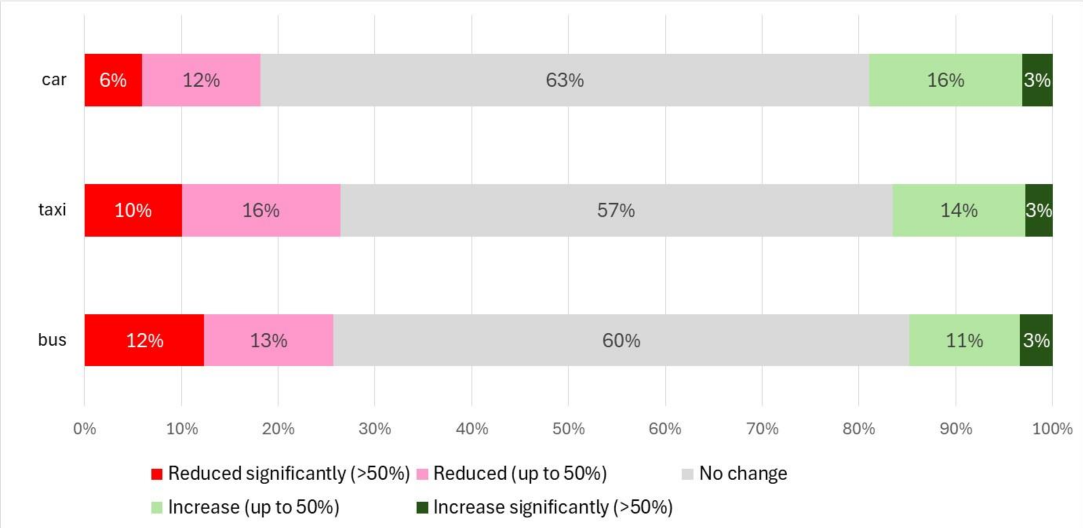


Figure 127. Impact of self-driving passenger transport vehicles on parking needs

Table 85. Average impact of self-driving passenger vehicles on parking needs, by country, gender, and age

	Car	Taxi	Bus
All	-0.02	-0.17	-0.20
UK	0.04	-0.04	-0.11
Germany	0.01	-0.15	-0.13
France	0.03	-0.12	-0.07
Netherlands	0.05	-0.10	-0.20
Spain	0.07	-0.01	-0.04
Poland	0.11	0.08	0.04
Greece	-0.29	-0.62	-0.62
Cyprus	-0.43	-0.78	-0.82
Women	-0.03	-0.18	-0.21
Men	-0.01	-0.16	-0.19
18-34	0.05	-0.09	-0.12
35-64	-0.03	-0.19	-0.22
65+	-0.10	-0.24	-0.27

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Table 85 shows that perceptions vary by country. In Greece and Cyprus, there is a stronger perception that parking needs will decrease, for all three types of vehicle. These are the only two countries with an overall negative score for change in parking needs in the self-driving car case. In addition, the score is below -0.5 in the other taxi and bus cases. Close or more than 50% of participants in Greece and Cyprus believe parking needs will decrease after the implementation of self-driving taxis and buses (Figure 129 and Figure 130). 35% (Greece) and 40% (Cyprus) think parking needs will decrease after the implementation of self-driving cars (Figure 128). In Poland, the average perception is that parking needs will increase, for all three vehicles, although the mean scores are low (Table 85). In the other countries, the average perception is that parking needs will increase with the implementation of self-driving cars but decrease with the implementation of the other vehicles. However, in Spain there are considerable proportions of participants (almost equal to those in Poland) thinking parking needs will increase.

As seen in both Table 85 and the three figures below, the perceptions of men and women differ little, for all three vehicles. As seen in the table, the average perceived change in parking needs decreases with age. However, as seen in the figures, increased age is associated both with fewer proportions of people thinking that parking needs will increase and with fewer proportions thinking parking needs will decrease – and with a higher proportion of people with neutral perceptions.

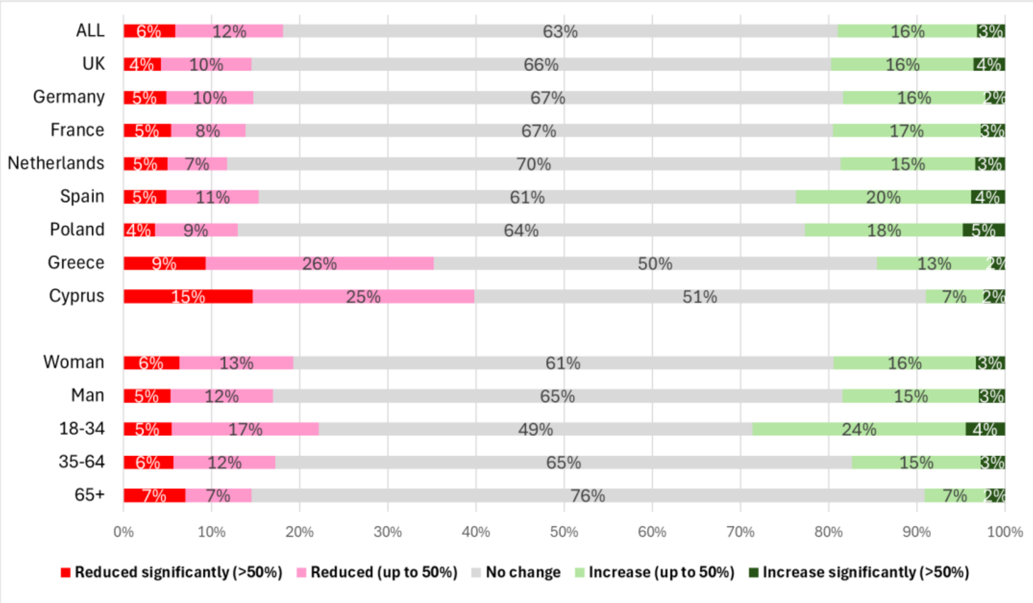


Figure 128. Impact of self-driving private car on parking needs, by country, gender, and age

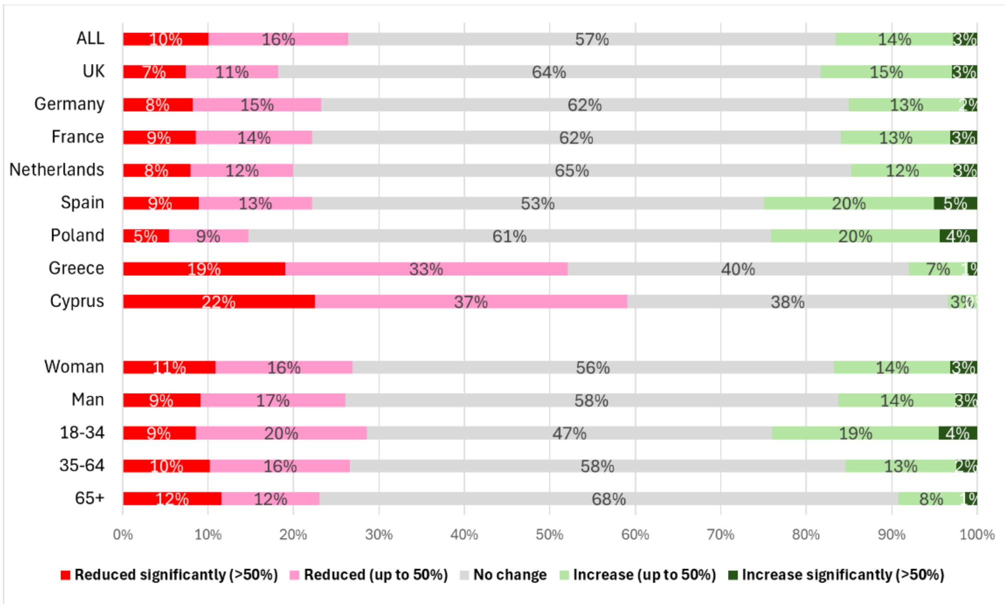


Figure 129. Impact of self-driving taxi on parking needs, by country, gender, and age

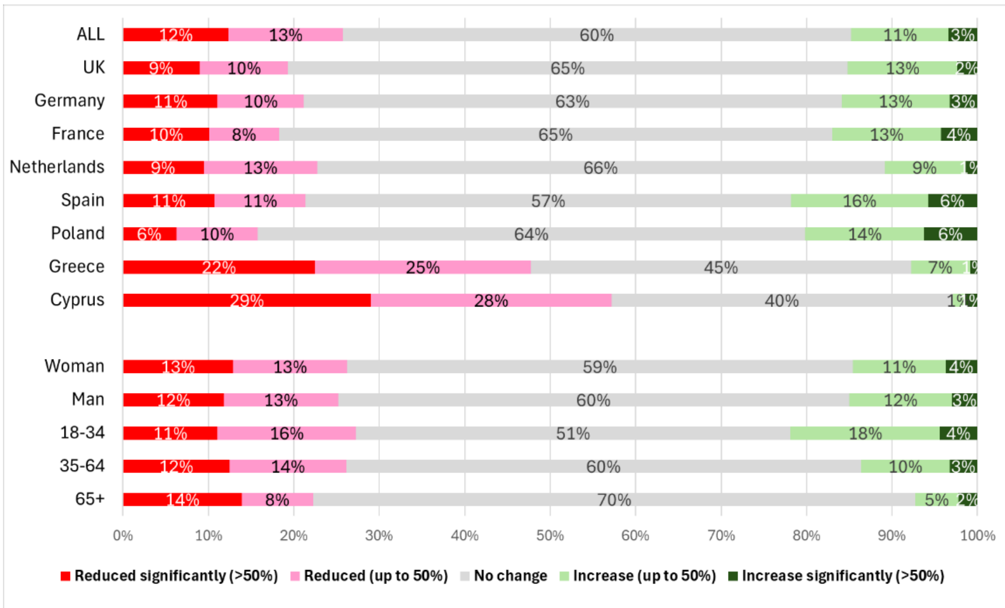


Figure 130. Impact of self-driving bus on parking needs, by country, gender, and age

5.7.7 Impact on residence location

Impact on residence location was expressed by participants on a 5-point scale from "relocated to a rural area" to "relocate to the city centre".

The large majority (76-78%) of participants do not think that self-driving passenger vehicles will have an effect on their decision of residence location area (Figure 131). Only 2-3% would consider relocating to the city centre, 11% would relocate close to the city centre, 6% would relocate to the city's suburbs, and 3-5% would relocate to a rural area. The decisions to relocate (or not) are very similar for all three vehicles.

The original scale was converted into a numerical scale from -2 to +2, assuming that higher values represent a move to more urbanised areas. Table 86 shows the average impact on this scale. Overall, the impacts are close to zero (i.e. to "no change"): 0.02 (car), 0.04 (taxi) and 0.01 (bus).

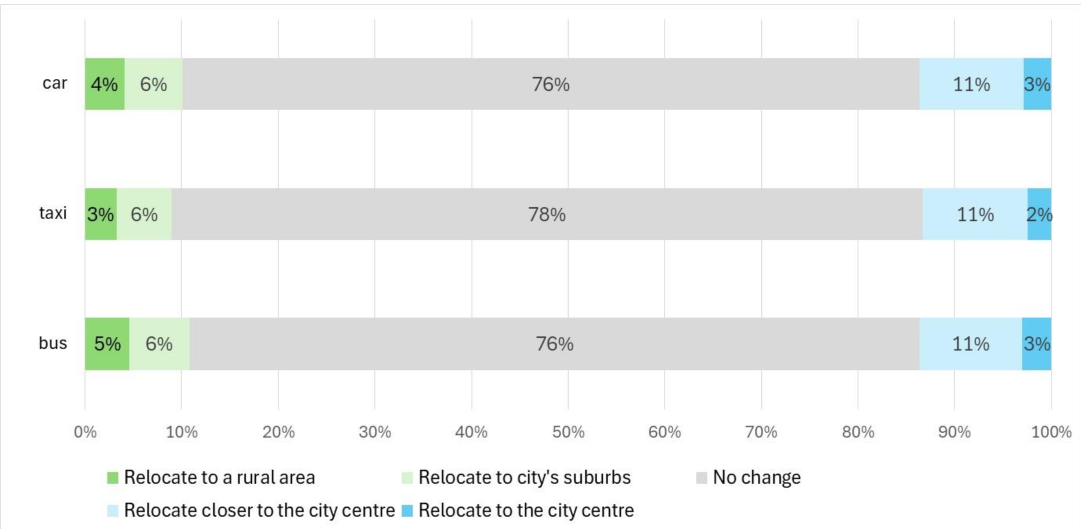


Figure 131. Impact of self-driving vehicles on residence location

Table 86. Average impact of self-driving passenger vehicles on tendency to move to more urbanised areas, by country, gender, and age

	Car	Taxi	Bus
All	0.02	0.04	0.01
UK	0.03	0.06	0.00
Germany	0.03	0.05	0.02
France	0.02	0.04	-0.03
Netherlands	0.02	0.04	0.01
Spain	0.14	0.15	0.11
Poland	0.09	0.08	0.12
Greece	-0.07	-0.07	-0.04
Cyprus	-0.18	-0.18	-0.19
Women	0.02	0.03	0.01
Men	0.03	0.04	0.02
18-34	0.12	0.13	0.13
35-64	0.01	0.02	0.00
65+	-0.08	-0.05	-0.12

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Table 86 also shows how average perceptions vary by country, gender, and age. Numbers tend to be broadly similar across the three vehicles. As in the case of parking needs analysed in the last section, Greece and Cyprus show a distinct pattern from other countries. In these two countries there is a net tendency to move to less urbanised areas (i.e. rural areas or city suburbs), as the mean score on the -2 to +2 scale is negative, for all three vehicles. In other countries, the mean score is almost always positive. 13% to 17% of participants in the two countries would consider moving to suburban or rural areas, as seen in Figure 132, Figure 133, and Figure 134.

In Spain, the score is considerably higher than in other countries, i.e., there is a stronger tendency to move to more urbanised areas (i.e. city centre or close to centre). 19-21% of participants in Spain would consider moving to those areas, as seen in the figures.

The mean scores for men and women are similar and are inversely related with age. The 18-34 group has a net tendency to move to more urbanised areas (mean score of 0.09-0.12), the 25-64 group is close to being neutral (-0.01 to -0.03), and the 65+ group tends move to less urbanised areas (around -0.1). As shown in the figures, this pattern is driven mostly by the proportion of people in the three age groups who would consider moving to suburban areas: 17-19% in the 18-34 age group, 9% in the 35-64 group, and 3% in the 65+ group. These numbers are very similar to the ones obtained in the case of passenger vehicles.

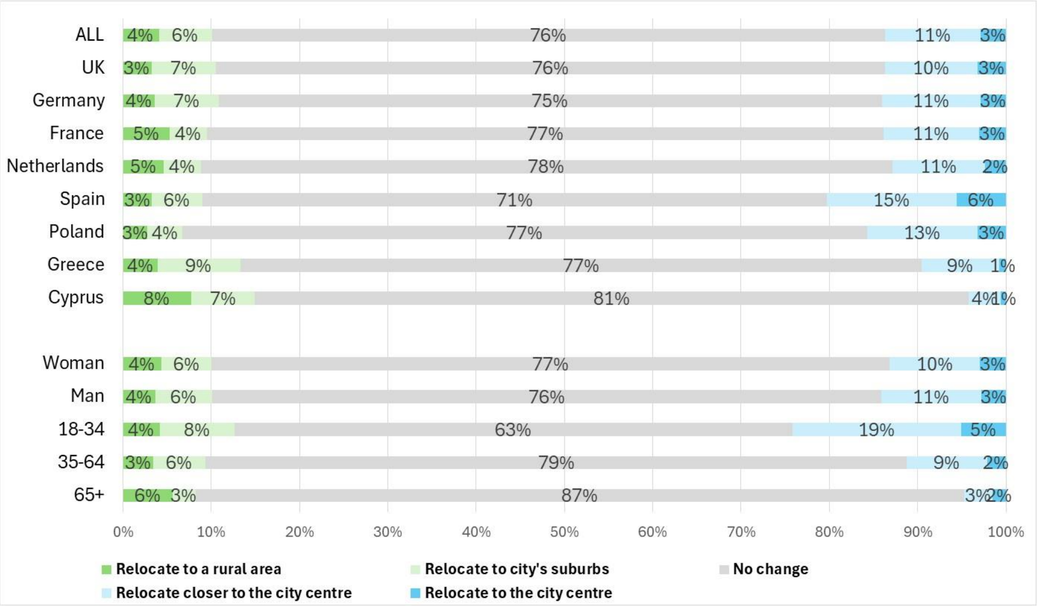


Figure 132. Impact of self-driving private car on residence location, by country, gender, and age

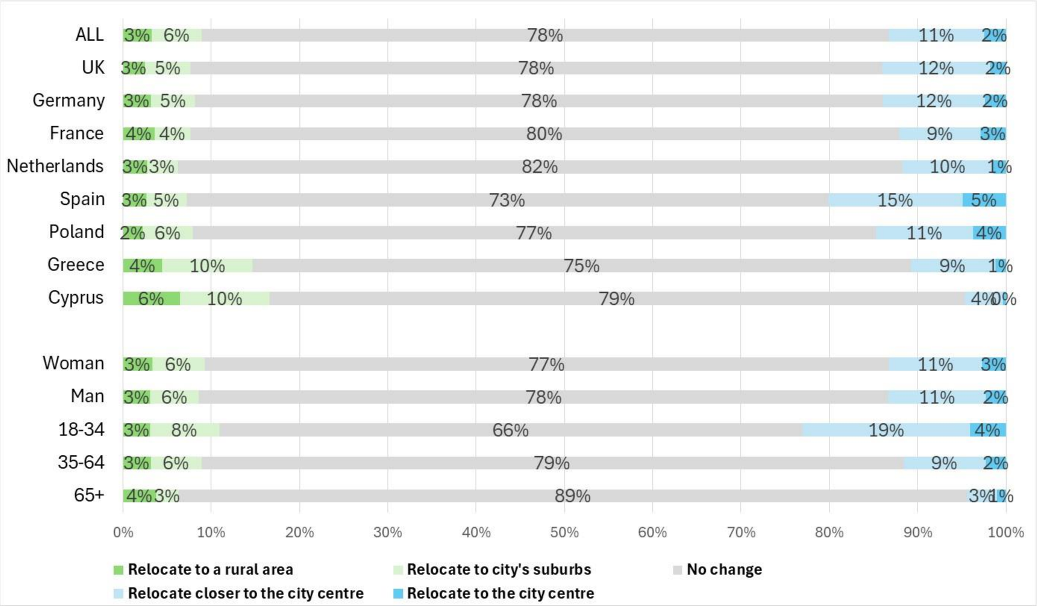


Figure 133. Impact of self-driving taxi on residence location, by country, gender, and age

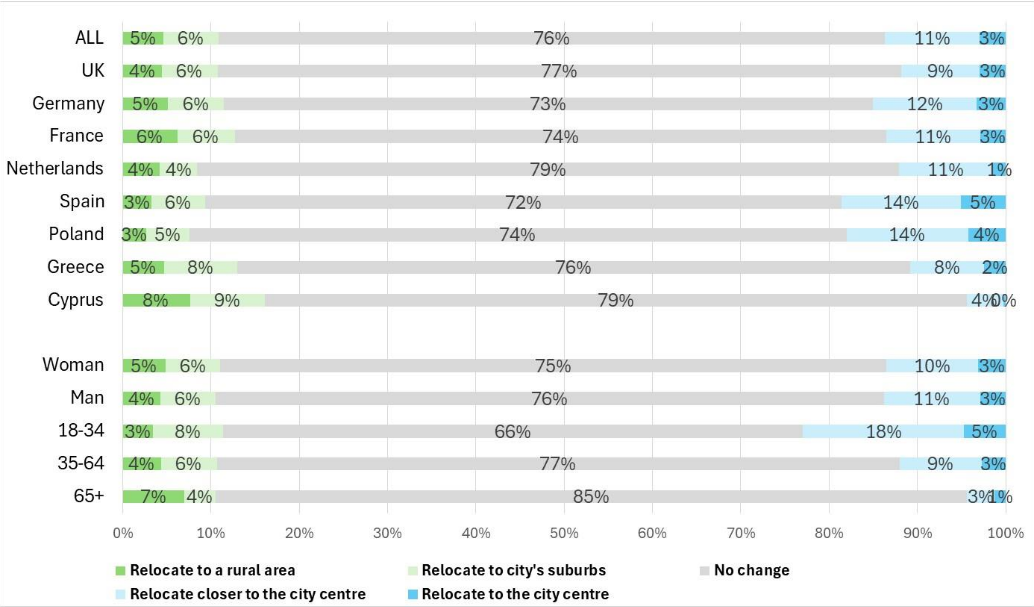


Figure 134. Impact of self-driving bus on residence location, by country, gender, and age

5.8 Models of intentions and impacts - passenger vehicles

5.8.1 Overview

This section estimates statistical models to identify the variables related to the survey participant's intentions and perceived impacts of self-driving passenger vehicles analysed in the previous two sections. Models for intentions include, as dependent variables, the likelihood of using each of the three passenger vehicles, and the willingness to pay to buy a self-driving car and to use each of the three vehicles. Models for impacts include, as dependent variables, change in travel time, number of trips, parking needs, and residence location, associated with each of the three vehicles.

The objective of the models is not to predict the factors explaining intentions and impacts. In fact, the indicators of goodness of fit of the estimated models are modest. The objective is rather to determine whether specific participant characteristics and other variables are significantly related to the intentions and impacts, when controlling for other relevant variables. For example, the models can identify whether some groups (e.g. age groups) have a statistically higher propensity to report a certain impact than other groups, when controlling for other factors that may also be related to that impact.

The models consider as variables:

- Participant **demographic characteristics**: gender, age, education, and health – all as binary variables
- Participant's **current travel context and behaviour**: ownership of driving licence, ownership of private vehicles, purpose of the most frequent trip, and most important factor determining choice of travel mode – all as binary variables. The number of trips by each mode and the duration of the most frequent trip were also included, as continuous variables.
- Attitude in relation to **technology adoption** – a binary variable for each answer in the 5-point scale, with the middle point ("early majority") used as reference category, thus omitted from the models.

- Level of previous **awareness of self-driving vehicles** – a binary variable for each answer in the 4-point scale, with the second point in the scale (“I have only listened about self-driving vehicles, but I do not know much”) used as the reference category.
- **Location**, i.e. type of residential area (e.g. city centre, village), and characteristics of the region (population density and income (Gross Domestic Product per capita).

The model of likelihood of using also includes as variables the **impacts** that participants expect that self-driving vehicles would have in their behaviour, i.e. the impacts examined in Section 5.7 (travel time, trips, parking needs, and residence relocation). The hypothesis is that people are more likely to intend to use a self-driving vehicle if they think that using it will have certain impacts in their lives that they perceive as beneficial. Parking needs were entered in the model as two binary variables, one identifying perceived positive changes (i.e., answers of “increase” or “increase significantly”) and other negative ones (i.e., “reduce” or “reduce significantly”), with “no change” as omitted category. Residence relocation was entered as a series of binary variables, each identifying a type of relocation (e.g. “relocation to city centre”), with “no change” as omitted category.

Ordinal logit models were used for dependent variables expressed on a 5-point scale (likelihood, and impact on parking needs, residence location). Log-linear models were used for continuous variables (impact of travel time and number of trips).

For each group of models (e.g. one model for each type of vehicle), variables were removed from the models when they were not significant at the 10% level in all models.

In this chapter, we report only the signs of the significant variables. Appendix 12 contains the full models. A positive/negative coefficient denotes that the explanatory variable has a statistically significant positive/negative influence on the dependent variable.

5.8.2 Models of intentions about passenger vehicles

The models of likelihood consider only the likelihood of using self-driving vehicles for non-commuting trips. As seen previously (Section 5.7.2), this likelihood is related to the ones for using the vehicles for other trip purposes. Non-commuting was used, rather than commuting, as commuting is not relevant for a large part of the sample (individuals who are not currently working).

Table 87 shows the estimated models. Likelihood of using a self-driving passenger vehicle is higher when participants think that it would increase their travel time or number of trips. It increases both when they think parking needs will increase and decrease, compared with no change in parking needs. It decreases when participants said they would relocate to rural areas.

Likelihood decreases with age and with not having children. Participants with higher university degrees (e.g. Master’s, PhD) and those with health issues affecting mobility are more likely to use self-driving bus, but as likely to use a self-driving car or car, compared with other participants.

As expected, the number of trips currently made by a given mode (conventional car, taxi, or bus) increases the likelihood of using the equivalent self-driving vehicle, and not having a car increases the likelihood of using a self-driving bus. Participants with longer current trip durations, and who attach more importance on travel cost and parking availability are also more likely to use self-driving vehicles.

As expected, faster adoption of technology, and previous awareness of self-driving vehicles increases the likelihood of using them.

Again as expected, the likelihood of using all vehicles is higher in city centres, and the likelihood of using buses is lower in villages (possibly because of current lack of bus services).

Participants in more densely populated regions were more likely to use a self-driving taxi or bus. Interestingly, regional income is inversely related to likelihood of using all three vehicles.

Table 87. Models of likelihood of using self-driving vehicles for non-commuting trips

	Car	Taxi	Bus
Impact on travel time	+	+	
Impact on trips	+	+	+
Impact on parking needs: positive	+	+	+
Impact on parking needs: negative	+	+	+
Relocate to rural	-		-
Age: 18-34	+	+	+
Age: 65+	-	-	
No children	-	-	-
Education: higher university degree			+
Health issue			+
Health issue (family)		-	
Current number of trips (car, taxi, or bus)	+	+	+
No car			+
Duration of most frequent trip	+		+
Most important factor: travel cost	+	+	+
Most important factor: parking availability	+	+	
Technology: “innovator”	+	+	
Technology: “early adopter”	+	+	
Technology: “late majority”	-	-	-
Technology: “laggard”	-	-	-
Not aware of self-driving vehicles	-	-	-
Aware of self-driving vehicles	+	+	+
Well aware of self-driving vehicles	+	+	
City centre	+	+	+
Village			-
Region: population density (log)		+	+
Region: Income per capita (log)	-	-	-

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models.

Table 88 shows the estimated models of willingness to pay. As expected, willingness to pay depends positively on current number of trips and regional income (except in the case of the self-driving bus), and on level of adoption of technology and previous awareness of self-driving vehicles.

The willingness to pay to buy a car also depends positively on several factors that affect travel mode choice. It is lower among women, the age 18-34 group, and individuals with no driving licence or no car.

Willingness to pay to use a self-driving car does not depend on the same variables as buying a car. It is higher among participants with a health issue, those who currently make longer trips and living in villages. It is lower among older participants, those without children, with education below university degree (which is probably an income effect) and those who do not own a car.

Willingness to pay to use a self-driving taxi is higher among women, the youngest age group, and those who attach importance to parking availability and safety. It is lower among individuals with no children and in less densely populated regions.

Willingness to use a bus is higher both among the 18-34 and 65+ age groups, those with education levels below university degree, those who make longer trips, living in villages, and in more densely populated regions. It is lower among individuals with no children, with a health issue affecting mobility and living in the city centre.

Table 88. Models of willingness to pay to use self-driving passenger vehicles

	Car (buy)	Car (use)	Taxi	Bus
Woman	-		+	
Age: 18-34	-		+	+
Age: 65+		-		+
No children		-	-	-
Education: below university degree		-		+
Health issue		+		-
Current number of trips (car, taxi, or bus)	+	+	+	
No driving licence	-			
No car	-	-		
Duration of most frequent trip		+		+
Most important factor: travel time	+			
Most important factor: travel cost	+			
Most important factor: convenience/comfort	+			
Most important factor: parking availability	+		+	
Most important factor: reliability	+			
Most important factor: waiting time	+			
Most important factor: safety	+		+	
Technology: “innovator”				
Technology: “early adopter”	+			+
Technology: “late majority”		-	-	
Technology: “laggard”	-			-
Not aware of self-driving vehicles	-	-	-	
Aware of self-driving vehicles	+	+	+	
Well aware of self-driving vehicles				+
City centre				-
Village		+		+
Region: population density (log)			-	+
Region: Income per capita (log)	+	+	+	

Notes: Log-linear model. Table shows only the sign of significant variables. Appendix 12 contains full models.

5.8.3 Models of impacts of passenger vehicles

Table 89 shows the model of impact of self-driving vehicles on travel time. There are fewer significant variables than in the models of intentions seen in the previous section. Age, not having children, and health issues are inversely related to change in travel time. As expected, current trip duration is positively related to change in travel time, for all vehicles. Individuals who currently do not have a car expect more positive changes in car travel time and lower changes in bus travel time (which may signal that some of them will buy switch from bus to car travel). Attaching importance to travel cost and parking availability, and living in the city centre or in higher-income regions, are related to more positive changes on travel time, but not for all three types of vehicles.

Table 89. Models of impact of self-driving passenger vehicles on travel time

	Car	Taxi	Bus
Age: 18-34	+	+	+
Age: 65+	-	-	-
No children	-	-	-
Health issue		-	
Health issue (family)	-		-
Current number of trips (car, taxi, or bus)		+	
No car	+		-
Duration of most frequent trip	+	+	+
Most important factor: travel cost	+	+	
Most important factor: parking availability	+		+
Technology: “innovator”	+	+	+
Technology: “early adopter”	+		
Technology: “late majority”			-
Technology: “laggard”	-	-	
Not aware of self-driving vehicles		+	
Well aware of self-driving vehicles	+		+
City centre	+		+
Region: Income per capita (log)	+	+	

Notes: Log-linear model. Table shows only the sign of significant variables. Appendix 12 contains full models.

Table 90 shows the models of the impact of self-driving vehicles on number of trips. The change in number of trips in inversely related to age. It is higher among women and lower among individuals without children. Current number of trips and trip duration have a positive influence on the expected change in trips. Attaching importance to travel cost and parking availability is related to more trips in the case of the bus. Living in the city centre increases expected number of trips and living in a richer area decreases that number. Living in a village decreases expected change in number of trips in the case of the car but decreases that number in the case of the taxi.

Table 90. Models of impact of self-driving passenger vehicles on number of trips

	Car	Taxi	Bus
Woman	+		+
Age: 18-34	+	+	+
Age: 65+	-	-	-
No children	-	-	-
Current number of trips (car, taxi, or bus)		+	+
Duration of most frequent trip	+		+
Most important factor: travel cost			+
Most important factor: parking availability			+
Technology: “innovator”	+	+	+
Technology: “early adopter”	+		+
Technology: “late majority”	-		-
Technology: “laggard”			-
Not aware of self-driving vehicles		+	+
Well aware of self-driving vehicles			+
City centre	+	+	+
Village	-	+	
Region: Income per capita (log)	-	-	-

Notes: Log-linear model. Table shows only the sign of significant variables. Appendix 12 contains full models.

Table 91 shows the models of impacts on parking needs. The youngest age group is more likely to report an increase in parking needs than other age groups, for all three vehicles, and the oldest age group is less likely to report an increase in the case of the self-driving car. Individuals without children are less likely to report an increase. Education and health are significant for individual vehicles only. The current number of trips has a positive influence in the case of the taxi and bus, and attaching importance to travel cost has an influence in the case of the car. Level of adoption of technology and awareness of self-driving vehicles have positive influences. Regional population density increases expected parking needs in the case of the car and taxi and regional income increases expected parking needs in the case of the bus.

Table 91. Models of impact of self-driving passenger vehicles on parking needs

	Car	Taxi	Bus
Age: 18-34	+	+	+
Age: 65+	-		
No children	-	-	-
Education: below university degree		+	
Health issue	-		
Health issue (family)			-
Current number of trips (car, taxi, or bus)		+	+
Most important factor: travel cost	+		
Technology: “early adopter”	+		+
Technology: “late majority”	+		
Well aware of self-driving vehicles	+	+	
Region: population density (log)	+	+	
Region: Income per capita (log)			+

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models.

Table 92 shows the models of impacts on residence relocation. The dependent variable is the intention to move to more urbanised areas. The age 18-34 age group has higher probability of indicating relocation, and individuals without children have lower probability, for all three types of vehicles. The 65+ age group, those and those who attach priority to travel safety show a lower propensity than others to move more urbanised areas if self-driving buses are implemented. Those with health issues affecting mobility also tend to not indicate intention to relocate to more urbanised areas. Current number of trip and trip duration also tends to have a positive influence. Level of adoption of technology and awareness are significant but mainly for the highest levels (“innovator” and “well aware”).

Table 92. Models of impact of self-driving passenger vehicles on intention to move to more urbanised areas

	Car	Taxi	Bus
Age: 18-34	+	+	+
Age: 65+			-
No children	-	-	-
Health issue	-		-
Health issue (family)	-	-	
Current number of trips (car, taxi, or bus)		+	+
Duration of most frequent trip	+	+	
Most important factor: safety			-
Technology: “innovator”	+	+	
Technology: “early adopter”	+		
Technology: “laggard”		-	
Not aware of self-driving vehicles			-
Well aware of self-driving vehicles	+	+	
City centre	+	+	+
Village			-
Region: Income per capita (log)		+	

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models.

5.9 Intentions regarding self-driving freight vehicles

5.9.1 Freight transport use cases presented to survey participants

The survey included two freight transport use cases based on self-driving vehicles: delivery robot (Figure 135) and delivery drone (Figure 136). These use cases were selected from a wider set co-created by citizens and organisations in previous activities of the project. Each participant was presented (randomly) with one of these two use cases. The use cases are defined in terms of three characteristics: ownership, delivery procedure, and possible time savings for travel and parking. The delivery robot is specified as a private vehicle - the citizen buys and maintains the robot and sends it out to pick up or deliver packages. The drone is a service provided by a company, which owns the vehicle.

Figure 135. Private delivery/pick-up robot use case

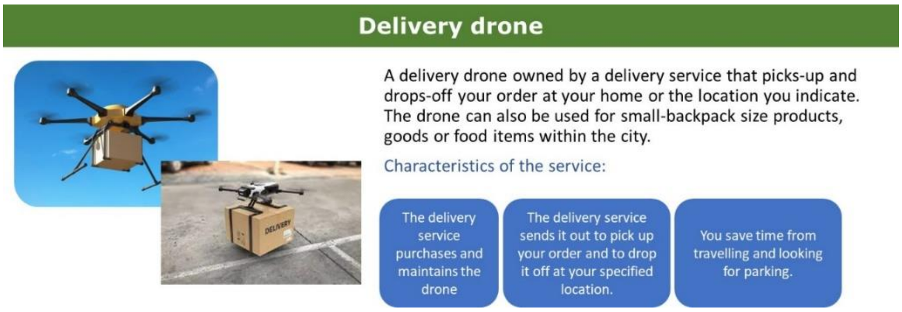


Figure 136. Delivery drone use case

5.9.2 Likelihood of using self-driving freight vehicles

Participants stated their likelihood of using either a delivery robot or a delivery drone, not both, as they were presented with only one of these use cases. As such, correlations between the two likelihoods cannot be estimated, as the data is completely separate. However, it is possible to estimate the correlations between both likelihoods and those of using self-driving passenger vehicles. Table 93 shows the correlations with the likelihood of using a self-driving car for non-commuting trips (analysed previously in Section 5.6.2). Correlations with other likelihoods of using self-driving passenger vehicles are not shown, as they are related to the one for self-driving car for non-commuting trips, as previously mentioned. Spearman correlations were used as both likelihoods of using passenger and freight variables are expressed on an ordinal scale (a 5-point scale).

Table 93 shows that the correlations between the private freight use case (i.e. robot) and private vehicles (car) or private service (taxi) are the highest (0.46), although even these are only moderate. The other correlations are smaller. This suggests that the answers to questions on likelihood to use freight vehicles provide extra information than the one provided by those about passenger vehicles, i.e. it is not only the case that high/low likelihoods of using a self-driving passenger vehicle are accompanied by high/low likelihoods of using a self-driving freight vehicle.

Table 93. Correlation between likelihoods of using freight and passenger vehicles

Likelihood A	Likelihood B	N	Correlation
robot	car (use – non-commuting)	2657	0.46
robot	taxi (use – non-commuting)	2645	0.46
robot	bus (use – non-commuting)	2634	0.38
drone	car (use – non-commuting)	2642	0.44
drone	taxi (use – non-commuting)	2623	0.41
drone	bus (use – non-commuting)	2681	0.39

Figure 137 shows participants' intentions to use the self-driving delivery robot and drone. Intentions are slightly stronger to use the drone: 11% of participants stated they were highly likely to use it, and another 23% are somewhat likely. The respective numbers for the delivery drone are 8% and 18%. The same number was neutral.

The delivery robot has proportions relatively close to those found earlier for buying a self-driving car (compare with Figure 106 in Section 5.6.2). However, the proportions stating they were somewhat or highly likely were smaller than those indicated for using a self-driving car or a bus for various purposes. The delivery drone had proportions closer to those stated for using a self-driving car or a bus.

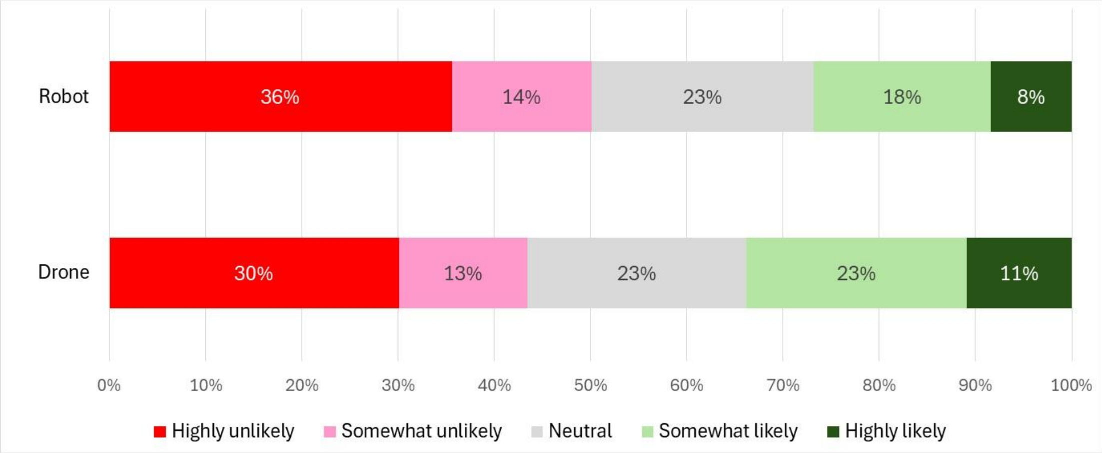


Figure 137. Likelihood of using freight self-driving vehicles

Table 94 shows the mean values of an indicator of likelihood of buying or using the two vehicles, overall, and by country, gender, and age. As done for passenger vehicles, the 5-point likelihood scale was converted into a numerical one, assuming values -2 (highly unlikely), -1, 0, 1, and 2 (highly likely).

The mean likelihood is almost always negative for both vehicles, i.e. there is a stronger tendency for being unlikely to use these vehicles than to being likely.

The mean likelihood of using a delivery robot is -0.5 (on the -2 to +2 scale), i.e. the average participant has a likelihood between “neutral” and “somewhat unlikely”. Participants in Greece were almost neutral (-0.05) and those in Cyprus had a positive intention (0.19). The lowest likelihoods were in the Netherlands (-0.81), France (-0.78), Germany (-0.61), and the United Kingdom (-0/59). The likelihood decreases with age.

The mean likelihood to use a delivery drone is less negative than the mean likelihood to use a robot. Participants in Cyprus were almost neutral (0.02). Again, the lowest likelihoods were in the Netherlands (-0.47), France (-0.48), Germany (-0.45), but the values for the United Kingdom were closer to the overall average, compared with the delivery robot. The likelihood was lower for men (-0.21) than women (-0.36) and is inversely related with age (with the youngest age group being almost neutral.

Table 94. Average likelihood of using self-driving freight vehicles, by country, gender, and age

	Delivery robot	Delivery drone
All	-0.50	-0.29
UK	-0.59	-0.21
Germany	-0.61	-0.45
France	-0.78	-0.48
Netherlands	-0.81	-0.47
Spain	-0.47	-0.21
Poland	-0.49	-0.22
Greece	-0.05	-0.10
Cyprus	0.19	0.02
Women	-0.49	-0.36
Men	-0.52	-0.21
18-34	-0.06	0.07
35-64	-0.45	-0.28
65+	-1.26	-0.84

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

The following figure and map add more detail to the results above for the delivery robot use case. Apart from Greece and Cyprus, the proportions stating they are (somewhat or highly) likely to use the robot are between 20% and 30% and the proportions stating they are (somewhat or highly) unlikely are between roughly 50% and 60% in all countries (Figure 138). The chart also shows that women and men have very similar intentions, and that likelihood decreases sharply with age. Among the oldest age group, 62% said they were highly unlikely to use the robot, and another 14% said they were somewhat unlikely – a total of 76% of negative intentions. Only 10% had positive intentions among this group (with only 3% saying they were highly likely).

The map in Figure 139 shows the proportion of participants (somewhat or highly) likely to use the delivery robot, by region. To ease comparison, the map uses the same classification scheme and the same legend colours as the maps shown previously for passenger transport use cases (Figure 109 to Figure 112 in Section 5.6.2). The proportion of participants stating they are likely to use the delivery robot is only above 25% in two regions in the United Kingdom: London and Wales. However, there are also regions in the United Kingdom with proportions below 10%. The whole of the former East Germany and surrounding regions, as well as some regions in France, Netherlands, and Poland also have proportions below 10%.

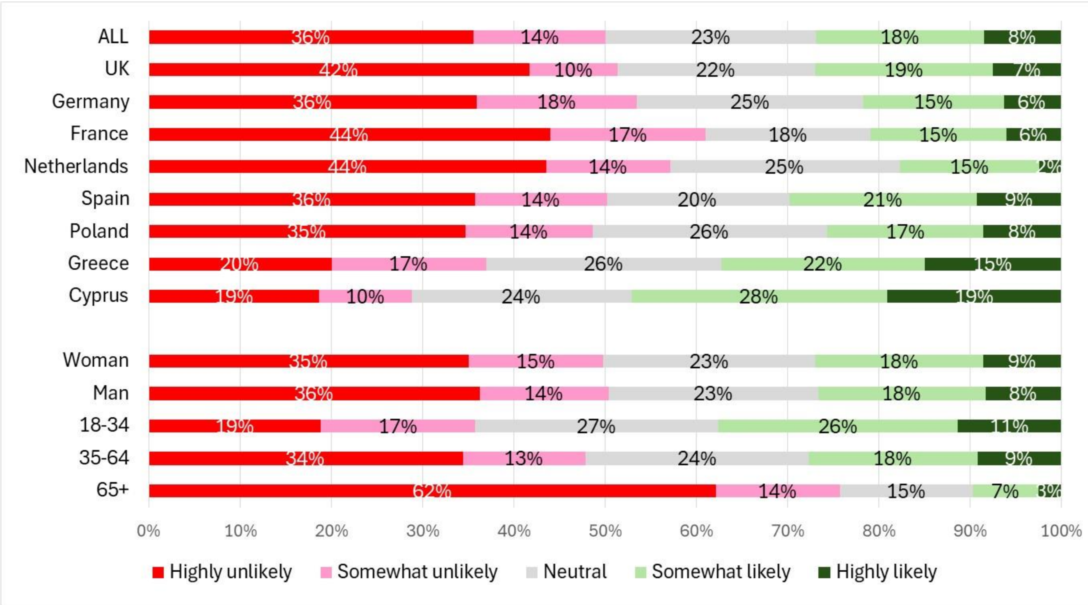


Figure 138. Likelihood of using self-driving delivery robot, by country, gender, and age

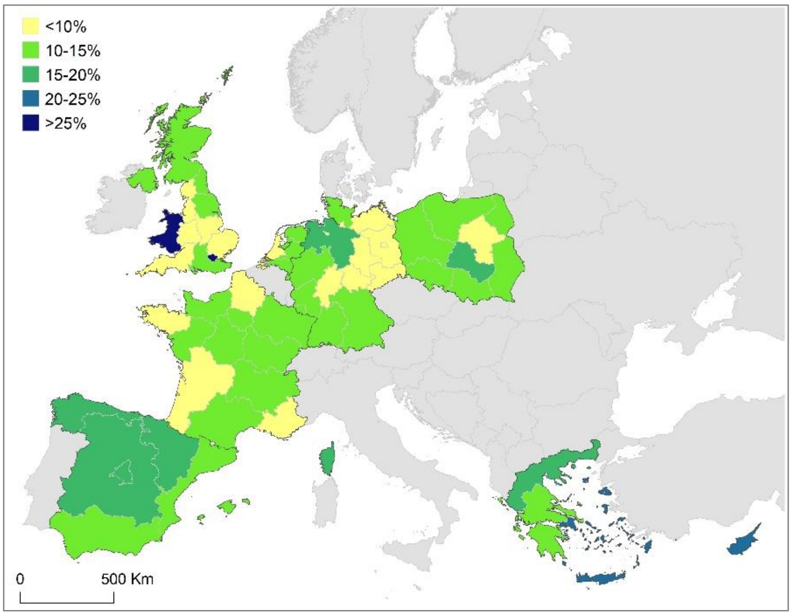


Figure 139. Proportion of participants likely to use delivery robot, by region

The following figure and map add detail to the results for the delivery drone. The proportions of participants (somewhat or highly) likely to use the robot are roughly between 30% and 40% in all countries (Figure 140) and those of participants unlikely to use it are between 40% and 50% in all countries except Cyprus. Again, women and men have very similar intentions and likelihood decreases sharply with age. Among the oldest age group, half said they were highly unlikely to use the robot, and another 11% said they were somewhat unlikely – a total of 61% of negative intentions (lower than in the case of the delivery robot). 22% had positive intentions among this group (with only 7% saying they were highly likely), higher than in the case of the robot.

The map in Figure 141 shows the proportion of participants (somewhat or highly) likely to use the delivery drone, by region. The proportion of participants stating they are likely to use the delivery drone are below 25% in all regions. There are also fewer within-country variations, compared with the case of the delivery robot or the passenger use cases shown in Section 5.6.2.

Later in this chapter (Section 5.11), we estimate statistical models relating likelihood with demographic, travel behaviour, and locational variables.

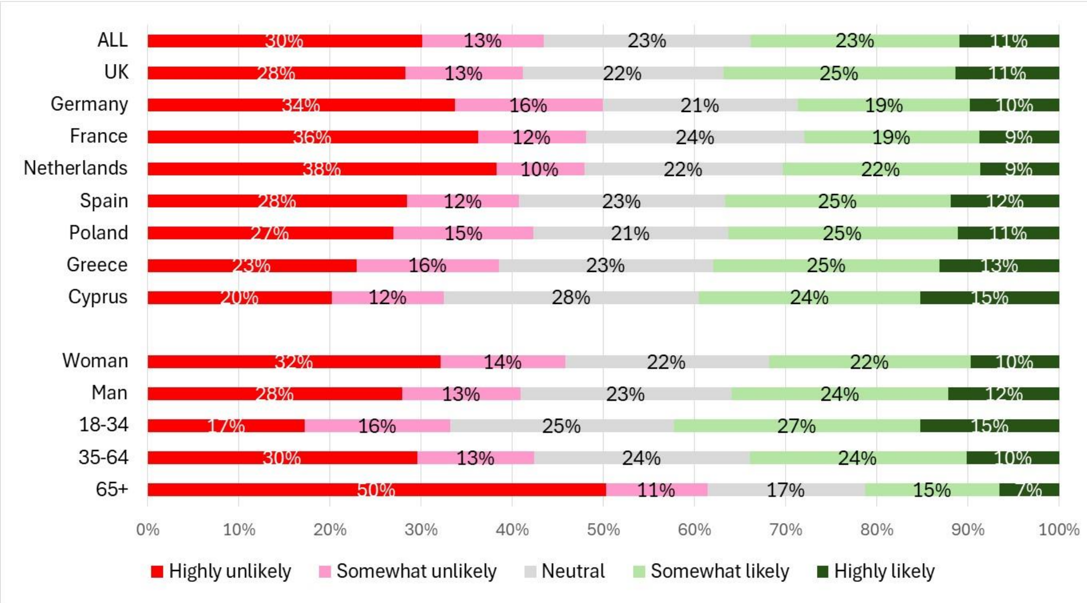


Figure 140. Likelihood of using delivery drone

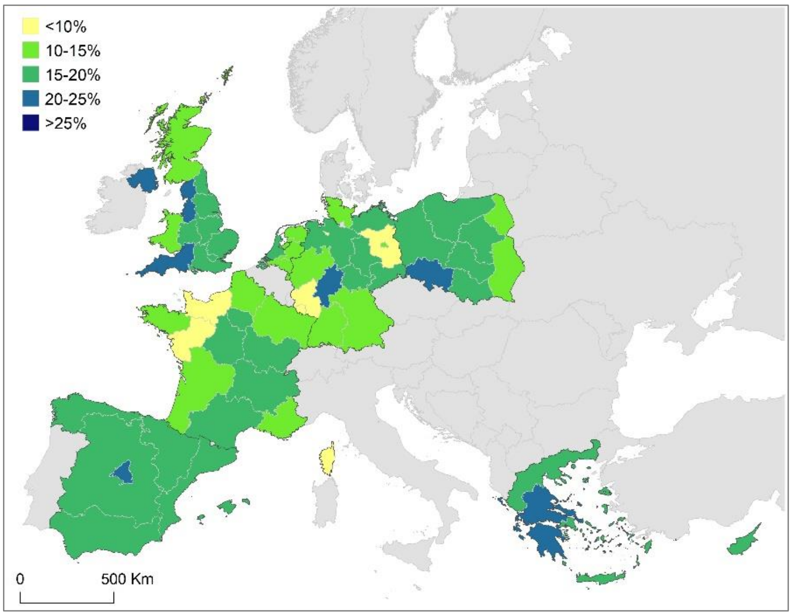


Figure 141. Proportion of participants likely to use delivery drone, by region

5.10 Impacts of self-driving freight vehicles on individual behaviour

5.10.1 Overview

This section reports the results of participants' stated impacts of self-driving freight vehicles on individual behaviour. Section 5.10.2 analyses correlations between the impacts. The following sections focus on the various impacts: delivery orders (5.10.3), order substitution (5.10.4), delivery costs (5.10.5), number of trips (5.10.6), parking needs (5.10.7), and residential location (5.10.8). The analysis uses similar methods as the one for passenger transport use cases in Section 5.7:

- For impacts on continuous scales (**number of delivery orders** and **number of trips**), we analyse the statistical distribution, across the whole sample, of the impacts of the two vehicles, and the average impact, overall and by country, gender, and age.
- For **order substitution,** expressed on a 5-point ordinal scale, we analyse the distribution of answers on the 5-point scale across the whole sample. We also estimate average substitution rates across countries, genders, and age groups.
- For other impacts on 5-point ordinal scales (**delivery costs**, **parking needs** and **residence location**), we analyse the distribution of participant answers on the 5-point scale, comparing the two vehicles across the whole sample, the average impacts across the whole sample and disaggregated by country, gender, and age, and the distribution of participant answers on the original 5-point scale for each vehicle, disaggregated by country, gender, and age.

These impacts are analysed separately. In Section 5.11, we estimate statistical models relating the impacts with demographic, travel behaviour, and locational variables.

5.10.2 Correlations between impacts

Table 95 shows the correlations between the various impacts of robots and drones. There are only two strong correlations (i.e. above 0.6): between number of delivery orders and number of trips (for both vehicles). While self-driving delivery vehicles could substitute shopping trips (which would result in a negative correlation), a positive correlation is also plausible because:

- If participants think that self-driving vehicles are more efficient in making deliveries, they can also think that this enables them to reduce both the number of orders they make (for example, because self-driving vehicles can consolidate orders) and the number of shopping trips.
- If, in contrast, they think their number of orders will increase, this could reduce the number of shopping trips than can be replaced by a larger number, in absolute value, of trips for other purposes such as leisure. For example, instead of a single trip to a supermarket, people could make several trips to other locations for leisure.
- There could even be substitution of destinations for shopping trips: if self-driving vehicles could delivery heavy products or large shopping baskets (e.g. supermarket deliveries), individuals could complement that with more short trips to small shops.

The other correlations range from very weak to slightly moderate (i.e. just above 40%). It is worth noting that all correlations are positive, i.e., changes in number of delivery orders, delivery costs, number of trips, parking needs, and residence re-location (towards more central areas) tend to all vary in the same direction.

Table 96 shows correlations between the perceived impacts of self-driving freight vehicles and the respective impacts of passenger vehicles. All correlations are around 0.40, i.e. the impacts are correlated, but the magnitude of this correlation is borderline between weak and moderate.

Table 95. Correlation between impacts of self-driving freight vehicles on individual behaviour

Impact A	Impact B	N	Correlation	
Number of orders (robot)	Delivery costs (robot)	3968	0.11	Spearman
Number of orders (robot)	Number of trips (robot)	3968	0.69	Pearsons
Number of orders (robot)	Parking needs (robot)	3968	0.10	Spearman
Number of orders (robot)	Residence location (robot)	3968	0.15	Spearman
Delivery costs (robot)	Number of trips (robot)	3968	0.16	Spearman
Delivery costs (robot)	Parking needs (robot)	3968	0.43	Spearman
Delivery costs (robot)	Residence location (robot)	3968	0.37	Spearman
Number of trips (robot)	Parking needs (robot)	3968	0.18	Spearman
Number of trips (robot)	Residence location (robot)	3968	0.17	Spearman
Parking needs (robot)	Residence location (robot)	3968	0.41	Spearman
Number of orders (drone)	Delivery costs (drone)	3973	0.14	Spearman
Number of orders (drone)	Number of trips (drone)	3973	0.69	Pearsons
Number of orders (drone)	Parking needs (drone)	3973	0.11	Spearman
Number of orders (drone)	Residence location (drone)	3973	0.23	Spearman
Delivery costs (drone)	Number of trips (drone)	3973	0.16	Spearman
Delivery costs (drone)	Parking needs (drone)	3973	0.42	Spearman
Delivery costs (drone)	Residence location (drone)	3973	0.40	Spearman
Number of trips (drone)	Parking needs (drone)	3973	0.19	Spearman
Number of trips (drone)	Residence location (drone)	3973	0.26	Spearman
Parking needs (drone)	Residence location (drone)	3973	0.44	Spearman

Note: N=number of observations.

Table 96. Correlation between impacts of self-driving passenger and freight vehicles

Impact A	Impact B	N	Correlation	
Number of trips (robot)	Number of trips (car)	2657	0.37	Pearsons
Number of trips (robot)	Number of trips (taxi)	2645	0.36	Pearsons
Number of trips (robot)	Number of trips (bus)	2634	0.43	Pearsons
Number of trips (drone)	Number of trips (car)	2642	0.39	Pearsons
Number of trips(drone)	Number of trips (taxi)	2623	0.37	Pearsons
Number of trips(drone)	Number of trips (bus)	2681	0.41	Pearsons
Parking needs (robot)	Parking needs (car)	2657	0.36	Spearman
Parking needs (robot)	Parking needs (taxi)	2645	0.38	Spearman
Parking needs (robot)	Parking needs (bus)	2634	0.47	Spearman
Parking needs (drone)	Parking needs (car)	2642	0.36	Spearman
Parking needs (drone)	Parking needs (taxi)	2623	0.39	Spearman
Parking needs (drone)	Parking needs (bus)	2681	0.49	Spearman
Residence location (robot)	Residence location (car)	2657	0.40	Spearman
Residence location (robot)	Residence location (taxi)	2645	0.38	Spearman
Residence location (robot)	Residence location (bus)	2634	0.42	Spearman
Residence location (drone)	Residence location (car)	2642	0.40	Spearman
Residence location (drone)	Residence location (taxi)	2623	0.39	Spearman
Residence location (drone)	Residence location (bus)	2681	0.43	Spearman

Note: N=number of observations. It differs from correlation to correlation as each participant answered questions for two types of passenger vehicle and one type of freight vehicle only.

5.10.3 Impact on number of delivery orders

Figure 142 and Figure 143 show the statistical distribution, across the whole sample, of the impact of delivery robots and drones on the number of online delivery orders that participants make per month. Table 97 shows the average impact by country, gender, and age.

As with the impacts reported for passenger transport vehicles, this one also follows a normal distribution centred around a peak slightly above zero. Most values are between -4 and +8 delivery orders per month. On average, robots and drones would increase orders by 0.2 and 0.4, respectively. This is a positive impact but of a small magnitude. Although data was not collected for the current number of monthly delivery orders people make, the 0.2 and 0.4 increases above can be compared with the frequency of orders shown in Figure 98, which shows that 64% of the sample makes deliveries at least "a few times per month" (with 16% making deliveries at least a few times per week).

The values are both positive and negative in different subsets of the data. Similarly to the impact of passenger vehicles in number of trips, seen before in Section 5.7.4, impacts tend to be higher (and positive) in Spain, Poland, Greece, and Cyprus than in the other four countries (where they are negative). Age is inversely related to change in number of delivery orders: younger age groups believe the number will increase more than older ones do.

The mix of positive and negative values is the result of different perceptions, which can be related either to an intention to make more delivery orders due to the availability of new, and flexible, modes, or to a belief that this flexibility is also related to efficiency, and more orders can be consolidated into a single delivery. There could also be a concern with the cost of the new modes, or with aspects such as safety and data protection, which could lead to an intention to reduce deliveries if they are made using self-driving vehicles.

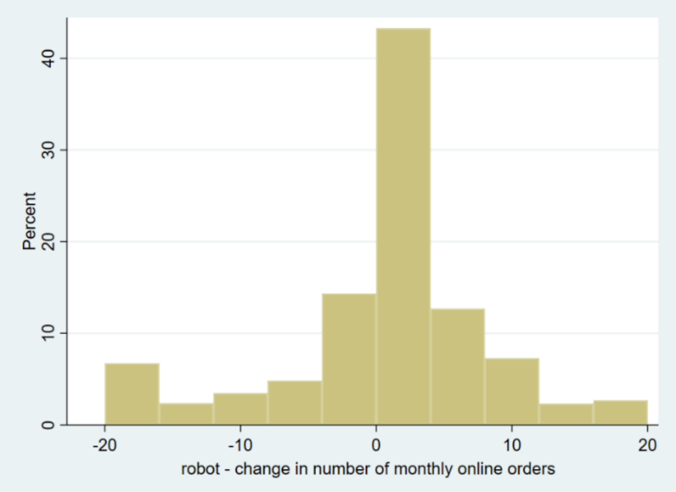


Figure 142. Impact of delivery robots on number of delivery orders

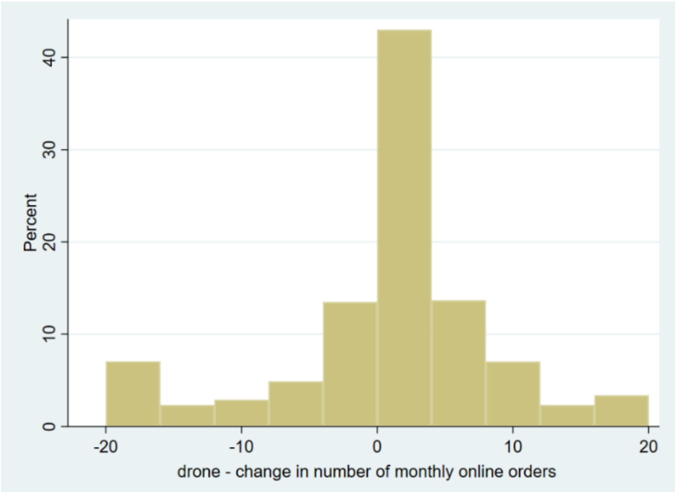


Figure 143. Impact of delivery drones on number of delivery orders

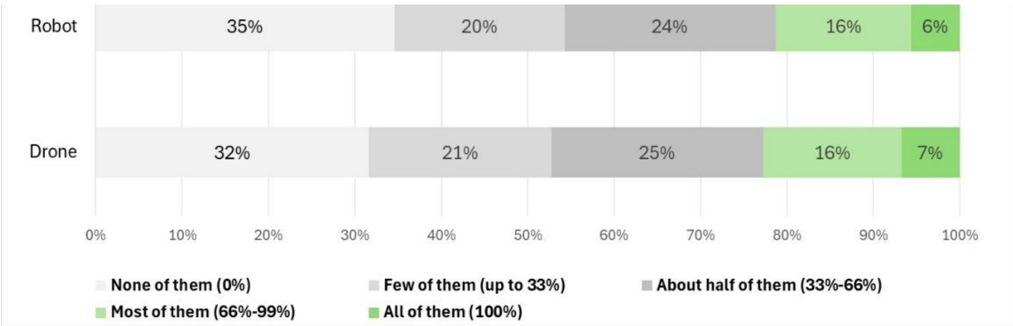
Table 97. Average impact on number of monthly delivery orders

	Delivery robot	Delivery drone
All	0.2	0.4
UK	-0.7	-0.6
Germany	-0.1	-0.1
France	-0.9	-0.4
Netherlands	-0.9	-1.0
Spain	0.6	0.4
Poland	0.0	0.9
Greece	2.3	2.7
Cyprus	2.7	2.3
Women	0.3	0.2
Men	0.0	0.6
18-34	1.9	1.9
35-64	0.0	0.2
65+	-1.9	-1.6

Notes: Cyprus sample is 18-64 only and is not gender-balanced.

5.10.4 Impact on order substitution

Participants were asked about the proportion of their monthly number of delivery orders they would substitute with a self-driving robot or drone. Answers were on a 5-point scale, from “none of them (0%)” to all of them (100%). Figure 144 shows the distribution of the answers. The chart shows results only for participants who currently make at least order per month. 6-7% of participants stated that they would substitute all their orders with these vehicles. A further 16% would substitute most of their orders. 35% would not substitute any of their orders with a delivery robot and 32% would not substitute any with a delivery drone.



Note: results include only participants who currently make at least "a few times per month"

Figure 144. Delivery orders that self-driving vehicles would substitute

Table 98 quantifies order substitution in terms of percentage of current delivery orders substituted by self-driving vehicles. This was estimated by multiplying:

- The number of current orders people make, estimated as the mid-point of the interval indicated in the question about order frequency (for example, "few times per week (2-3 times per week") was assigned a value of 2.5; and
- The mid point of the interval indicated for substitution of current orders. For example, someone indicating they would substitute "most of them (66%-99%)" with a given self-driving vehicle would be assigned a value of 82%.

The values were then aggregated for the whole sample to estimate a percentage of substituted orders, i.e. the total number of delivery orders substituted with self-driving vehicle as a percentage of the total number of delivery orders current made. A similar aggregation was made for countries, genders, and age groups.

Table 98 shows the results. Self-driving delivery vehicles would substitute an estimated percentage of 34%-35% of orders. In the case of robots, the percentages are higher in Poland (39%), Greece (37%), and Cyprus (42%). In the case of drones, the proportion is roughly similar in all countries except the Netherlands, where is smaller (29%). The proportions are the same or similar between men and women and are inversely related with age.

Table 98. Proportion of delivery orders substituted with self-driving vehicles

	Delivery robot	Delivery drone
All	34%	35%
UK	31%	36%
Germany	32%	35%
France	32%	35%
Netherlands	27%	29%
Spain	34%	37%
Poland	39%	39%
Greece	37%	37%
Cyprus	42%	36%
Women	34%	34%
Men	34%	37%
18-34	45%	46%
35-64	34%	34%
65+	17%	22%

Notes: Cyprus sample is 18-64 only and is not gender-balanced.

5.10.5 Impact on delivery costs

Opinions about impacts of self-driving delivery vehicles on delivery costs were expressed by participants on a 5-point scale from “reduced significantly (50% reduction or more) to “increase significantly” (50% increase or more). The results are almost identical for delivery robots and drones (Figure 144). 62% of the sample think there will be no change. Almost equal proportions think costs will increase (18-19%) and decrease (19-20%). If we convert the original 5-point scale to a numerical scale from -2 to +2 and estimate average scores (Table 100), this is only slightly negative (-0.05 for the robot and -0.04 for the drone).

In Greece and Cyprus, there is a stronger perception that delivery costs will decrease, for both types of vehicle (Table 100, Figure 146, Figure 147). In Spain and Poland and (in the case of drones) also in Germany, on average participants think deliver costs will increase. Women have a stronger tendency to believe delivery costs will decrease, compared with men. On average, the 18-34 group thinks delivery costs will increase (Table 100). This is a view held by 28-29% of participants in this group (Figure 146, Figure 147). The other age groups think delivery costs will decrease, with the 65+ being more likely to think they will decrease than the 35-64 group.

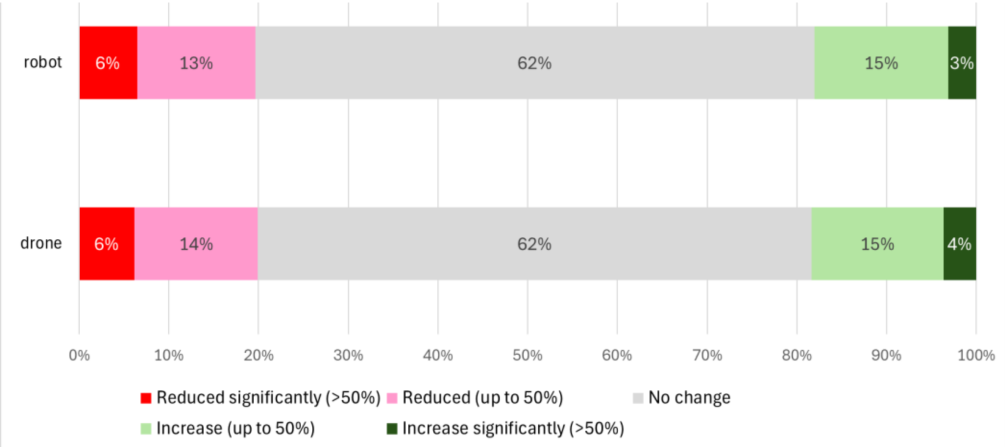


Figure 145. Impact of self-driving freight transport vehicles on delivery costs

Table 99. Average impact of self-driving freight vehicles on delivery costs

	Robot	Drone
All	-0.05	-0.04
UK	0.00	0.00
Germany	-0.03	0.07
France	-0.05	-0.03
Netherlands	-0.04	-0.06
Spain	0.06	0.08
Poland	0.10	0.06
Greece	-0.19	-0.19
Cyprus	-0.48	-0.52
Women	-0.08	-0.06
Men	-0.02	-0.03
18-34	0.06	0.07
35-64	-0.09	-0.06
65+	-0.11	-0.13

Notes: Cyprus sample is 18-64 only and is not gender-balanced.

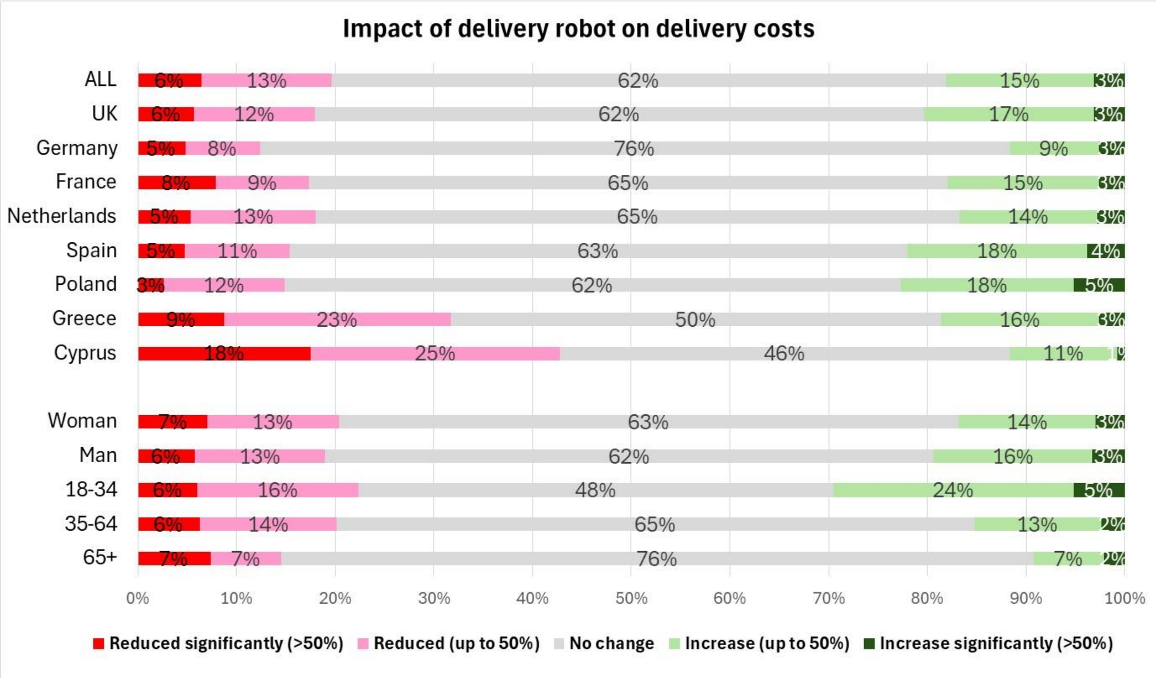


Figure 146. Impact of delivery robot on delivery costs

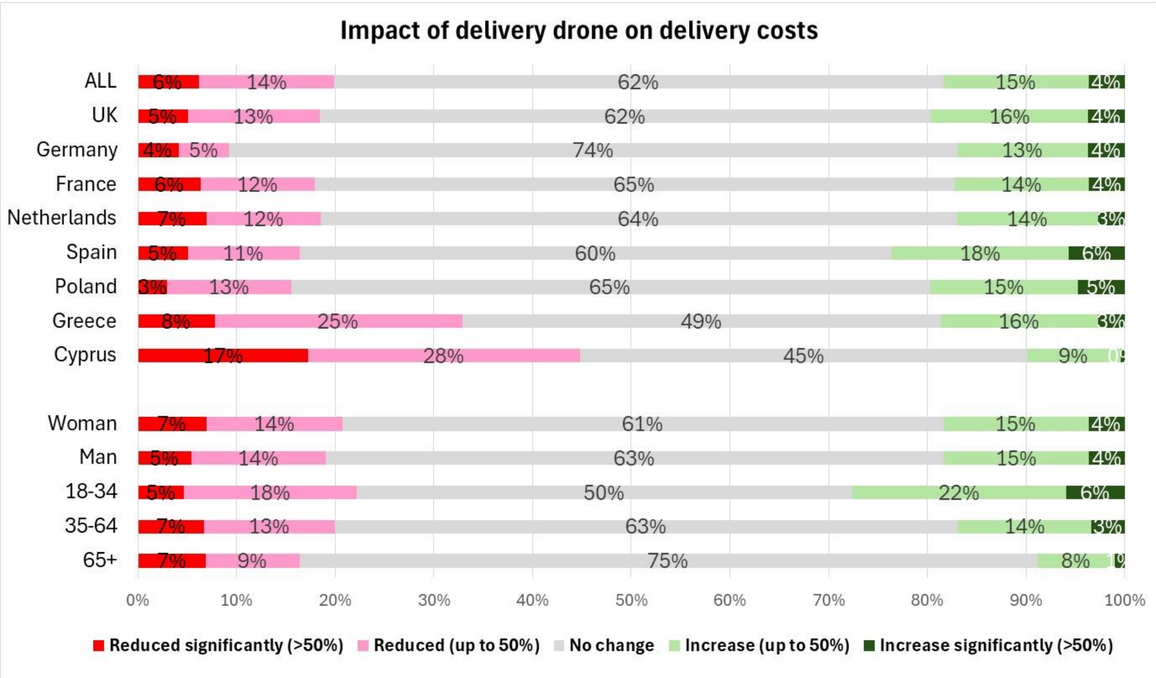


Figure 147. Impact of delivery drone on delivery costs

5.10.6 Impact on number of trips

Figure 148 and Figure 149 show the statistical distribution, across the whole sample, of the impact of delivery drones and robots on the number of delivery orders that participants make per month. Table 100 shows the average impact by country, gender, and age.

The distributions are remarkably similar to the ones for the impact on number of orders (e.g. compare Figure 148 with Figure 142 and Figure 149 with Figure 143), as the variables are strongly correlated as seen in Section 5.10.2.

On average, the delivery robot has no impact on number of trips and the delivery drone has almost no impact (average impacts of 0 and 0.2 respectively) (Table 100). Drones increase trips slightly more or decrease less than delivery robots do in almost all cases. Both vehicles (very) slightly decrease the number of trips in the United Kingdom, Germany, France, and Netherlands. However, they increase trips in Cyprus (1.7-2.2 additional trips per week de to the robot and drone, respectively), followed by Greece (1.5-1.8), Poland (0.7-1.3), and Spain (0.5-0.7). The impact of trips by men and women is similar. There is no impact on trips by the 35-64 group, a positive impact on trips by the 18-34 group (1.4-1.9) and a negative impact on trips made by the 65+ group (-1.7 and -1.4)

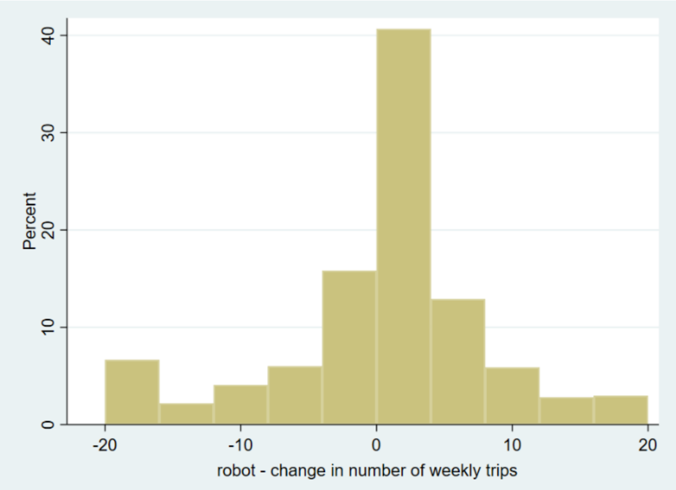


Figure 148. Impact of delivery robots on number of trips per week

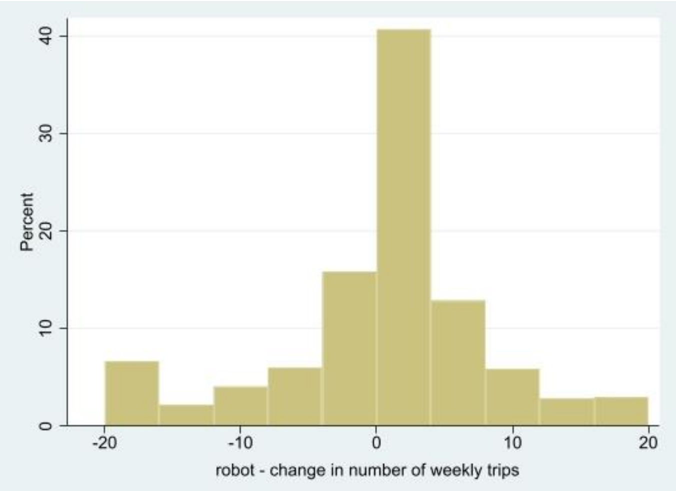


Figure 149. Impact of delivery drones on number of trips per week

Table 100. Average impact of self-driving freight vehicles on number of trips per week

	Delivery robot	Delivery drone
All	0.0	0.2
UK	-1.0	-1.4
Germany	-0.6	-0.3
France	-0.8	-0.2
Netherlands	-0.9	-1.2
Spain	0.5	0.7
Poland	0.7	1.3
Greece	1.5	1.8
Cyprus	1.7	2.2
Women	0.1	0.2
Men	-0.1	0.3
18-34	1.4	1.9
35-64	0.0	0.0
65+	-1.7	-1.4

Notes: Cyprus sample is 18-64 only and is not gender-balanced.

5.10.7 Impact on parking needs

Opinions about change in parking needs are similar in the case of the delivery drone and robot. As shown in Figure 150, the proportion of people who think their parking needs will decrease is higher than the proportion who think they will increase: 15% think the delivery robot will increase their parking needs and 24% think it will decrease. The numbers for the drone are 14% and 22%, respectively. The numbers are also similar to the ones seen in the case of the self-driving bus, as seen in Figure 127.

Table 101 shows the average impact on this scale, on a numerical scale from -2 to +2 based on the original ordinal scale. The impacts are negative (-0.18 for the robot and -0.15 for the drone, respectively). These compare with values of -0.02 (car), -0.17 (taxi) and -0.20 (bus), shown previously in Table 85. The expected reduction in parking needs is consistent with prior expectations: the use of these vehicles could reduce the need for shopping trips.

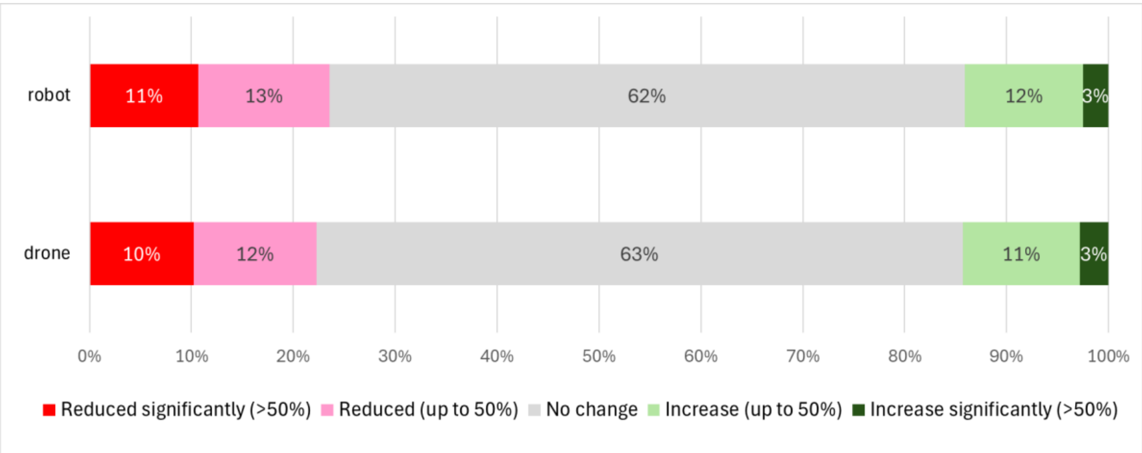


Figure 150. Impact of self-driving freight transport vehicles on parking needs

Table 101. Average impact of self-driving freight vehicles on parking needs

	Robot	Drone
All	-0.18	-0.15
UK	-0.12	-0.15
Germany	-0.12	-0.04
France	-0.06	-0.12
Netherlands	-0.18	-0.17
Spain	-0.07	0.02
Poland	0.02	0.07
Greece	-0.48	-0.44
Cyprus	-0.69	-0.72
Women	-0.19	-0.17
Men	-0.16	-0.13
18-34	-0.09	-0.04
35-64	-0.19	-0.17
65+	-0.26	-0.27

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Table 101 also shows how perceptions vary by country, region, and age. As in the case seen before for passenger vehicles (Section 5.7.6), in Greece and Cyprus, there is a stronger perception that parking needs will decrease, as seen by a more negative mean score, in both robot and drone cases. 37-39% of Greek participants and 50-53% of Cyprus participants believe parking needs will decrease (Figure 151 and Figure 152). The mean perception about parking needs in relation to the implementation of the delivery drone is still negative for all other countries except Poland, and the perception in relation the drone is negative for all countries except Poland and Spain (Table 101). In both Spain and Poland there are considerable proportions (18-22%) thinking parking needs will increase, in both the robot and drone cases. This pattern is similar to the one found for passenger transport vehicles in Section 5.7.6.

Women have slightly stronger perceptions that parking needs will decrease, compared to men (Table 101). As in the case of self-driving passenger vehicles, the average perceived change in parking needs decreases with age (Table 101). However, as seen in Figure 151 and Figure 152, increased age is associated both with fewer proportions of people thinking that parking needs will increase but also with fewer proportions thinking parking needs will decrease – and with a higher proportion of people with neutral perceptions. These patterns are similar to the ones found for passenger transport vehicles.

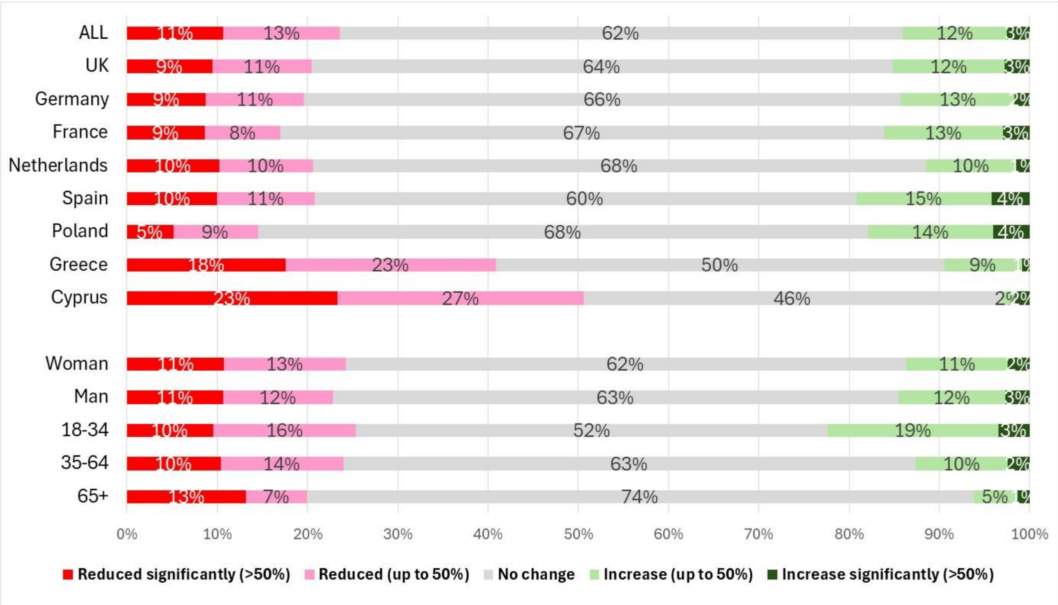


Figure 151. Impact of delivery robot on parking needs

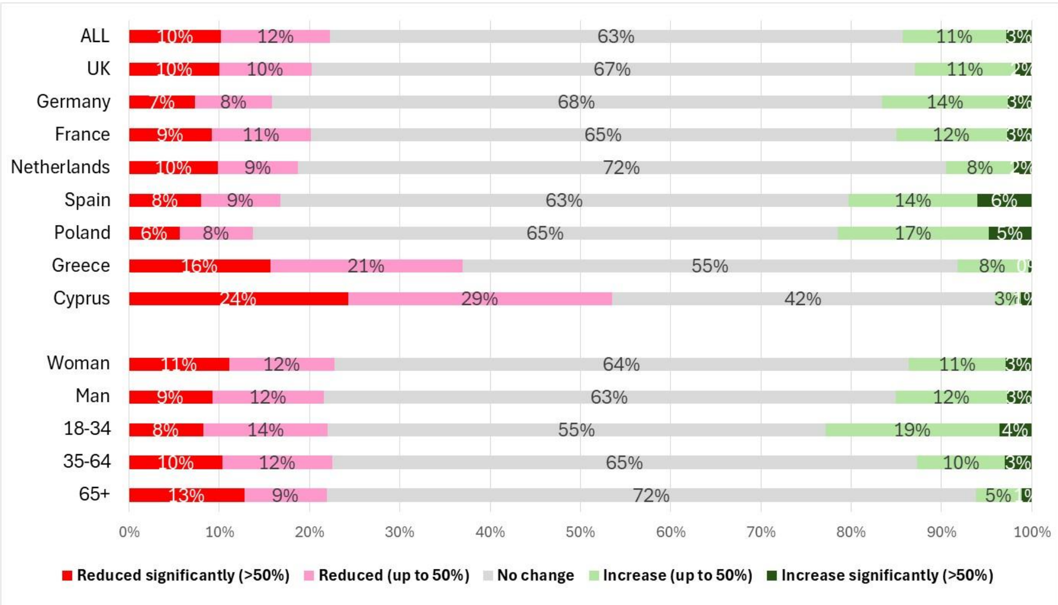


Figure 152. Impact of delivery drone on parking needs

5.10.8 Impact on residential location

Impact on residence location was expressed by participants on a 5-point scale from “relocated to a rural area” to “relocate to the city centre”.

The results are similar to the ones obtained for self-driving passenger transport vehicles (Section 5.7.7). The large majority (77%) of participants do not think that self-driving freight vehicles will have an effect on their decision of residence location area (Figure 153). Only 2-3% would consider relocating to the city centre, 10% would relocate close to the city centre, 6% would relocate to the city’s suburbs, and 5% would relocate to a rural area. The decisions to relocate (or not) are almost identical for the two vehicles.

The original scale was converted into a numerical scale from -2 to +2, assuming that higher values represent a move to more urbanised areas. Table 102 shows the average impact on this scale. Overall, the impacts are almost zero (i.e. “no change”): -0.01 (robot) and 0.01 (drone).

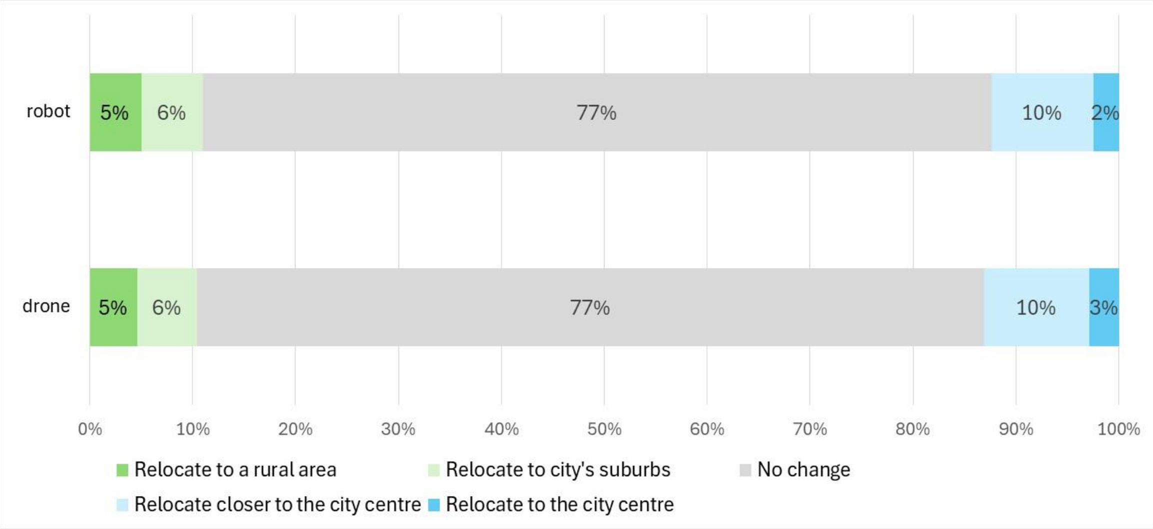


Figure 153. Impact of self-driving freight transport vehicles on residence location

Table 102. Average impact of self-driving freight vehicles on tendency to move to more urbanised areas, by country, gender, and age

	Robot	Drone
All	-0.01	0.01
UK	-0.04	-0.06
Germany	-0.05	-0.01
France	-0.02	0.01
Netherlands	0.00	-0.02
Spain	0.07	0.12
Poland	0.11	0.11
Greece	-0.08	-0.03
Cyprus	-0.17	-0.14
Women	-0.02	0.01
Men	0.00	0.01
18-34	0.09	0.12
35-64	-0.03	-0.01
65+	-0.10	-0.11

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Decisions are very similar for the robot and drone cases across all countries, genders, and age (Table 102, Figure 154, and Figure 155).

There is a clear net tendency to move to less urbanised areas (i.e. rural areas or city suburbs) in Cyprus, in the case of both vehicles, as the mean score on the -2 to +2 scale is negative. 15%-16% of participants in Cyprus would move to these areas if they could use a delivery robot or drone (Figure 154 and Figure 155). In the case of the robot, in Greece, United Kingdom, and Germany, there is a similar tendency (but weaker than in Cyprus). In the case of the drone, this happens mainly in the United Kingdom.

In Spain and Poland, the tendency is to move towards more urbanised areas (city centre or areas close to centre). In Spain, 20% of participants would consider moving to these areas if they could use a delivery robot (Figure 154), and 18% would do so if they could use a delivery drone (Figure 155). In Poland, the numbers are slightly lower but still considerably higher than in other countries.

The mean scores for men and women are similar and are inversely related with age (Table 102), which is the pattern previously found for passenger vehicles. The 18-34 group tends to move to more urbanised areas (mean score of 0.12-0.13), the 25-64 is almost neutral (0-0.02), and the 65+ tends to move to less urbanised areas (-0.5 to -0.12). As shown in the figures, this pattern is driven mostly by the proportion of people in the three age groups who would consider moving to suburban areas: 18-19% in the 18-34 age group, 9% in the 35-64 group, and 3% in the 65+ group.

Figure 154. Impact of delivery robot on residence location

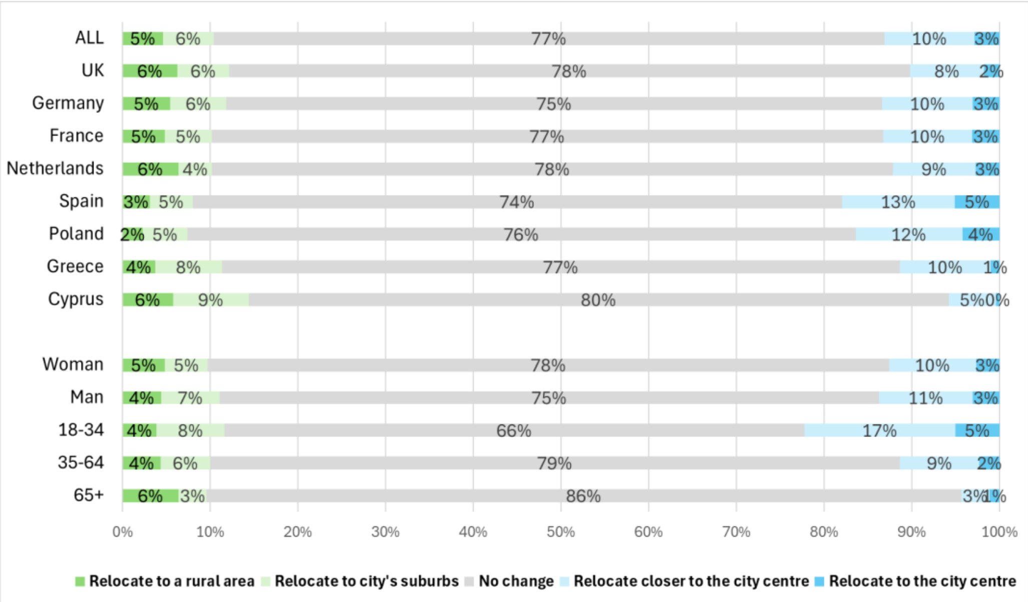
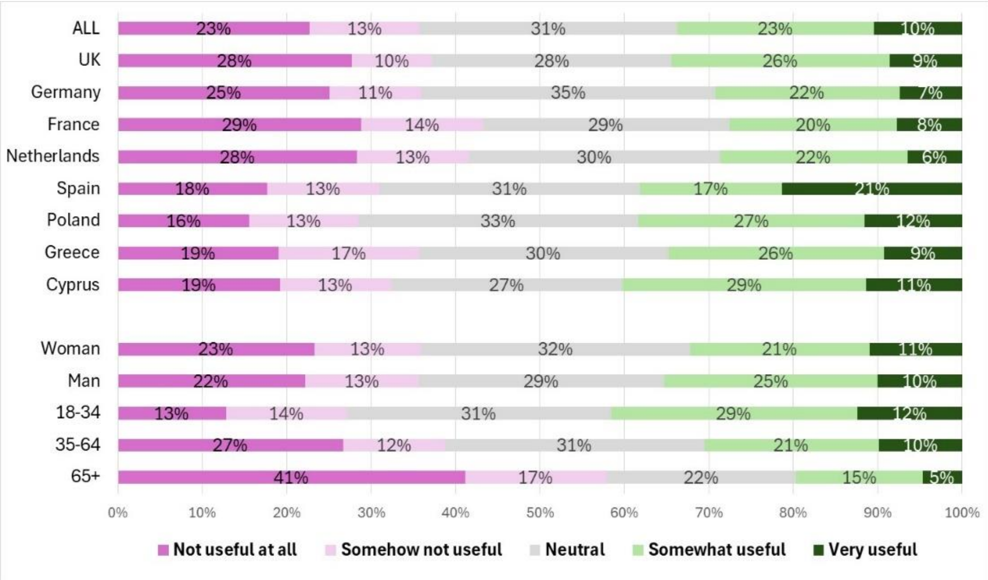


Figure 155. Impact of delivery drone on residence location

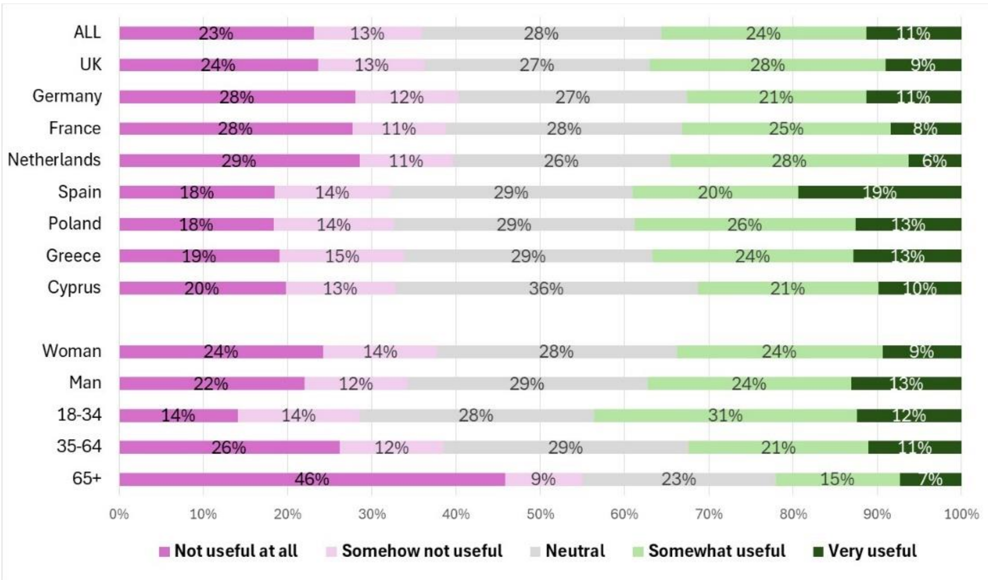
5.10.9 Utility of self-driving freight transport vehicles for work

Figure 156 and Figure 157 show the participants' perceptions of how useful delivery robots and drones could be for the organisation they work for. The question was only asked to individuals who are currently working (full or part time). There are few differences between perceptions of robots and drones. Overall, around 10-11% think these vehicles can be very useful and another 23%-24% think they can be somewhat useful. The proportions of participants with a negative view are higher: 13% think the two vehicles are "somewhat not useful" and 23% think they are "not useful at all". Spanish participants had the most optimistic views. Men are slightly more optimistic than women. Perceptions of utility decrease steadily with age. More than half of the 65+ age group thinks the two vehicles will not be useful.



Note: Question only asked to participants who are currently working

Figure 156. Utility of delivery robot for the organisation the participant works for



Note: Question only asked to participants who are currently working

Figure 157. Utility of delivery drone for the organisation the participant works for

5.11 Models of intentions and impacts - freight vehicles

5.11.1 Overview

This section estimates statistical models to identify the variables related to participants' intentions and perceived impacts of self-driving freight vehicles. Models for intentions include, as dependent variables, the likelihood of using the two types of vehicles (delivery robots and drones). Models for impacts include, as dependent variables, the change in number of delivery orders, delivery cost, number of trips, parking needs, and residence relocation, associated with the two vehicles.

As in the case of passenger vehicles, the objective of the models is to determine whether specific participants characteristics and other variables are significantly related to the intentions and impacts, when controlling for other relevant variables. The groups of explanatory variables are the same as in passenger transport models: participant demographic characteristics and current travel context and behaviour, attitude in relation to technology adoption, level of previous awareness of self-driving vehicles, and location. The model of likelihood of using the vehicles also includes as variables the impacts that participants expect that those vehicles would have in their behaviour.

Ordinal logit models were used for dependent variables expressed on a 5-point scale (likelihood, and impacts on delivery costs, parking needs, and residence location). Log-linear models were used for continuous variables (impact on delivery orders and number of trips). For each group of models (e.g. one model for each type of vehicle), variables were removed from the models when they were not significant at the 10% level in all models. We report only the signs of the significant variables. Appendix 12 contains the full models.

5.11.2 Models of intentions about freight vehicles

Table 103 shows the estimated models of likelihood of using the self-driving freight vehicles. The likelihood is higher when participant believe that use will increase their number of delivery orders and trips. It is higher both for people who think delivery costs and parking needs will increase and those who think they will decrease (compared with those who think there will be no change). Intention to relocate to a rural area decreases likelihood of using both vehicles. Moves to suburban areas decrease likelihood of using a drone and moves to the city centre reduce likelihood of using the delivery robot.

Both vehicles are more likely to be used by participants in the 18-34 age group and those who make more trips. and less likely to be used by those in the 65+ group and who have no children. In addition, the delivery robot is more likely to be used in the city centre and less likely to be used in villages and in regions with higher income. The drone is more likely to be used by participants with a higher university degree (Master's, PhD) and those whose most frequent trip is shopping, and less likely to be used by women. Levels of technology adoption and awareness of self-driving vehicles tend to be related to higher likelihood.

Table 103. Models of likelihood of using self-driving freight vehicles

	Robot	Drone
Impact on number of delivery orders	+	+
Impact on delivery costs: negative	+	+
Impact on delivery costs: positive	+	+
Impact on number of trips	+	+
Impact on parking needs: negative	+	+
Impact on parking needs: positive	+	+
Relocate to rural	-	-
Relocate to suburban		-
Relocate to city centre	-	
Woman		-
Age: 18-34	+	+
Age: 65+	-	-
No children	-	-
Education: higher university degree		+
Current number of trips (all modes)	+	+
No driving licence		-
Most frequent trip: shopping		+
Technology: “innovator”	+	
Technology: “early adopter”		
Technology: “late majority”	-	-
Technology: “laggard”	-	-
Not aware of self-driving vehicles	-	-
Aware of self-driving vehicles		+
Well aware of self-driving vehicles	+	+
City centre	+	
Village	-	
Region: Income per capita (log)	-	

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models

5.11.3 Models of impacts of freight vehicles

The models of impacts of freight vehicles have few significant variables, compared to equivalent models in the case of passenger vehicles. Table 104 shows the models of the impacts on delivery orders. Change in delivery orders decreases with age and with having children. Women are more likely to increase number of orders than man if delivery robots were available. Delivery orders are positively related with current number of trips (in the case of the robot) and negatively related with not having a car (in the case of drones). Levels of adoption of technology and awareness of self-driving vehicles are both positively related to change in orders. Living in the city centre increases the change, but living in richer areas reduces it.

Table 104. Models of impact of self-driving freight vehicles on delivery orders

	Robot	Drone
Woman	+	
Age: 18-34	+	+
Age: 65+	-	-
No children	-	-
Current number of trips (all modes)	+	
No car		-
Technology: “innovator”	+	+
Technology: “early adopter”	+	+
Technology: “late majority”	-	-
Technology: “laggard”		
Aware of self-driving vehicles		+
Well aware of self-driving vehicles		
City centre	+	+
Region: Income per capita (log)	-	-

Notes: Log-linear model. Table shows only the sign of significant variables. Appendix 12 contains full models

Table 105 shows the models of the impacts on delivery orders. The 18-34 age group reported higher expected change in delivery costs. In the case of the robot, change in delivery costs is higher in city centres and lower for women. In the case of the drone, change in higher in richer regions and lower for households without children and individuals who make less trips. Again, adoption of technology and awareness of self-driving vehicles relate positively with delivery costs.

Table 105. Models of impact of self-driving freight vehicles on delivery costs

	Robot	Drone
Woman	-	
Age: 18-34	+	+
No children		-
Current number of trips (all modes)		-
Technology: “innovator”		+
Technology: “early adopter”	-	
Well aware of self-driving vehicles	+	+
City centre	+	
Region: Income per capita (log)		+

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models

Figure 113 shows the impact on number of trips. The model has some similarities with the one above for number of orders, when it comes to household composition, technology, awareness, and living in the centre. However, there are some differences. Women are more likely to increase number of trips. Current number of trips is positively related to change in trips (in the case of delivery robots), and regional income is negatively related with change in trips. Participants whose current main trip purpose is shopping are less likely to reduce number of trips if they had access to delivery robots.

Table 106. Models of impact of self-driving freight vehicles on number of trips

	Robot	Drone
Woman	+	
Age: 18-34	+	+
Age: 65+	-	
No children		-
Current number of trips (all modes)	+	
Most frequent trip: shopping	-	
Technology: “innovator”	+	+
Technology: “early adopter”	+	+
Technology: “late majority”	-	-
Technology: “laggard”		
Not aware of self-driving vehicles		+
City centre	+	+
Region: Income per capita (log)	-	-

Notes: Log-linear model. Table shows only the sign of significant variables. Appendix 12 contains full models

Table 107 shows the impact on parking needs. Apart from the usual effects of technology adoption and awareness of self-driving vehicles, only six variables are significant. The youngest age group, those with education below university degree, and those living in the city centre are more likely to move and women are less likely. In the case of robots, those with higher university degrees are more likely to move and those who currently make more trips are less likely.

Table 107. Models of impact of self-driving freight vehicles on parking needs

	Robot	Drone
Woman	-	-
Age: 18-34	+	+
No children		-
Education: below university degree	+	+
Education: higher university degree	+	
Current number of trips (all modes)	-	
Technology: “innovator”		
Technology: “early adopter”	+	
Well aware of self-driving vehicles		+
City centre	+	+

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models

Table 108 shows the models of impacts on residence location. The dependent variable is the intention to move to more urbanised areas. Apart from the usual effects of technology adoption and awareness of self-driving vehicles, only four variables are significant: the youngest age group and those living in the city centre is more likely to move. Women (in the case of delivery robots) and those without children (in the case of drone) are less likely.

Table 108. Models of impact of self-driving freight vehicles on intention to move to more urbanised areas

	Robot	Drone
Woman	-	
Age: 18-34	+	+
No children		-
Technology: “innovator”	+	+
Technology: “early adopter”		
Technology: “late majority”		
Technology: “laggard”		-
Not aware of self-driving vehicles	-	
Well aware of self-driving vehicles	+	
City centre	+	+

Notes: Ordinal model. Table shows only the sign of significant variables. Appendix 12 contains full models

5.12 Needs and requirements

This section presents results of the part of survey that captured needs and requirement, i.e. specific preferences for the use of self-driving vehicles. This includes preferences for the type of vehicle (Section 5.12.1) and for the use of travel time (Section 5.12.2).

5.12.1 Preferred type of self-driving passenger transport vehicle

Participants were asked to rank five types of self-driving passenger transport vehicles. The options included the three vehicles presented in the impact questions presented in Section 5.7 of this report (private car, taxi, and public bus) and two extra vehicles: a pod (defined as a small two-seater vehicle for shorter trips) and an on-demand shuttle bus. Figure 158 shows the vehicle ranked as the most preferred.

The private car was the most preferred vehicle (ranked as number one by 37% of the sample) (Figure 158), followed by bus (15%), taxi (13%), pod (10%), and on-demand shuttle (6%). 18% of the sample indicated that they would not use any of these vehicles. Cyprus had the strongest preferences for the private car (47%), pod (18%), and on-demand shuttle (13%) among all countries. Greece has the strongest preference for the taxi (21%) and pod (18%), with the second strongest preference for the on-demand shuttle (11%) (considerably higher than the average of 6%). In both countries, almost no participants stated they would not use any of the vehicles. Preferences did not differ much between men and women. Preference for the car and taxi decreased with age, and preference for none of the vehicles increased with age.

A separate question asked about the most preferred vehicle for commuting trips – the results are shown in Figure 159. Preferences for car are only slightly weaker, comparing with the general case shown in Figure 158. The only relevant difference is the increase in the proportion of participants aged 65+ stating they would not use any vehicle (which is related to a lower need to commute among this age group).

Figure 160 shows the rank position of the private car among the five vehicles (i.e. excluding participants who stated they would not use any of the five vehicles. The private car was ranked the most preferred by 45% of participants, second by 16% and third by 13%. Only 26% of the sample did not include the car on the top three preferred vehicles. The private car was ranked in relatively lower positions in Greece and among the 65+ group, compared with other sub-sets of the sample.

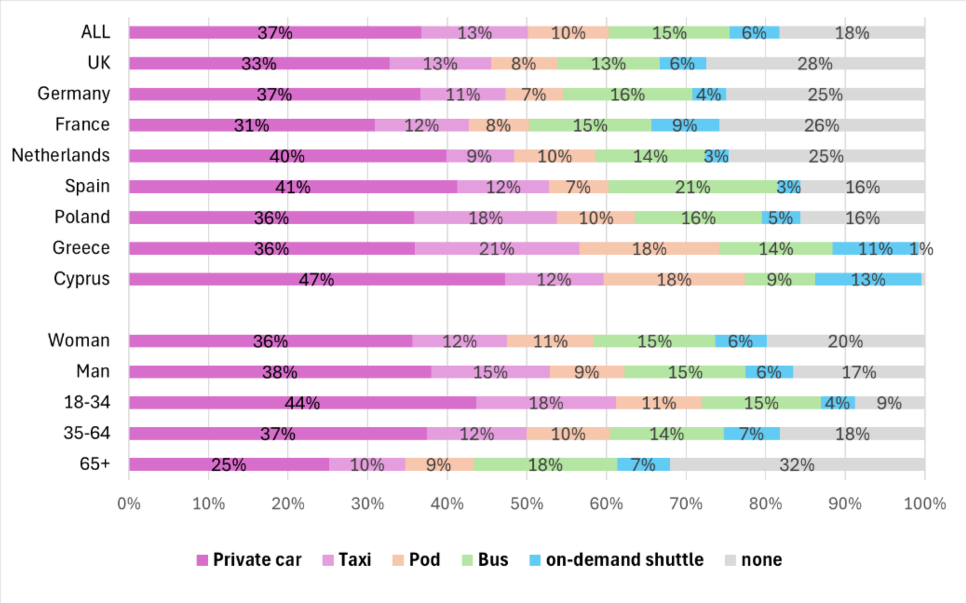


Figure 158. Preferred self-vehicle type, by country, gender, and age

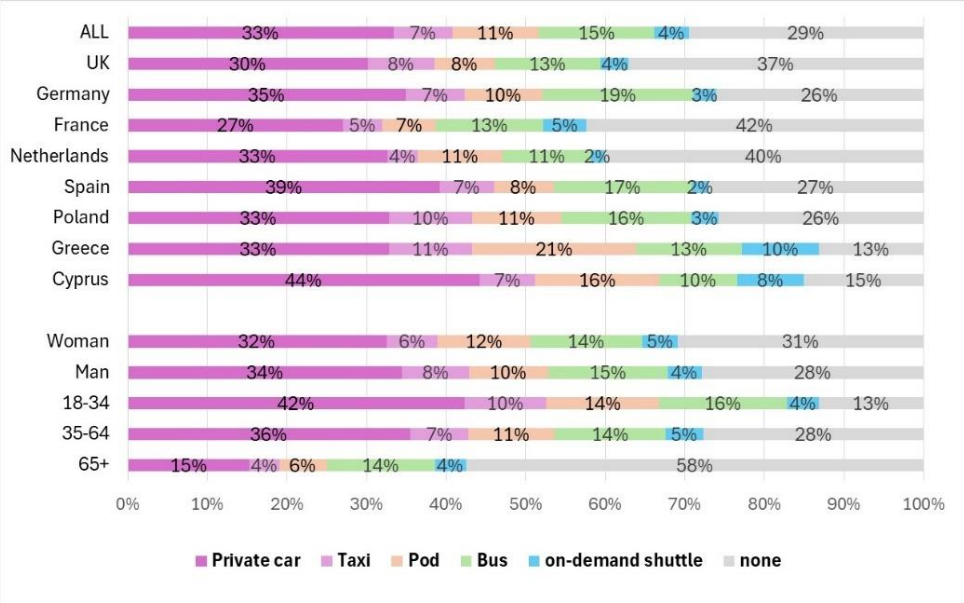
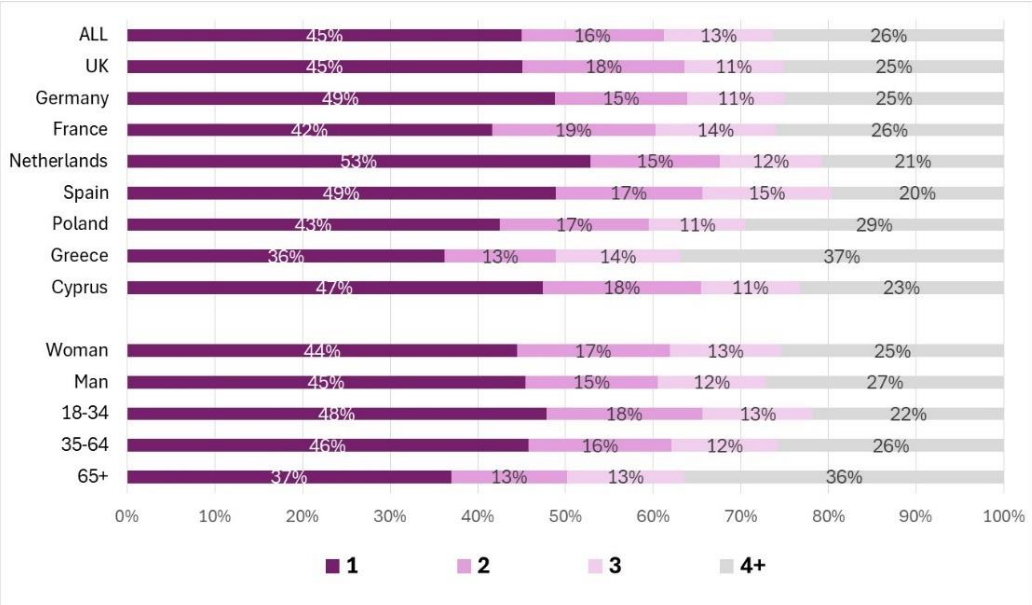


Figure 159. Preferred self-vehicle type for commuting trips, by country, gender, and age



Notes: Excludes participants who stated they would not use any of the vehicles

Figure 160. Rank position of private car, by country, gender, and age

5.12.2 Activities while travelling in a self-driving vehicle

Figure 161 shows the activities that participants would engage with while travelling in self-driving vehicles. Among the three most frequent ones are activities that currently public transport users usually engage with: surf the web (43%) and talk on the phone (41%).

However, the other frequent activity is simply “focus on the road” (41%). This could be for relaxation, but it could also be because individuals do not fully trust the software driving the vehicle. This was indeed mentioned by some participants in the open-ended question at the end of the questionnaire as we will see later in Section 5.15 (even though the question was about impacts, some participants mentioned that they would still monitor the road and hoped there could be a way to regain control of the vehicle in emergency situations).

The preference for “focus on the road” is also consistent with the results obtained through the survey conducted at the beginning of the project, with smaller samples of participants in each country. This other survey was implemented when recruiting participants to join the project “satellites” network and join project activities (e.g. the qualitative assessment of impact, demonstration and virtual reality experiments reported in previous chapters of this report). In that survey, the most common activity participants mentioned was “look outside window” (51%, across all countries).

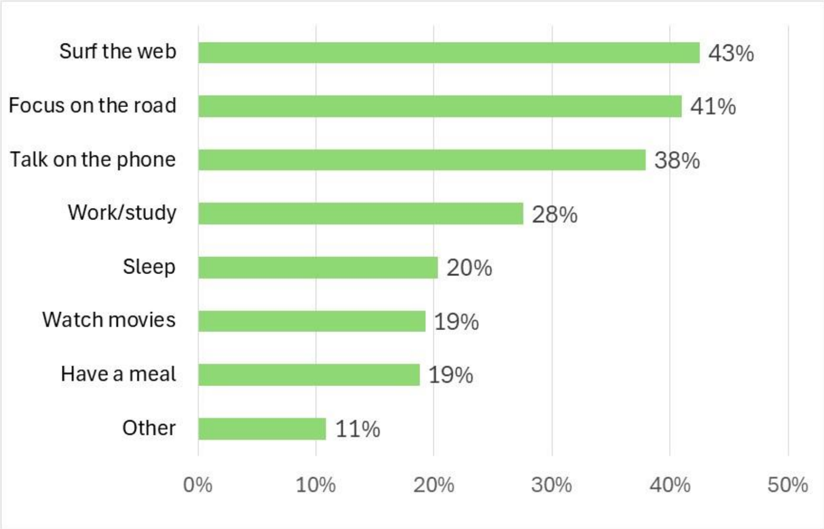


Figure 161. Activities while travelling in self-driving vehicles (% of whole sample)

As seen in the chart above, “work and study” was indicated as an activity by 28% of participants across the whole sample. The chart in Figure 162 and map in Figure 163 show this proportion varies within sub-sets of the sample. Intention to work or study while travelling on self-driving vehicles is stronger in Cyprus (48%) and Greece (38%) and among the 18-34 age group (42%). This intention is homogeneously strong across all Greek regions (Figure 163). It is also strong in several Spanish regions.

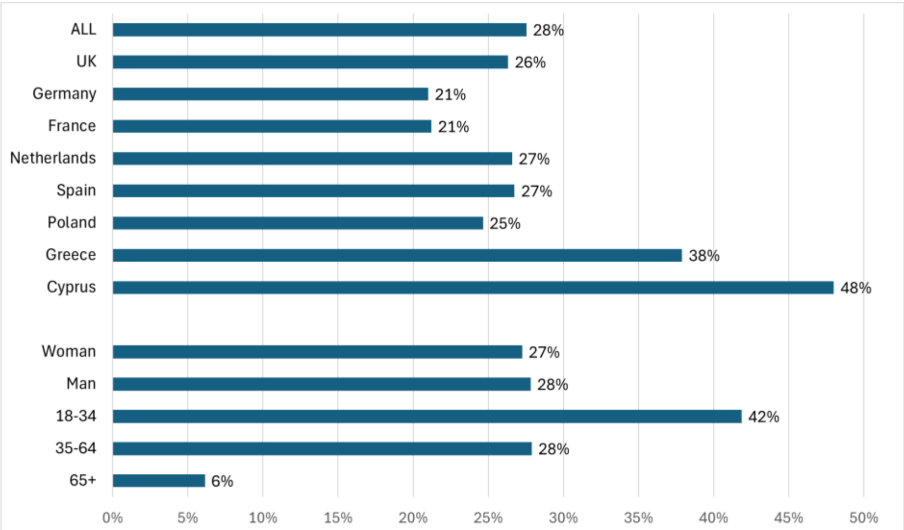


Figure 162. Activities while travelling in self-driving vehicles, by country, gender, and age: work/study (%)

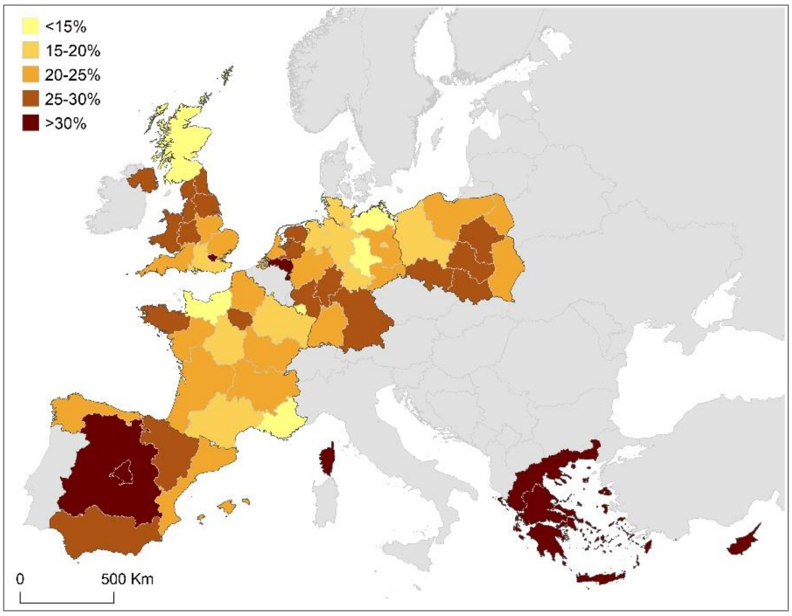


Figure 163. Activities while travelling in self-driving vehicles: work/study (%), by region

The following three figures show variations in intention to engage in the three main activities.

"Surf the web" and "talk on the phone" are more popular options in Spain and Cyprus (Figure 164 and Figure 165). In the United Kingdom and France, there is a stronger preference for talking on the phone than surfing the web, while in other countries, there is a stronger preference for surfing the web. The older age group has much weaker intention to engage in the two activities (26-27%) than the younger groups (between 39% and 47%). Women and slightly less likely to engage in the two activities than men are.

These age and gender patterns change for the "focus on the road" alternative. The older age is much more likely to indicate they would "focus on the road" (56%) than engaging in phone-related activities (Figure 166). In addition, women are more likely than men to intend to focus on the road. Greece is the country where this activity is more likely to happen.

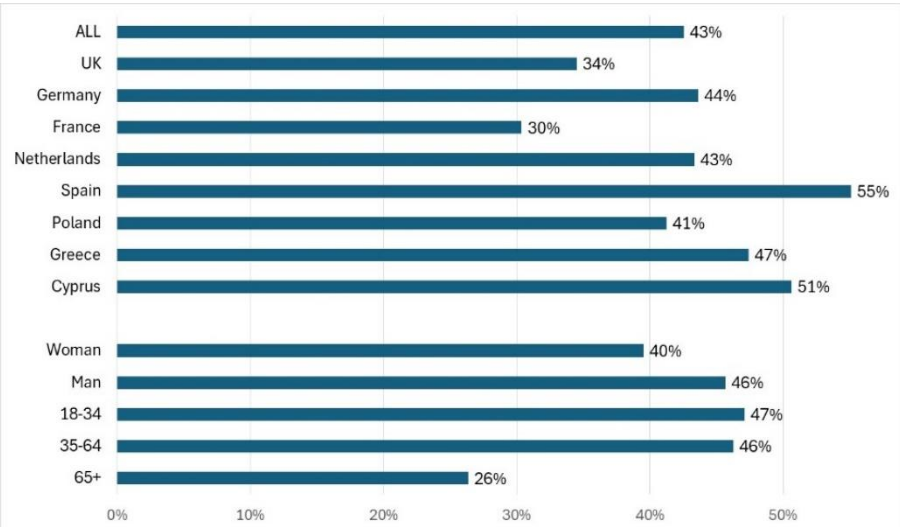


Figure 164. Activities while travelling in self-driving vehicles, by country, gender, and age: surf the web (%)

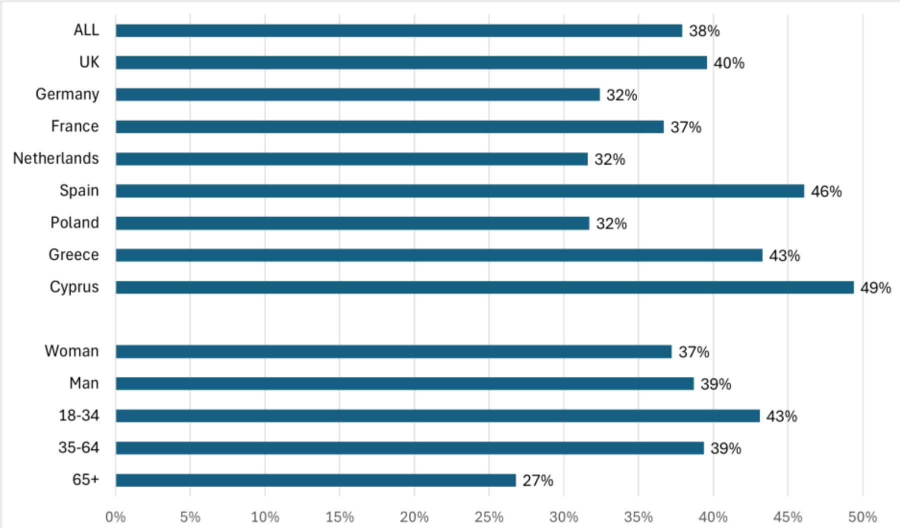


Figure 165. Activities while travelling in self-driving vehicles, by country, gender, and age: talk on the phone (%)

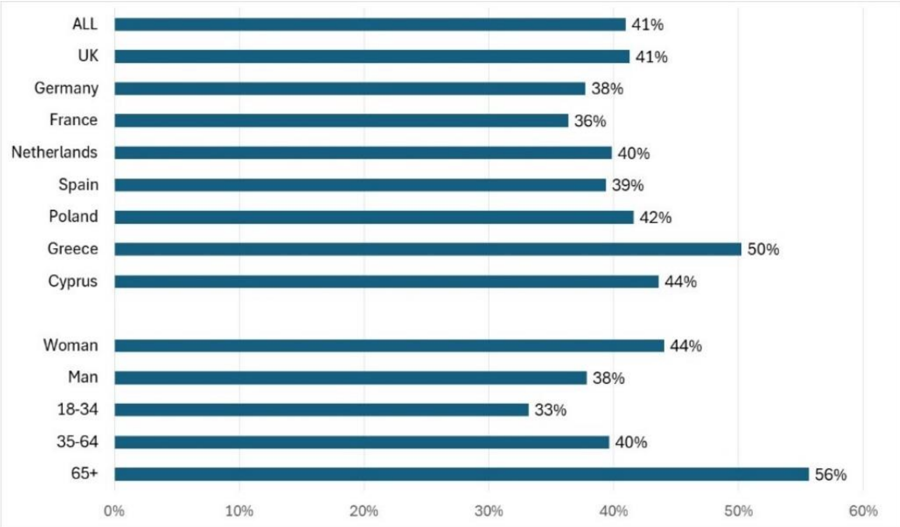


Figure 166. Activities while travelling in self-driving vehicles, by country, gender, and age: focus on the road (%)

Analysis of variations in intention to engage in other activities (not shown in any chart) revealed considerable age differences: the 18-34 age group is much more likely to sleep, watch movies, or have a meal (29%-31%), followed by the 36-64 group (17%-20%) and the 65+ group (6%-9%).

5.13 Implementation timeline of self-driving passenger transport vehicles

Participants were asked for their perception about the time when several types of self-driving passenger vehicles would be deployed in their region. Again, this considered five types of vehicles and not only the three vehicles presented in the impact questions presented in Section 5.7 of this report.

Figure 167 compares the participants' perceived implementation timelines of the five vehicles, across the whole sample. The perceptions vary little from vehicle to vehicle and there is a fairly equal distribution of participants across the five years shown as options and the "never" option. The most frequent time mentioned was 2040 (20-22% of participants), except in the case of the on-demand shuttle, which more people believe that it will never be implemented (22%). There is also a fair amount of scepticism regarding the other four vehicles, which 17-20% of participants think they will never be implemented. Between 11-14% of participants think self-driving passenger vehicles will be implemented before 2030.

Figure 168 to Figure 172 show how perceptions in the implementation timeline of each type of vehicle differ by country, gender, and age. Perceptions do not vary much from vehicle to vehicle. Participants in Spain are more optimistic regarding the timeline of implementation of all vehicles. Those in Greece are also more optimistic than other countries but tend to point to a slightly delayed timeline than in Spain. In both countries, the proportion of participants believing the vehicles will never be implemented is lower than in other countries, as 11-13%, compared to 17-20%, apart from the on-line shuttle, which has higher proportion of people believing it will never be implemented, in all countries.

Perceptions vary little between men and women, but there is always a higher proportion of women believing the vehicles will never be implemented, for all vehicles, but especially the on-demand shuttle. Differences by age are also mainly on the proportion believing the vehicles will never be implemented, which increases steadily with age.

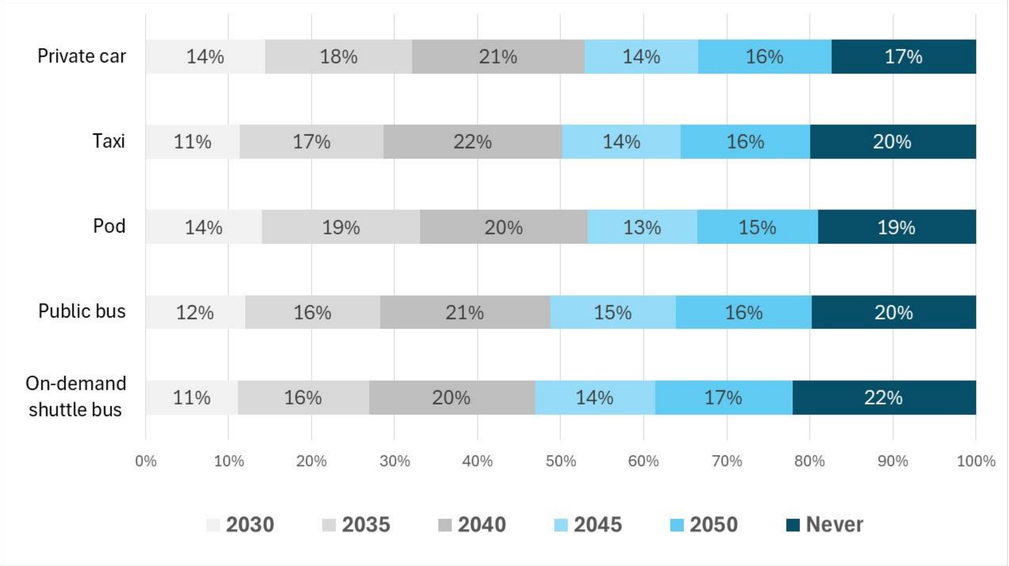


Figure 167. Perception of when self-driving vehicles will be implemented in one's region (whole sample)

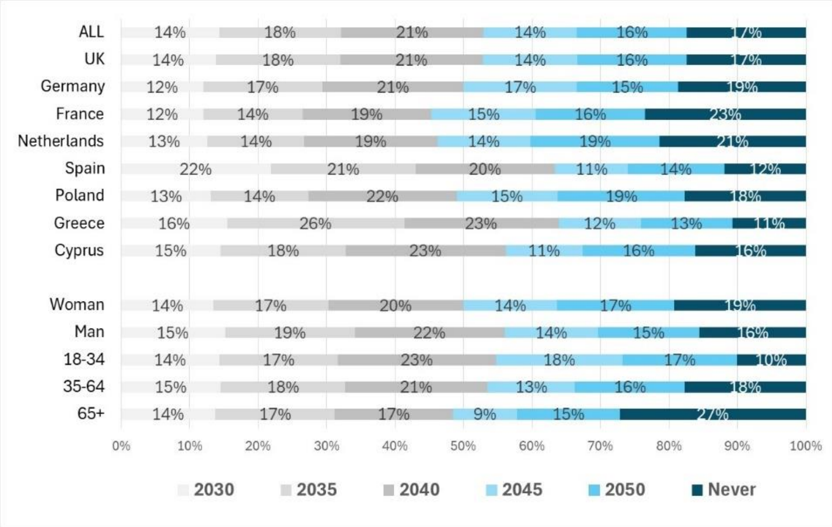


Figure 168. Perception of when self-driving cars will be implemented in one's region

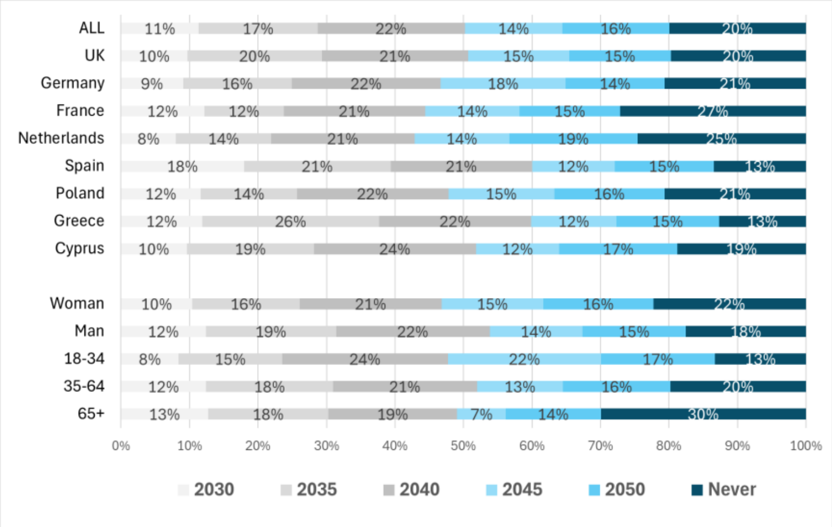


Figure 169. Perception of when self-driving taxis will be implemented in one's region

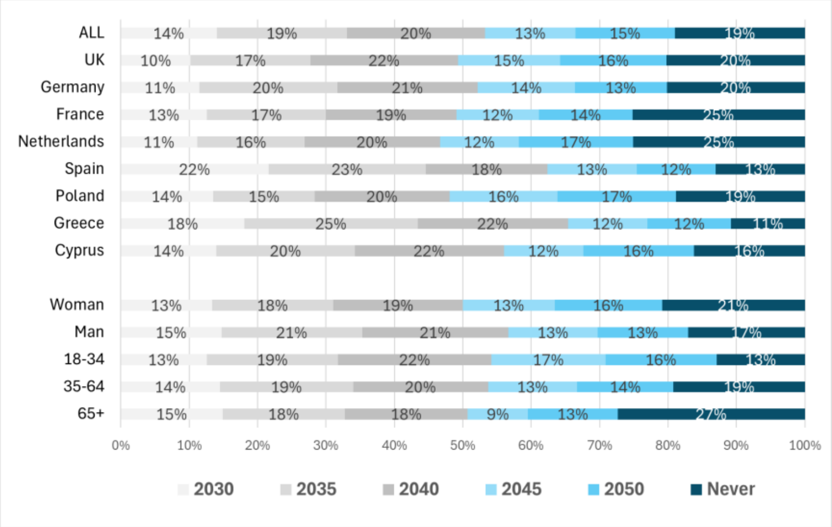


Figure 170. Perception of when self-driving pods will be implemented in one's region

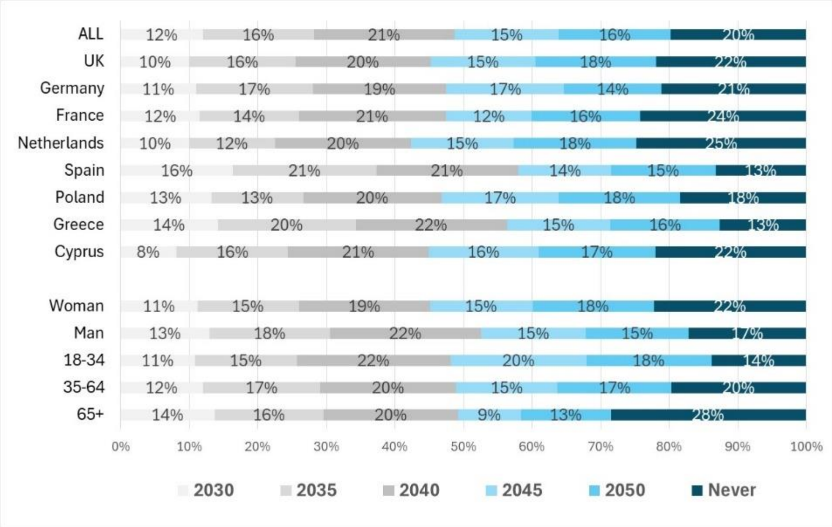


Figure 171. Perception of when self-driving buses will be implemented in one's region

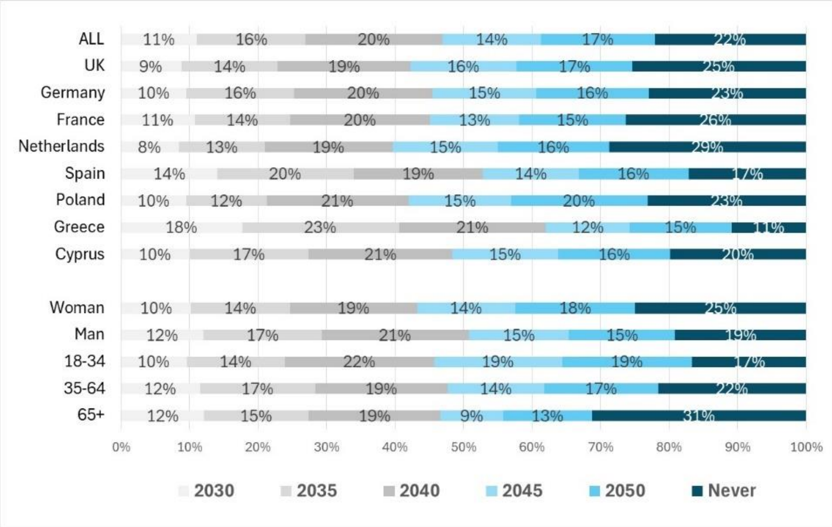


Figure 172. Perception of when self-driving on-demand shuttle buses will be implemented in one's region

The two maps that follow show geographic variations in two extreme positions: thinking that none of the five vehicles will ever be implemented (Figure 173) and thinking that all the five vehicles presented will be implemented in the next 6 years, i.e., by 2023 (Figure 174).

The highest proportions of participants believing none of the self-driving vehicles will be implemented (Figure 173) are higher in some regions of France, Germany, and the United Kingdom, and the lowest proportions in all regions of Spain, Greece, and Cyprus, as well as Norther Ireland (United Kingdom).

The highest proportions of participants believing all the vehicles will be implemented before 2030 (Figure 174) are in some regions of Spain and Greece, and the lowest are in regions scattered across all other countries (except Cyprus).

Comparing these maps with those showing levels of awareness of self-driving vehicles (shown previously in Figure 101 and Figure 102), the conclusion is that while in some regions, optimism regarding timeline occurs simultaneously with high levels of awareness (e.g. Madrid, most regions in Greece), and pessimism with low awareness (e.g. some regions in France), there are also regions where such relationships do not occur. For example, participants in the United Kingdom tend to be the most aware of self-driving vehicles, but there is a fair amount of scepticism regarding the implementation timeline of these vehicles in several of its regions.

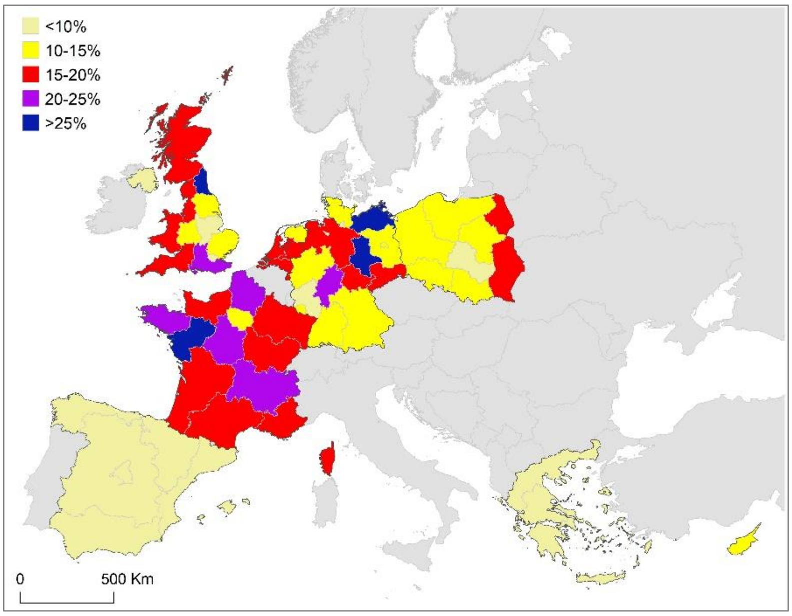


Figure 173. Proportion of participants who think none of the self-driving vehicle types will ever be implemented in their area, by region

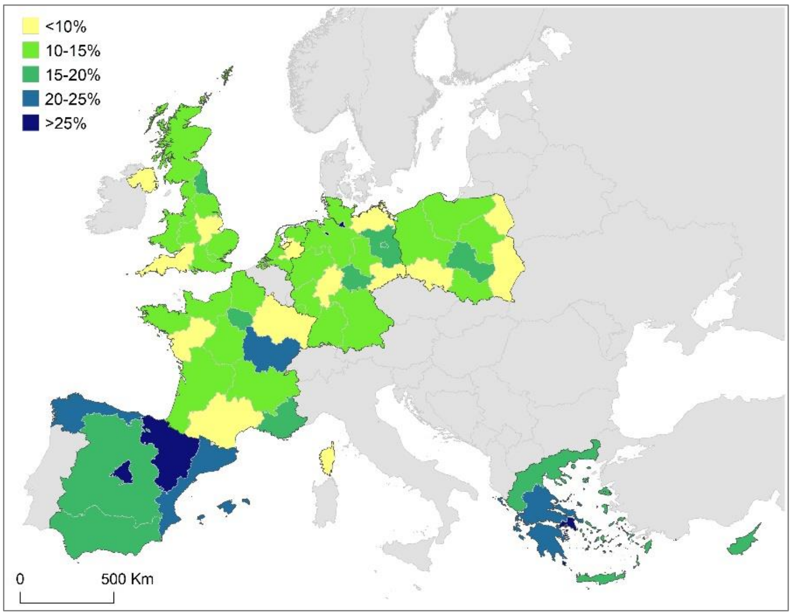


Figure 174. Proportion of participants who think all the self-driving vehicle types will be implemented in their area by 2030, by region

5.14 Wider impacts

5.14.1 Overview

This section reports the results of participants' stated impacts of self-driving vehicles on their regions, and not on their individual behaviour or circumstances, as in Sections 5.7 and 5.10. The section is split according to the Move2CCAM project impact dimensions presented earlier: Mobility (Section 5.14.2), road network (5.14.3), land use (5.14.4), environment (5.14.5), economy (5.14.6), equity (5.14.7), public health (5.14.8), safety (5.14.9), and security (5.14.10). Each of the impact dimensions is assessed by several impact indicators, as presented earlier in Section 5.2.1. The results are based on participants' perceptions of probable change in the indicators following the implementation of self-driving vehicles, on a 5-point scale from "reduced significantly (50% reduction or more) to "increase significantly" (50% increase or more).

All nine sections follow the same structure, analysing:

- The distribution of participant answers on the 5-point scale, comparing the various indicators across the whole sample.
- The average impacts across the whole sample and disaggregated by country, gender, and age. As done previously, the 5-point scale was converted into a numerical one, assuming values from -2 to +2. The assumption is that participants perceive the original scale as a linear one, i.e. moves from one point to the next one always correspond to the same increase in impact.
- The distribution of participant answers on the original 5-point scale for each indicator, disaggregated by country, gender, and age.

5.14.2 Mobility

Figure 175 compares the results for the eight indicators of mobility impacts and Table 109 shows the average impacts, on a -2 to +2 scale. On average, participants think that number of trips and travel costs will increase (average of 0.20 and 0.14 respectively) (Table 109). More people think that number of trips and travel costs will increase or increase significantly than decrease or decrease significantly, but 49% think number of trips will not change, and 42% think travel costs will not change (Figure 175). The results for participants' perception of change in number of trips in their region are consistent with that they indicated for the change in their own trips. As seen in Section 5.7.4, on average participants thought their number of trips would increase.

Results for number of shopping trips and delivery costs are consistent with the ones for overall number of trips and travel costs. On average, participants think shopping trips will increase (mean score of 0.21), with about half of the sample saying it will not change, but more thinking it will increase (34%) than decrease (15%). This is consistent with opinions about change in personal (for all purposes), as seen in Section 5.7.4. On average, participants think that delivery costs will increase very slightly (mean score of 0.08), with 31% thinking they will increase and 24% think they will decrease. This is consistent with the perceptions about own delivery costs, which as seen in Section 5.10.5, is believed to be slightly negative on average but with most people (62%) having a neutral view. While the sign of the average change in personal and regional delivery costs is different, the magnitudes of the changes are very small, so the results are consistent.

Participants also have a neutral view regarding travel time (Table 109), with half thinking it will not change, and about the same number thinking it will increase and decrease (Figure 175). This contrasts with participant perceptions on change in their own travel time, which as seen in Section 5.7.4, it was positive (1.5 to 2.2 minutes, depending on the type of vehicle).

As expected, participants think that ownership of self-driving vehicles will increase (mean score of 0.20), and ownership of conventional private vehicles will decrease (mean score of -0.25). 17% think that ownership of conventional vehicles will increase and 44% think it will not change. This suggests that people believe that self-driving vehicles will coexist with conventional vehicles, not replacing them completely. More surprising is the fact that 19% think that ownership of self-driving vehicles will decrease. This suggests a disbelief that these vehicles will be implemented.

On average, participants think use of self-driving shared vehicles will increase (mean score 0.20), with 37% thinking will increase and 16% thinking it will decrease.

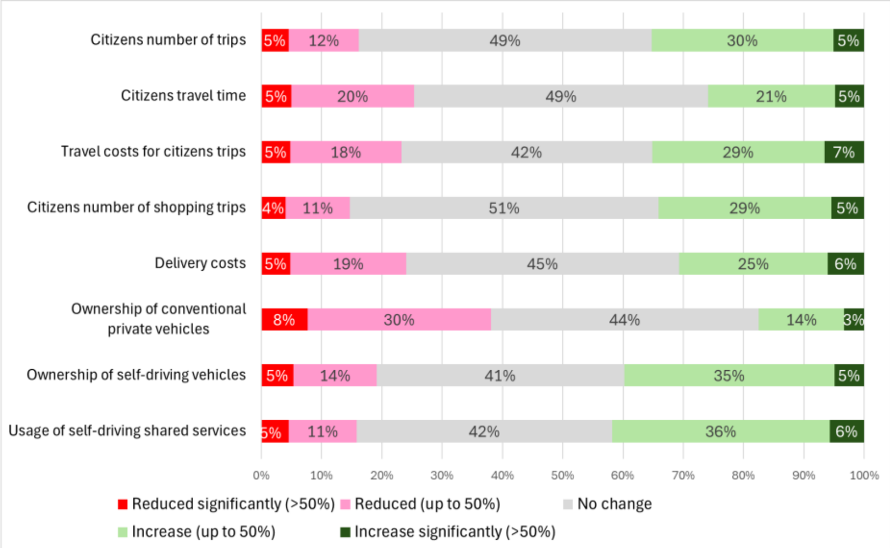


Figure 175. Impact on mobility indicators

Table 109. Average impacts on mobility

	Citizens number of trips	Citizens travel time	Citizens number of shopping trips	Travel costs for citizens trips	Delivery costs	Ownership of conventional private vehicles	Ownership of self-driving vehicles	Usage of self-driving shared services
ALL	0.20	0.00	0.21	0.14	0.08	-0.25	0.20	0.27
UK	0.26	0.05	0.19	0.27	0.15	-0.18	0.32	0.32
Germany	0.23	0.09	0.17	0.20	0.08	-0.19	0.16	0.22
France	0.15	0.08	0.21	0.20	0.11	-0.18	0.08	0.23
Netherlands	0.22	-0.05	0.17	0.23	0.08	-0.28	0.18	0.25
Spain	0.31	0.18	0.33	0.20	0.09	-0.16	0.29	0.42
Poland	0.35	0.19	0.35	0.22	0.21	-0.13	0.30	0.29
Greece	0.03	-0.32	0.13	-0.09	-0.03	-0.46	0.18	0.26
Cyprus	-0.17	-0.49	-0.02	-0.45	-0.27	-0.66	0.04	0.10
Women	0.20	-0.02	0.25	0.13	0.22	-0.25	0.20	0.25
Men	0.19	0.03	0.29	0.15	0.20	-0.25	0.20	0.29
18-34	0.32	0.06	0.34	0.19	0.30	-0.11	0.31	0.34
35-64	0.20	0.00	0.29	0.10	0.21	-0.29	0.21	0.29
65+	0.03	-0.05	0.12	0.16	0.08	-0.36	0.04	0.12

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Table 109 and the seven figures below disaggregate the results for all indicators by country, gender, and age. Greece and Cyprus show lower mean values and Poland and Spain show higher values, for all indicators. More than half of participants in Cyprus think that travel time and travel costs will decrease (Figure 177 and Figure 178) and that ownership of conventional vehicles will decrease (Figure 181). The values for the other four countries tend to be around the overall average. Views in France tend to be more pessimistic than average. Compared with average, French participants indicated that the number of trips will increase less (except shopping trips), travel time and cost will increase more, delivery costs will increase more, ownership of self-driving vehicles will increase less, and that of conventional vehicles will decrease less. As an example, only 31% of French participants think ownership of self-driving vehicles will increase (Figure 182).

The differences between the impacts reported by men and women are minimal, as seen in the table and all the figures below.

All the indicators correlate with age (Table 109). An increase in age is related to lower mean scores for all variables, i.e. perceptions of lower increase in number of trips (overall and for shopping), lower increase in travel time (which becomes a decrease in the case of people aged 65+), lower increases in travel and delivery costs, lower increase in ownership of self-driving vehicles (but also higher decrease in ownership of conventional vehicles), and lower usage of self-driving vehicles. The differences across groups are particularly striking in the case of the first indicator (number of trips). As shown in Figure 176, almost equal proportions of the three age groups think there will be a decrease. However, while 46% of the 18-34 age group thinks there will be an increase, only 23% of the 65+ group thinks so – this is because of a large (59%) proportion thinking there will be no change, among the 65+ age group.

Figure 176. Impact on citizens' number of trips

Figure 177. Impact on citizens travel time

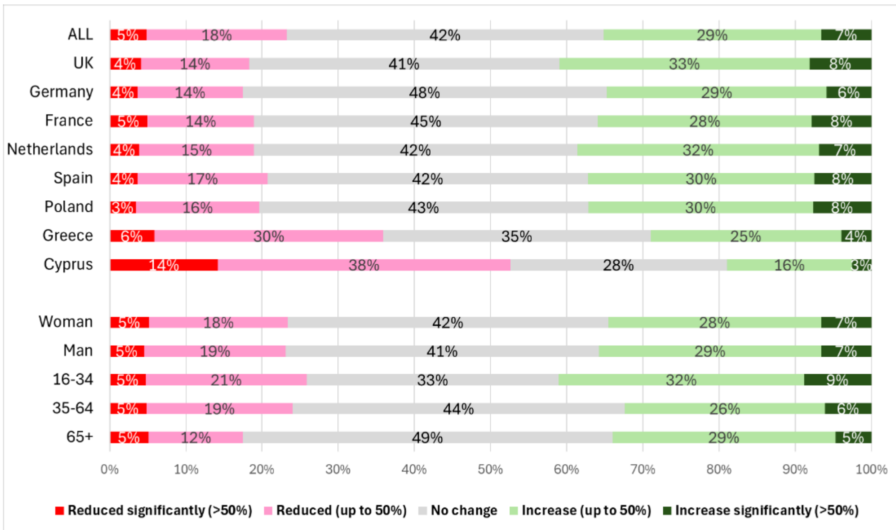


Figure 178. Impact on travel cost for citizens' trips

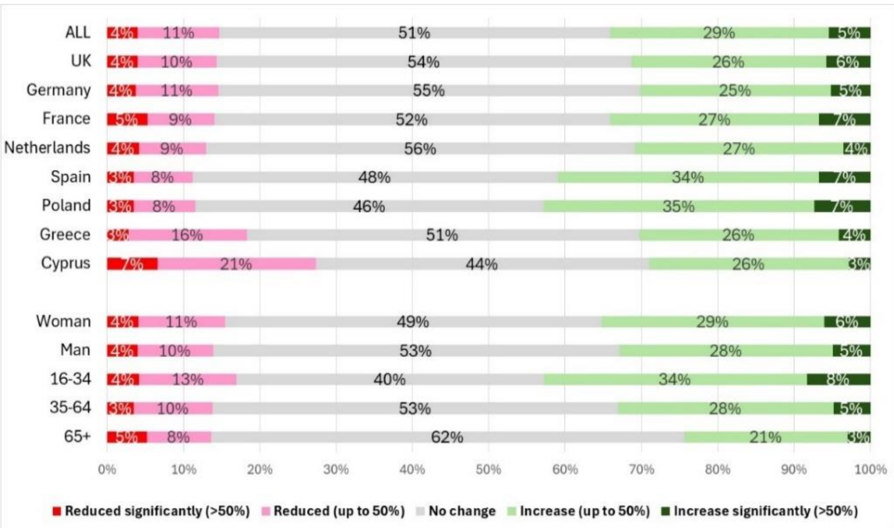


Figure 179. Impact on citizens' number of trips for shopping

Figure 180. Impact on delivery costs

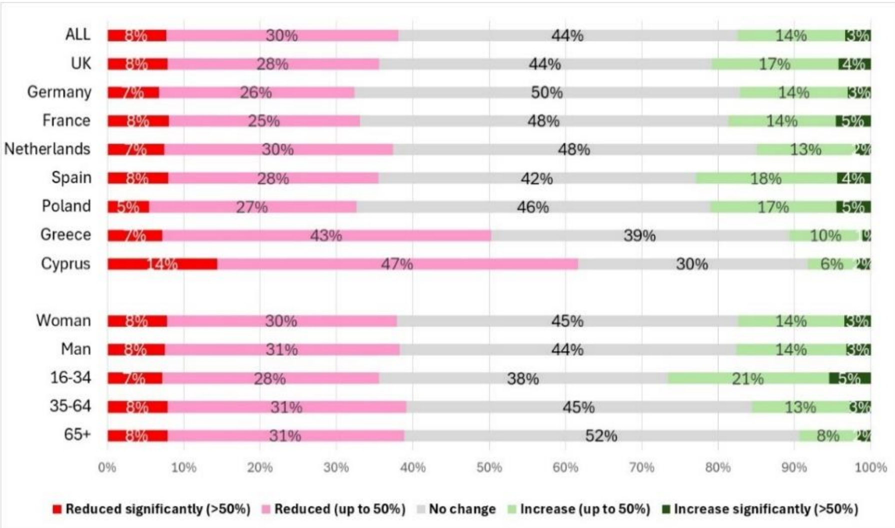


Figure 181. Impact on ownership of conventional private vehicles

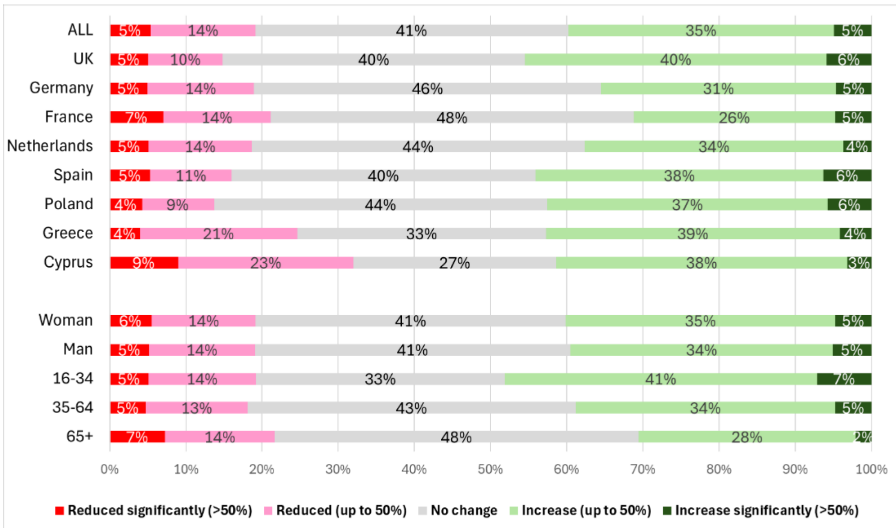


Figure 182. Impact on ownership of self-driving vehicles

Figure 183. Impact on self-driving shared services (public transport, car clubs)

5.14.3 Transport network

Figure 184 shows the results for the two indicators of impacts on the transport network and Table 110 shows the average impacts, on a -2 to +2 scale.

On average, participants believe that the number of vehicles on the network will increase (mean score of 0.13), but this will not have an impact on congestion (mean score close to zero: -0.02) (Table 110). About the same proportion (44-45%) think there will be no change in these indicators, but more participants (34%) think they will be an increase or significant increase in vehicles than those who think there will be a decrease or significant decrease (24%), while the distribution of perceptions in the case of congestion is more balanced (26% vs 28%). The results are consistent with those in the previous section: the increase in number of vehicles on the network is consistent with the belief that number of trips will increase. The almost neutral impact on congestion is also consistent with the perfectly neutral impact on travel time (although it should be noted that travel time is affected not only by road performance but also by trip distance, an aspect not captured in this survey).

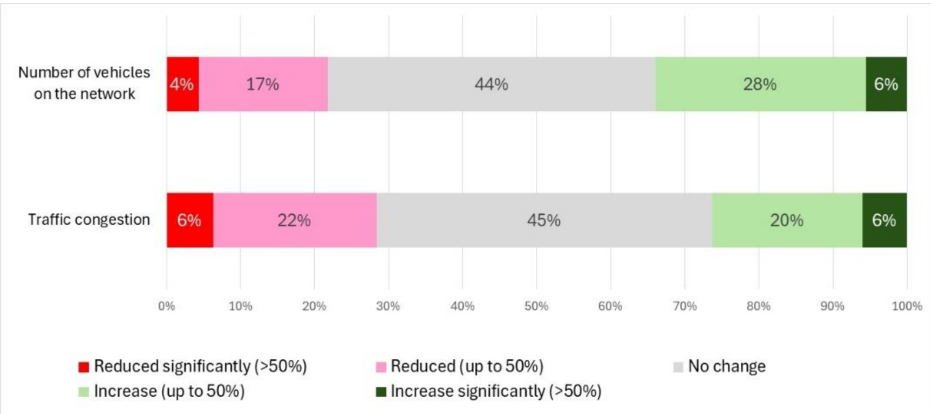


Figure 184. Indicators of impact on transport network

Table 110. Average impacts on the road network

	Number of vehicles on the network	Traffic congestion
ALL	0.13	-0.02
UK	0.23	0.13
Germany	0.22	0.02
France	0.10	0.04
Netherlands	0.21	-0.11
Spain	0.28	0.08
Poland	0.29	0.04
Greece	-0.11	-0.13
Cyprus	-0.43	-0.48
Women	0.16	0.00
Men	0.10	-0.05
18-34	0.22	0.08
35-64	0.11	-0.06
65+	0.08	-0.07

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Greece and Cyprus are distinct cases again, with a belief that number of vehicles and congestion will decrease. About half of Cyprus participants think these indicators will decrease (Figure 185 and Figure 186). In the Netherlands, the average perception is also that congestion will decrease. In the United Kingdom, the average perception is that road congestion will increase. On other countries, the perception is that the effect will be minimal.

On average, men think that number of vehicles will increase less, and congestion will decrease and women think vehicles will increase more and congestion will be unaffected. The expected increase in number of vehicles is inversely related with age. The 18-34 group think congestion will increase, while the 35-64 and 65+ groups think it will increase. As seen in Figure 186, gender and age differences in perceptions of changes in congestion apply mostly to the balance between participants who think it will increase (up to 50%) and those who think there will be no change. The proportions who think it will decrease are similar across genders and age groups.

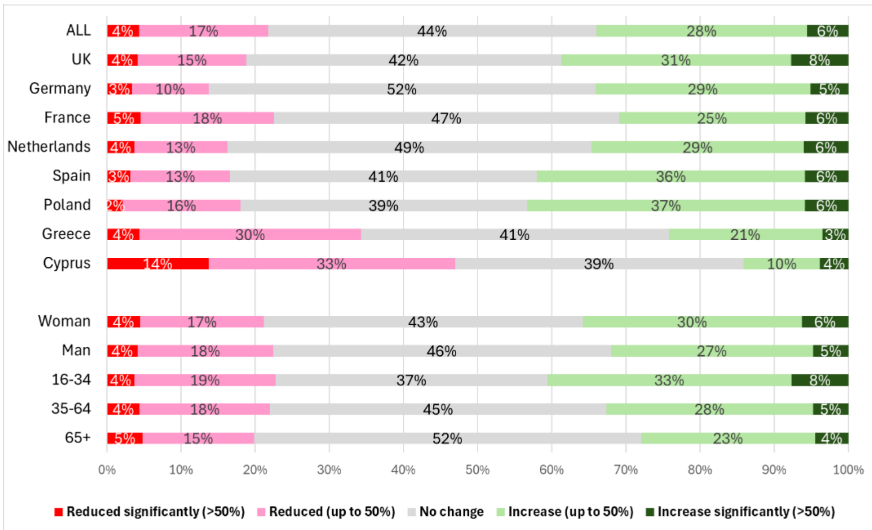


Figure 185. Impact on number of vehicles on the network

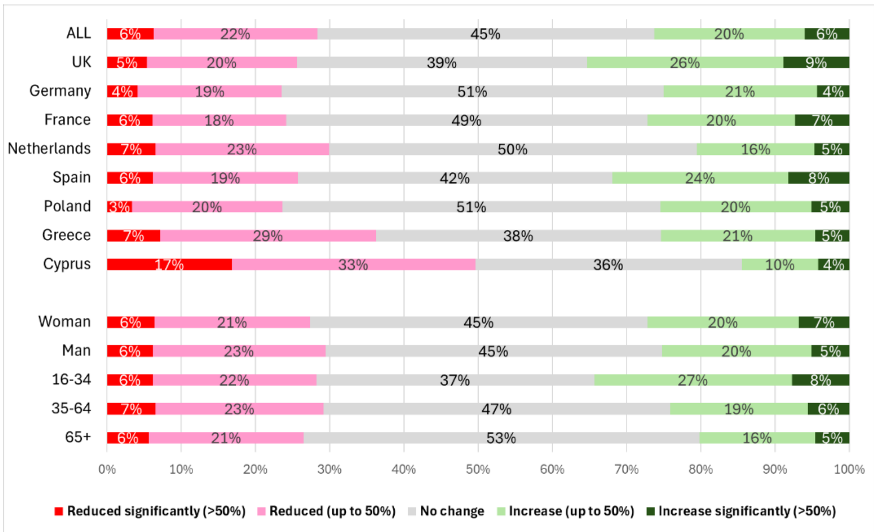


Figure 186. Impact on traffic congestion

5.14.4 Land use

Figure 187 compares the results for the four indicators of land use impacts and Table 111 shows the average impacts, on a -2 to +2 scale.

On average, there is a belief on both a move to rural area and to city centres, but slightly stronger for rural areas (mean scores of 0.15 vs. 0.07) (Table 111). However, 57% think there will be no change in residence location (Figure 187). These results are consistent with those reported by participants for their own intentions to move (Sections 5.7.75.10.8), which showed an almost perfect neutral view on average (linked to high proportions of participants indicating no change, and a balance between those reporting moving to more urbanised and less urbanised areas).

Participants believe there will be slightly less demand for parking spaces in the city centre (-0.05) but a considerable increase demand for redesigned transport infrastructure (0.35) (Table 111). 26% of participants think demand for parking will increase, much smaller than the 43% who think demand for redesigned transport infrastructure will increase (Figure 187). The results for parking are consistent with those participants reported for their own parking needs (5.7.6 and 5.10.7), which showed a slight decrease in parking needs (mean scores of -0.2 to -0.20 depending on the self-driving vehicle considered. It should be noted however, that the question in the present section is specific to the city centre, so numbers are not fully comparable.

Overall, the results for these two indicators suggest that on average participants think that the implementation of self-driving vehicles can be accommodated with redesigned infrastructure, rather than increasing the pressure on existing infrastructure such as parking space.

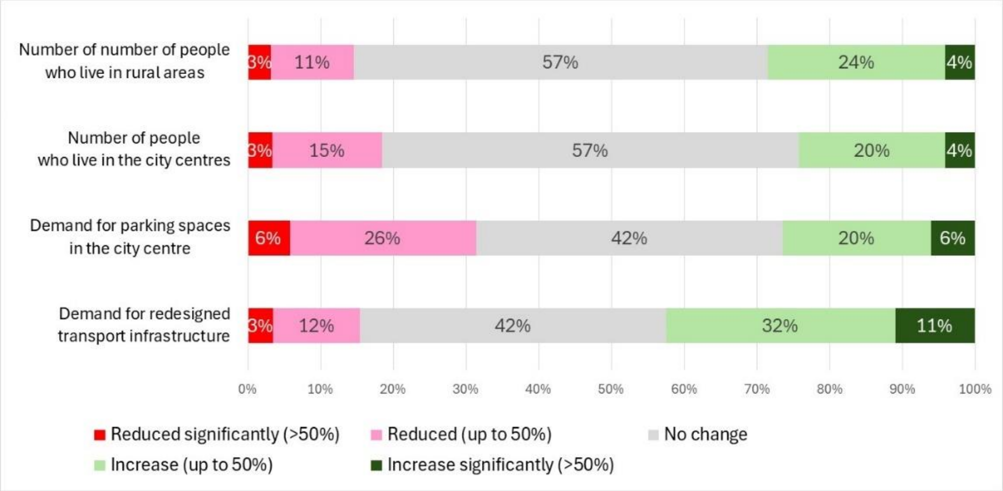


Figure 187. Impact on land use indicators

Table 111. Average impacts on land use

	Number of number of people who live in rural areas	Number of people who live in the city centres	Demand for parking spaces in the city centre	Demand for redesigned transport infrastructure
ALL	0.15	0.07	-0.05	0.35
UK	0.15	0.11	0.01	0.41
Germany	0.24	0.07	-0.09	0.29
France	0.15	0.08	0.04	0.36
Netherlands	0.13	0.05	-0.10	0.33
Spain	0.27	0.23	0.01	0.44
Poland	0.24	0.16	0.12	0.52
Greece	0.00	-0.10	-0.15	0.19
Cyprus	-0.16	-0.20	-0.44	0.08
Women	0.17	0.05	-0.04	0.35
Men	0.13	0.08	-0.06	0.34
18-34	0.20	0.18	0.07	0.40
35-64	0.13	0.03	-0.06	0.32
65+	0.11	-0.01	-0.19	0.33

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Greece and Cyprus are still special cases, although not as much as for the previous impacts. All indicators tend to be lower in these two countries (Table 101). The belief that people will move is stronger in Spain, and Poland, both when considering moves to rural areas and to city centres. In Germany, the main tendency is to believe that people will move to rural areas (34%) than to city centres (25%) (Figure 188 and Figure 189). In Poland, there is a stronger tendency to believe that both demand for parking and for redesigned transport infrastructure will increase, compared with all other countries.

Perceptions do not vary much by gender. Age decreases the perceptions that residents will move, either to rural areas or to the city centre. On average, the 18-34 age group tends to believe that demand for parking spaces will slightly increase and is more likely to believe that demand for redesigned transport infrastructure will increase, compared with the older age groups. As shown in Figure 190 and Figure 191, this is driven mainly by differences in the proportion of participants who think these demands will increase (green bars in the figure) rather than the proportions who thing they will decrease (red bars).

Figure 188. Impact on number of people who live in rural areas

Figure 189. Impact on number of people who live in the city centres

Figure 190. Impact on demand for parking spaces in the city centre

Figure 191. Impact on demand for redesigned transport infrastructure

5.14.5 Environment

Figure 191 compares the results for the three indicators of environmental impacts and Table 112 shows the average impacts, on a -2 to +2 scale. On average people believe that emissions and noise will decrease and demand for electricity to charge vehicles will increase (Table 112). This suggests that people assume that self-driving vehicles will be electric. In absolute value, the impact on demand for electricity is higher than the impacts on emissions and noise. This is also visible in Figure 191, which shows that more than half of the sample (56%) think demand for electricity will increase or increase substantially, while 38% think emissions will decrease, and 44% think noise will decrease.

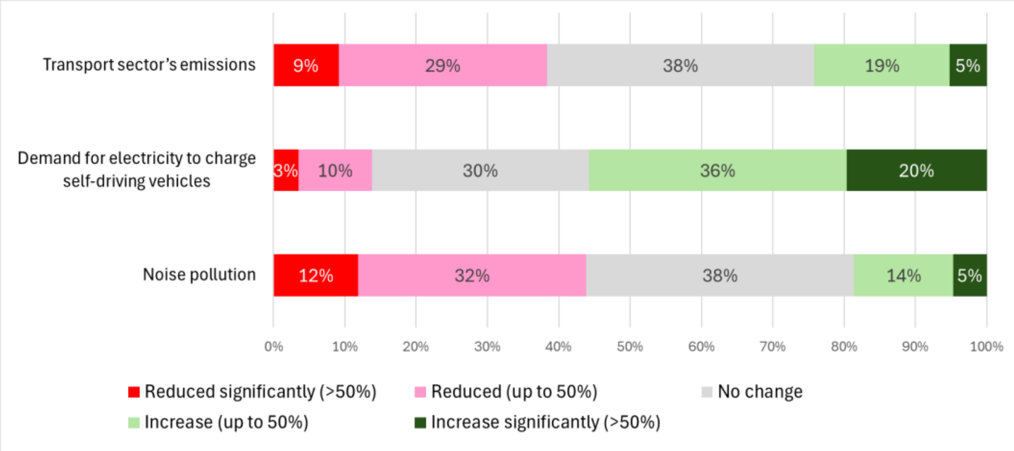


Figure 192. Impact on environmental indicators

Table 112. Average impacts on environment

	Transport sector's emissions	Demand for electricity to charge self-driving vehicles	Noise pollution
ALL	-0.18	0.58	-0.32
UK	-0.11	0.75	-0.23
Germany	-0.10	0.53	-0.23
France	-0.05	0.58	-0.25
Netherlands	-0.18	0.65	-0.38
Spain	-0.06	0.67	-0.24
Poland	0.01	0.63	-0.19
Greece	-0.54	0.40	-0.55
Cyprus	-0.74	0.30	-0.76
Women	-0.13	0.59	-0.27
Men	-0.24	0.57	-0.38
18-34	-0.02	0.57	-0.17
36-64	-0.20	0.56	-0.35
65+	-0.37	0.67	-0.49

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

As with other impacts, Greece and Cyprus are special cases, with the three indicators assuming a more negative value. All countries share the belief that emissions and noise will decrease and demand for electricity will increase. The only exception is Poland, where people do not expect emissions to change, on average - as shown in Figure 193, in Poland about equal numbers think emissions will increase and decrease. The expectation that demand for electricity will grow is highest in the United Kingdom, with 61% thinking demand will increase and only 9% thinking it will decrease.

As shown in both Table 112 and the figures below, men and women think about the same regarding demand for electricity, on average, but men believe emissions and noise will decrease more. Age increases the belief that emissions and noise will decrease and that demand for electricity will increase.

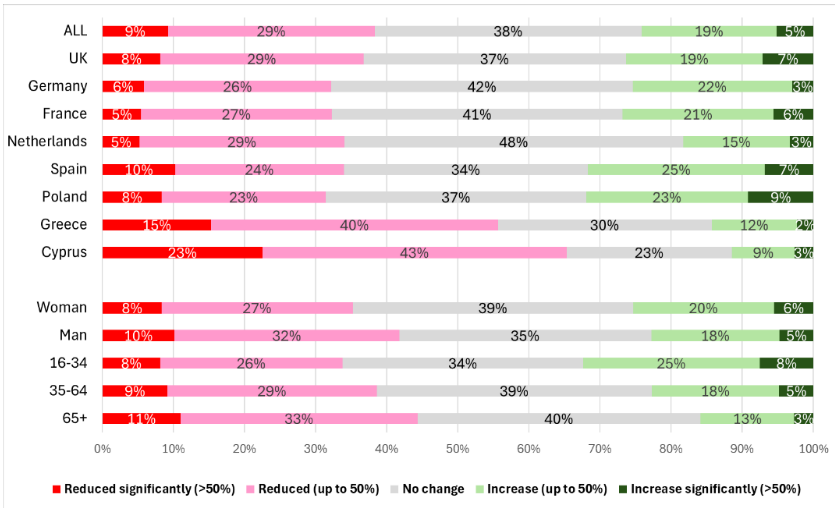


Figure 193. Impact on transport sector's emissions

Figure 194. Impact on demand for electricity to charge self-driving vehicles

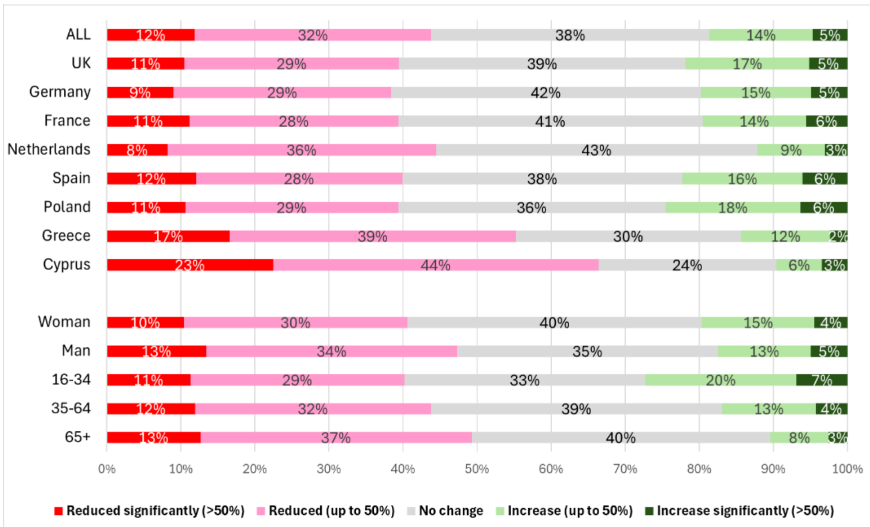


Figure 195. Impact on noise pollution

5.14.6 Economy

Figure 196 compares the four indicators of economic impacts and Table 113 shows the average impacts on a -2 to +2 scale. On average, participants think that economic growth (0.28), investments (0.44), and new skills requirements (0.38) will grow. 42%, 50%, and 47% share the view that these three indicators will increase, or increase substantially, compared with 12-16% who think they will decrease or decrease substantially.

Potential job losses are only one of the main concerns regarding self-driving vehicles, as found in previous literature and in other activities of this project. However, in this survey, there is only a slight tendency among participants to think job losses will increase (mean score of 0.04) on the -2 to +2 scale. This is mainly because opinions are split. Only about a third of participants think job losses will not change. 34% think they will increase and 32% think they will decrease.

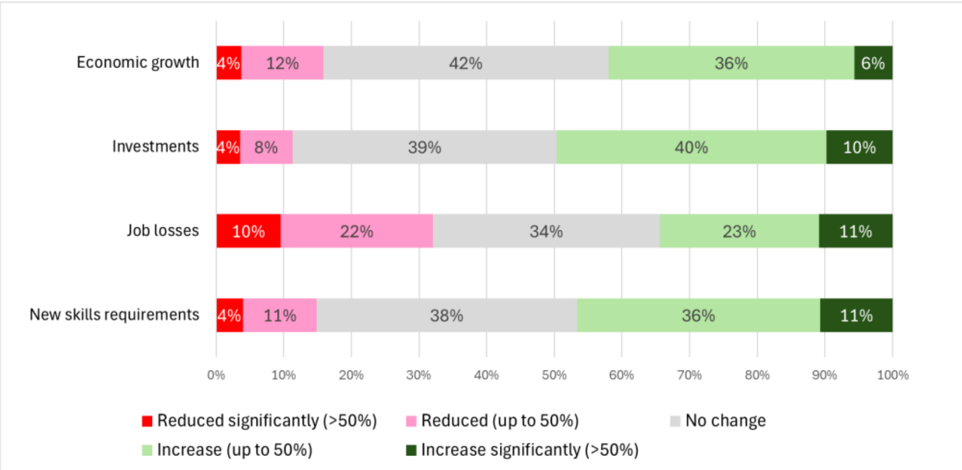


Figure 196. Impact on economic indicators

Table 113. Average impacts on the economy

	Economic growth	Investments	Job losses	New skills requirements
ALL	0.28	0.44	0.04	0.38
UK	0.32	0.41	0.28	0.31
Germany	0.35	0.39	-0.17	0.37
France	0.18	0.41	0.19	0.36
Netherlands	0.26	0.54	0.40	0.41
Spain	0.36	0.54	-0.27	0.37
Poland	0.38	0.47	-0.04	0.35
Greece	0.18	0.38	-0.05	0.50
Cyprus	0.08	0.39	-0.18	0.44
Women	0.27	0.44	0.04	0.37
Men	0.29	0.45	0.03	0.40
18-34	0.30	0.47	0.13	0.35
36-64	0.30	0.46	0.03	0.41
65+	0.20	0.36	-0.09	0.36

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Indicators of economic growth and investment are positive in all countries and for all genders and age.

As seen in Table 113 and in the figures below, belief that self-driving vehicles will increase economic growth is, on average, higher in the United Kingdom, Germany, Poland, and Spain, compared with the other countries. Belief that they will increase investment is higher in Netherlands and Spain. In Greece and Cyprus, there is a weaker belief that economic growth and investment will increase but also higher belief that new skills requirements will increase (Figure 200). Beliefs about job loss are split into three groups, with participants in the United Kingdom, France, and the Netherlands thinking, on average, that they will increase, those in Germany, Spain, and Cyprus thinking they will decrease, and those in Poland and Greece having an opinion close to neutral. The differences in these three groups of countries are clear in the balance between red and green bars in Figure 199.

Perceptions about economic impact are similar for men and women. The 65+ age group is more sceptical that self-driving vehicles will increase economic growth and investment than the other age groups. On average, the 18-34 and 35-64 groups have almost identical views on the change in these indicators, as seen in Table 113. However, this average masks variations in opinions within these two age groups. As seen in Figure 197 and Figure 198, the youngest age group (18-34) have the highest proportions (of all three age groups) thinking economic growth and investment will increase, but also the highest proportions thinking it will decrease.

The perception that the vehicles will increase job losses is inversely related with age, which is mostly driven by the differences in proportions of participants thinking job losses with increase, rather than the ones thinking they will increase.

Perceptions about demand for new skills requirements are slightly higher among the 35-64 age group.

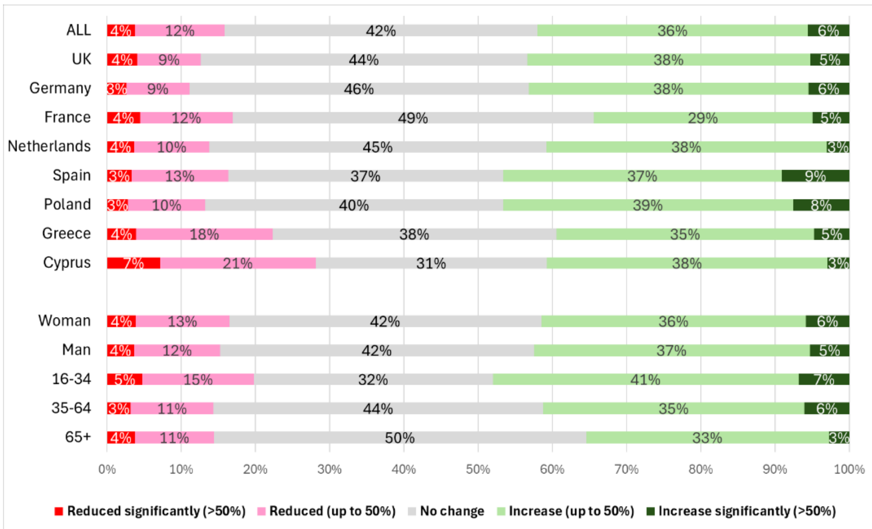


Figure 197. Impact on economic growth

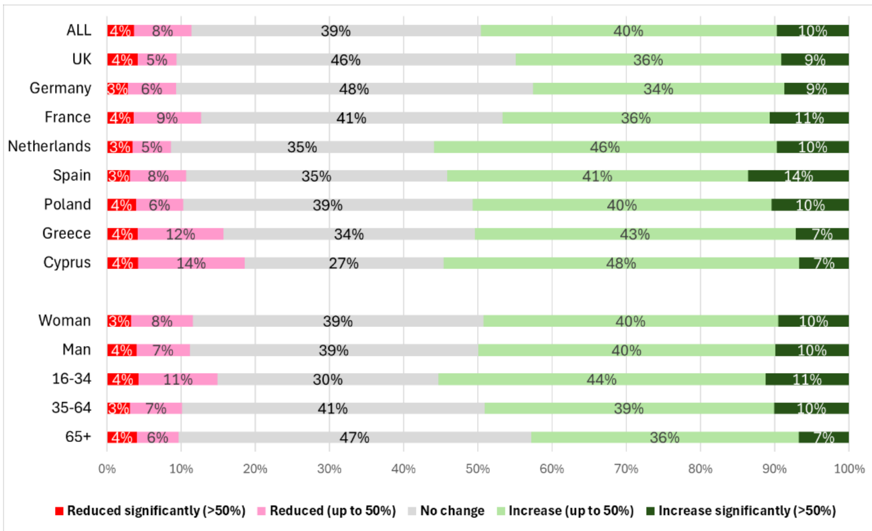


Figure 198. Impact on investments

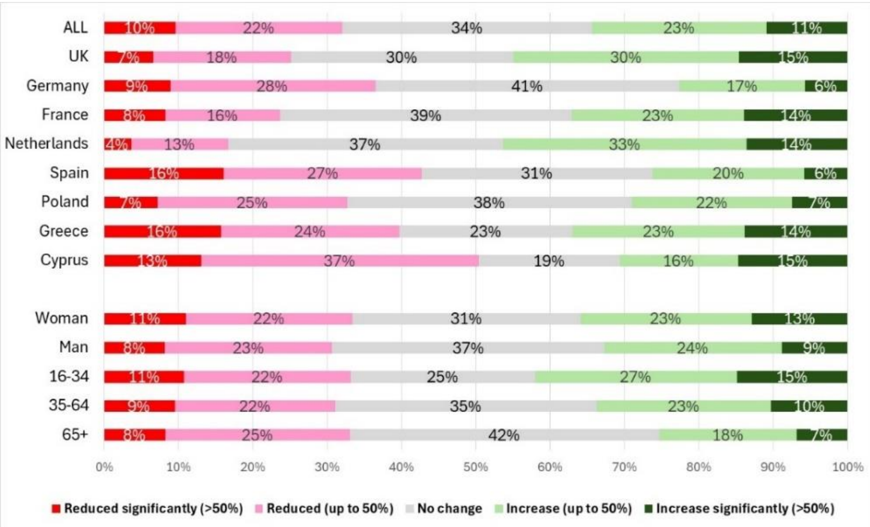


Figure 199. Impact on job losses

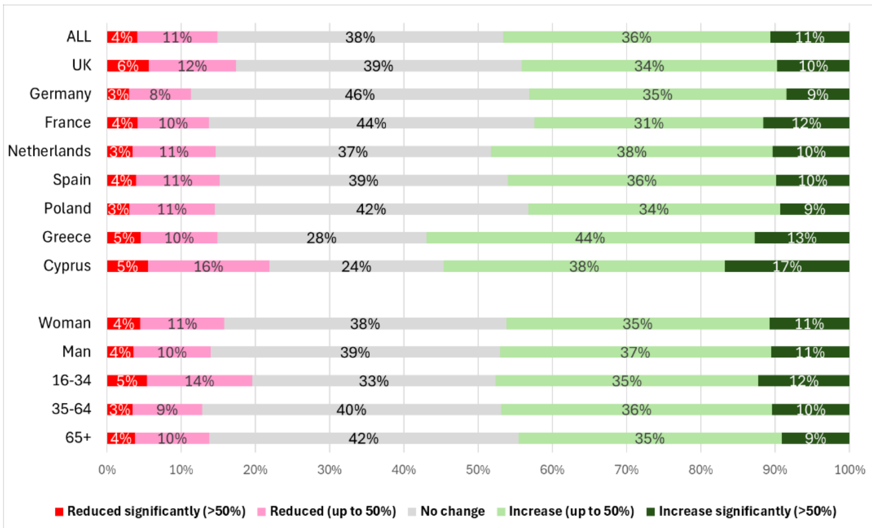


Figure 200. Impact on new skills requirements

5.14.7 Equity

Figure 201 shows the results for the five indicators of equity and Table 114 shows the average impacts on a -2 to +2 scale. All four indicators of accessibility are expected to increase, as seen by positive mean scores in Table 114. Accessibility of specific groups (individuals with special mobility needs, older people, families with children) is expected to increase more than general accessibility. 40% think general accessibility will increase or increase significantly (Figure 201), compared with 51% (individuals with special mobility needs, and older people) and 45% (families with children). The values of the indicator for individuals with special mobility needs have similar distributions as the one for older people.

The perceived change in employment opportunities is close to neutral (-0.09). This is consistent with perception about job losses, examined in the previous section, with on average is also close to neutral. 39% think employment opportunities will not change, 29% think they will increase and 32% think they will decrease (Figure 201).

Figure 201. Impact on equity indicators

Table 114. Average impacts on environment

	Accessibility of general population	Accessibility of people with special mobility needs	Accessibility of older people	Accessibility of families with kids	Employment opportunities
ALL	0.21	0.48	0.44	0.37	-0.09
UK	0.26	0.53	0.48	0.40	-0.05
Germany	0.25	0.44	0.41	0.34	0.13
France	0.09	0.41	0.39	0.31	-0.02
Netherlands	0.18	0.43	0.43	0.26	-0.08
Spain	0.17	0.55	0.47	0.40	-0.12
Poland	0.26	0.48	0.40	0.47	0.05
Greece	0.27	0.52	0.46	0.40	-0.43
Cyprus	0.28	0.58	0.59	0.43	-0.38
Women	0.20	0.48	0.41	0.37	-0.14
Men	0.23	0.49	0.47	0.37	-0.04
18-34	0.30	0.50	0.42	0.39	0.00
35-64	0.24	0.53	0.51	0.41	-0.11
65+	0.04	0.36	0.31	0.24	-0.17

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Mean indicators of accessibility are positive in all countries and for all genders and age (Table 114). They tend to vary across countries less than other indicators examined in previous sections. They are also similar between men and women and the 18-34 and 35-64 age group. The 65+ age group, on average, has lower mean scores for the four indicators of accessibility. As shown in the figures below, this is mainly because of lower proportions thinking accessibility will decrease.

Perception about employment opportunities is negative in Greece and Cyprus and closer to neutral in other countries (Table 114, Figure 206). This contrasts with the results on job losses examined in the previous section, where participants in Greece and Cyprus were slightly more likely to think that job losses will decrease, rather than increase. The two results are compatible, as job losses reflect mainly professions that may disappear with the implementation of self-driving vehicles, while changes in employment opportunities encompass both these job losses but also the creation of new jobs.

Men and less likely than women to think employment opportunities will decrease. Participants in the 18-34 age group are neutral, but those in older age groups tend to think opportunity opportunities will decrease (Table 114, Figure 206).

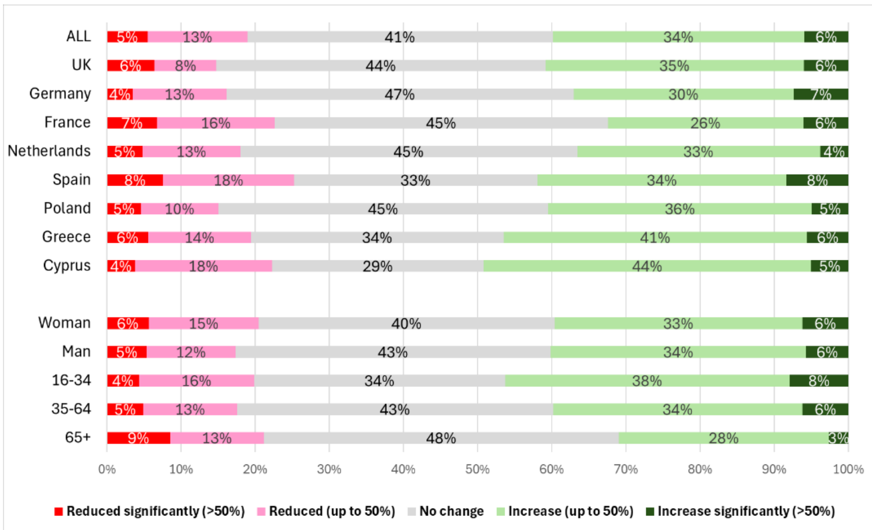


Figure 202. Impact on accessibility of general population

Figure 203. Impact on accessibility of people with special mobility needs

Figure 204. Impact on accessibility of older people

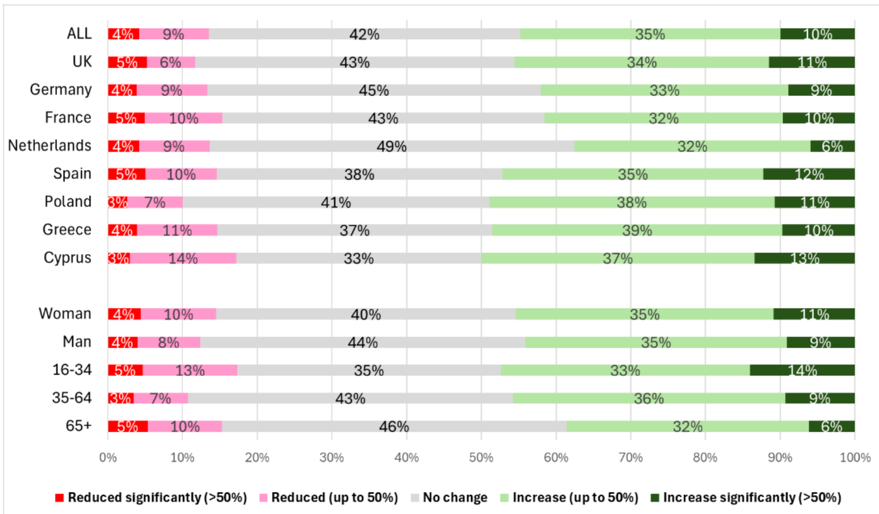


Figure 205. Impact on accessibility of families with kids

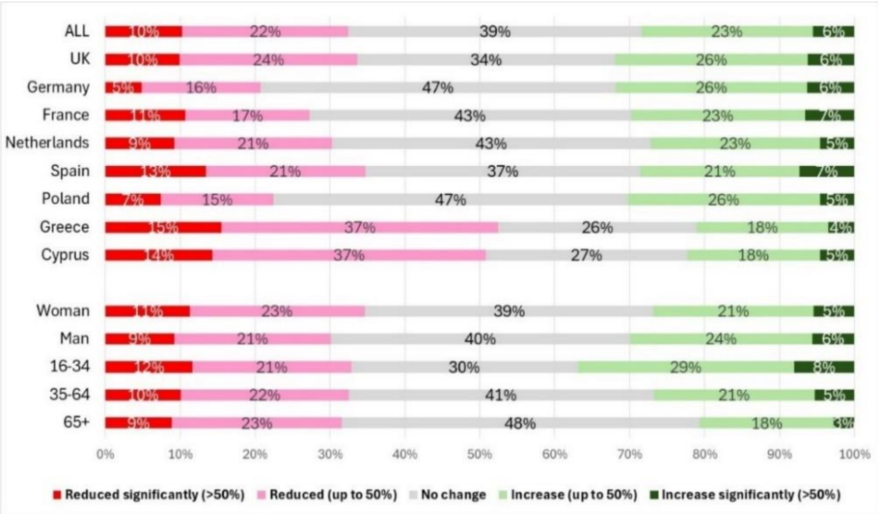


Figure 206. Impact on employment opportunities

5.14.8 Public health

Figure 207 shows the results for the three public health indicators and Table 115 shows the average impacts on a =2 to +2 scale. The overall perception about travel stress is almost neutral (-0.04). 29% think stress will increase or increase significantly and 31% think it will decrease or decrease significantly. Access to health care and emergency response are expected to increase (mean scores of 0.29). Both have similar distributions of perceptions (Figure 207), with 37-38% thinking they will increase and 12-14% thinking they will decrease.

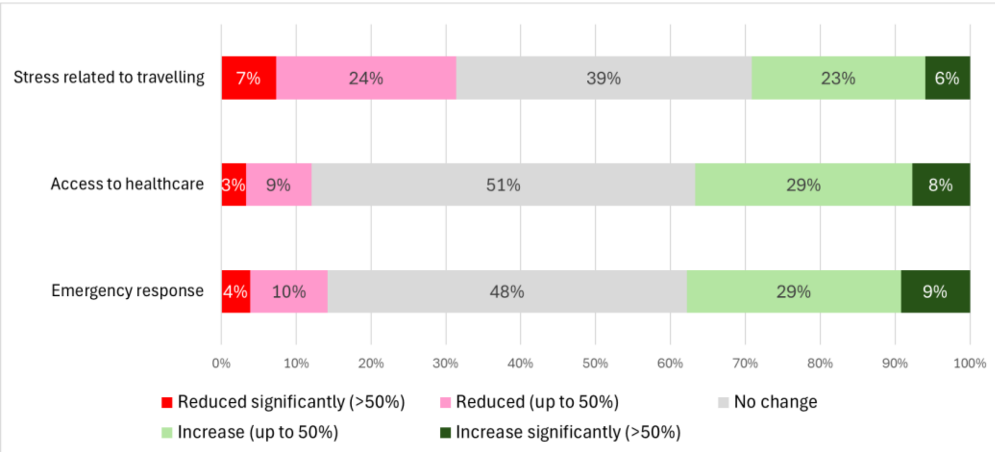


Figure 207. Impact on public health indicators

Table 115. Average impacts on public health

	Stress related to travelling	Access to healthcare	Emergency response
ALL	-0.04	0.29	0.29
UK	0.04	0.33	0.28
Germany	-0.04	0.22	0.21
France	0.04	0.34	0.35
Netherlands	-0.01	0.27	0.24
Spain	0.03	0.28	0.38
Poland	0.21	0.39	0.32
Greece	-0.35	0.22	0.30
Cyprus	-0.53	0.23	0.17
Women	-0.05	0.30	0.30
Men	-0.02	0.27	0.28
18-34	0.00	0.38	0.35
35-64	-0.07	0.29	0.32
65+	0.01	0.15	0.13

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

While impact on travel stress is neutral in most countries, it is positive in Poland and negative in Greece and Cyprus (Table 115). On average, it varies little across genders and age groups. While the youngest age group is more likely to believe stress will increase, it is also more likely to believe it will decrease (Figure 208).

The impacts on access to healthcare and emergency response are positive in all countries and across all genders and ages groups. They vary less, across countries, than other indicators examined in this chapter. The two impacts are similar for men and women, and inversely related to age.

Figure 208. Impact on stress related to travelling

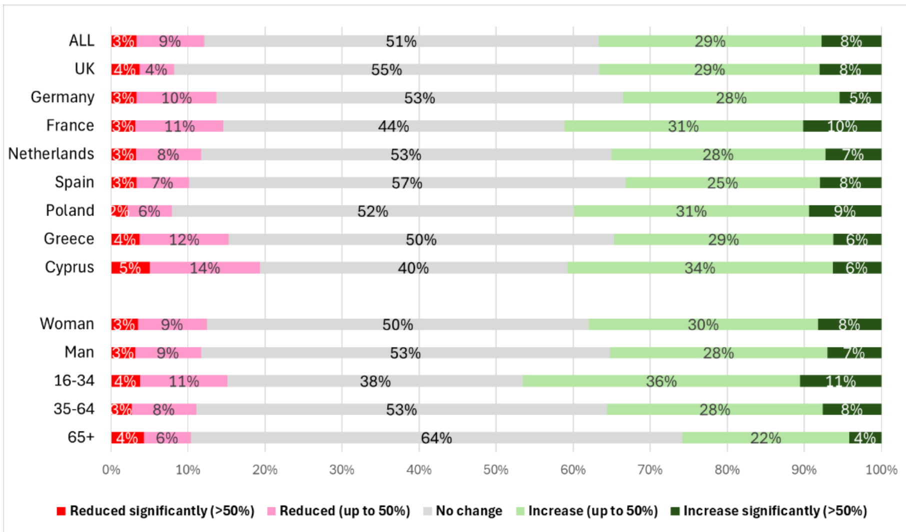


Figure 209. Impact on access to health care

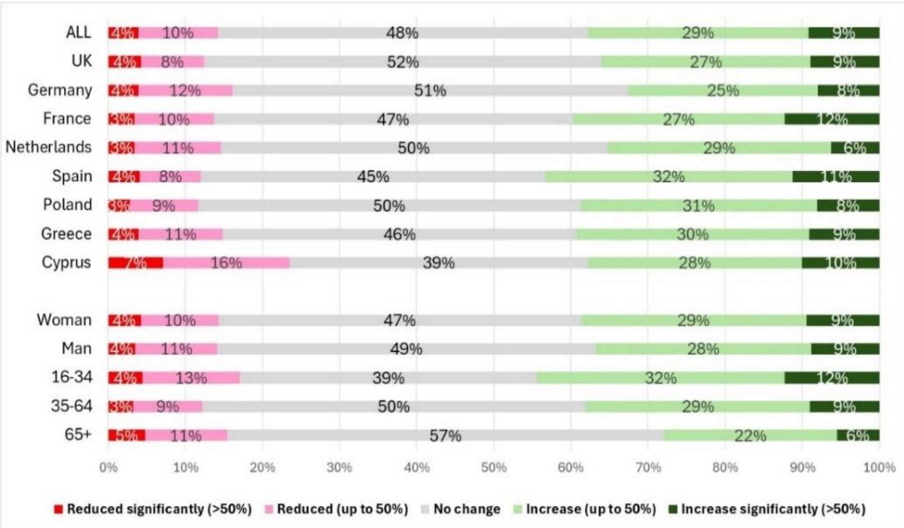


Figure 210. Impact on emergency response

5.14.9 Safety

Figure 211 and Table 116 show the results for the four indicators of safety. Whether self-driving vehicles are safer than human-driven ones is one of the essential questions at the centre of research on self-driving vehicles. As seen in the figure and table, participants in this survey lean slightly more towards the belief that self-driving vehicles are safer. 28% think that "accidents" (i.e. traffic collisions[5]) will increase, compared with 38% who think they will decrease. The mean score is -0.12. The perceptions about traffic fatalities are even more optimistic (23% vs. 44%, mean score of -0.23). The results are consistent with those of the qualitative assessment (Section 2), which showed that citizens generally think that safety might increase because of lack of human error, but they also have some concerns about possible malfunctions.

[5] While the use of the word "accident" is discouraged in research and journalism (https://www.rc-rg.com/guidelines), we use it in this survey as it is more likely to be understood by participants in all eight countries as more accurate alternatives such as "collisions" and "crashes"

On average, survey participants also think that traffic violations and tickets (-0.42) and harassment events (-0.25) will decrease.

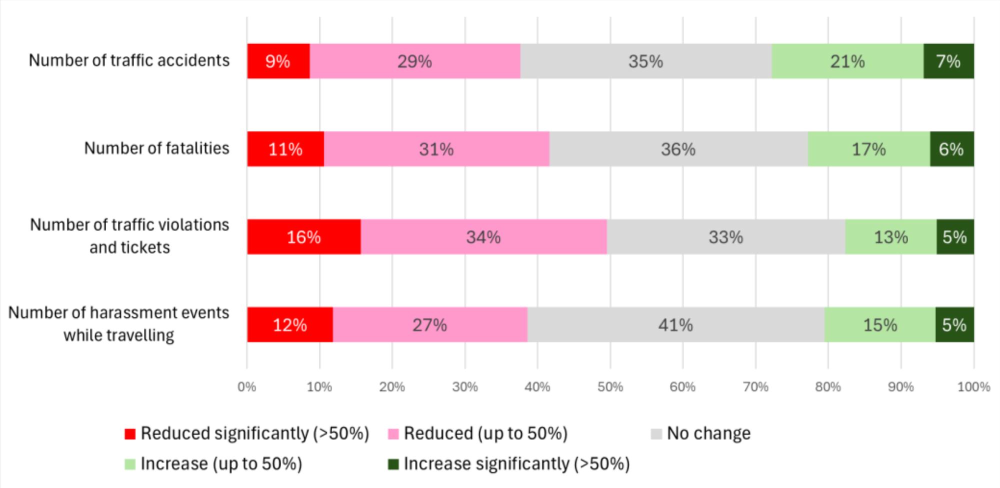


Figure 211. Impact on safety indicators

Table 116. Average impacts on safety

	Number of traffic accidents	Number of traffic fatalities	Number of traffic violations and tickets	Number of harassment events while travelling
ALL	-0.12	-0.23	-0.42	-0.25
UK	0.05	-0.06	-0.31	-0.15
Germany	-0.01	-0.08	-0.27	-0.11
France	-0.13	-0.22	-0.39	-0.14
Netherlands	-0.06	-0.14	-0.43	-0.23
Spain	-0.03	-0.24	-0.47	-0.14
Poland	0.01	-0.16	-0.25	-0.23
Greece	-0.34	-0.47	-0.62	-0.50
Cyprus	-0.70	-0.77	-0.91	-0.73
Women	-0.09	-0.20	-0.39	-0.21
Men	-0.14	-0.27	-0.46	-0.28
18-34	-0.06	-0.16	-0.34	-0.19
35-64	-0.14	-0.27	-0.45	-0.26
65+	-0.14	-0.26	-0.48	-0.28

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

As seen in the table and in the figures that follow, participants in Greece and Cyprus are considerably more optimistic than those in other countries, regarding the reduction in all four indicators. In particular, the table shows that these two countries drive the overall mean score of number of traffic accidents to be negative, as in other countries the perception is close to be neutral. The balance between participants believing accidents will increase and decrease in these other countries is clear in Figure 212. For the other three indicators, all countries show mean negative values.

All indicators are negative, on average, for all genders and age groups. Men and the 35-64 and 65+ age groups are more likely to believe that all four indicators will decrease.

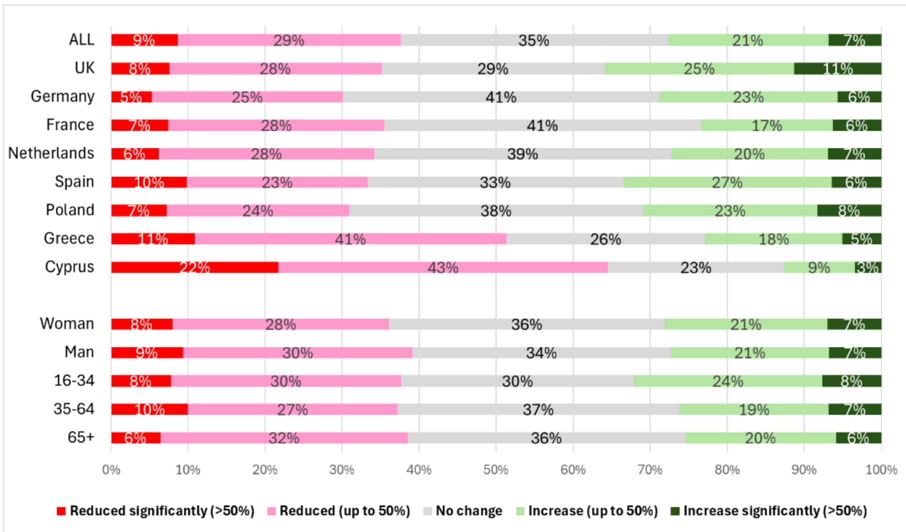


Figure 212. Impact on number of traffic accidents

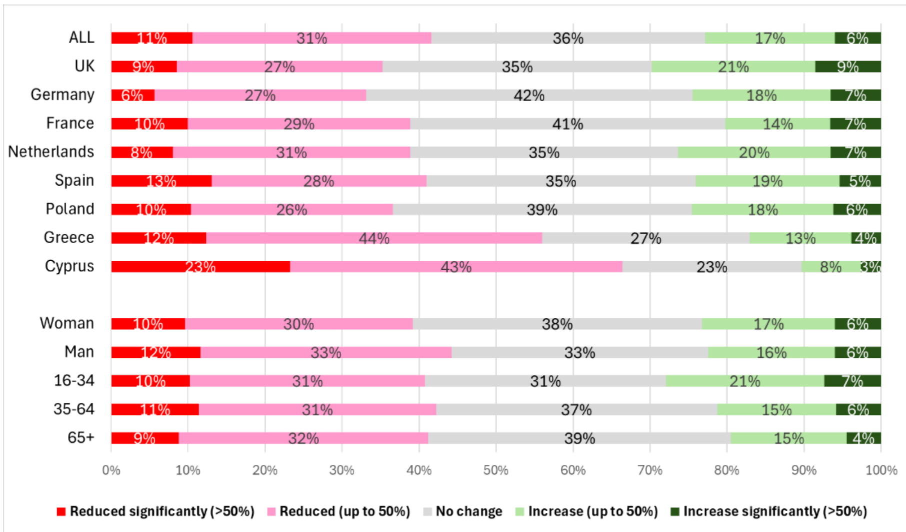


Figure 213. Impact on number of traffic fatalities

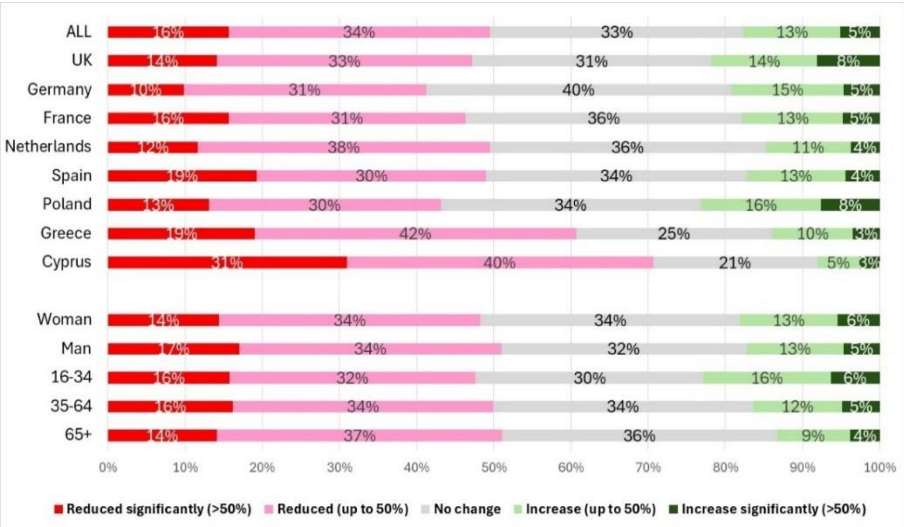


Figure 214. Impact on number of traffic violations and tickets

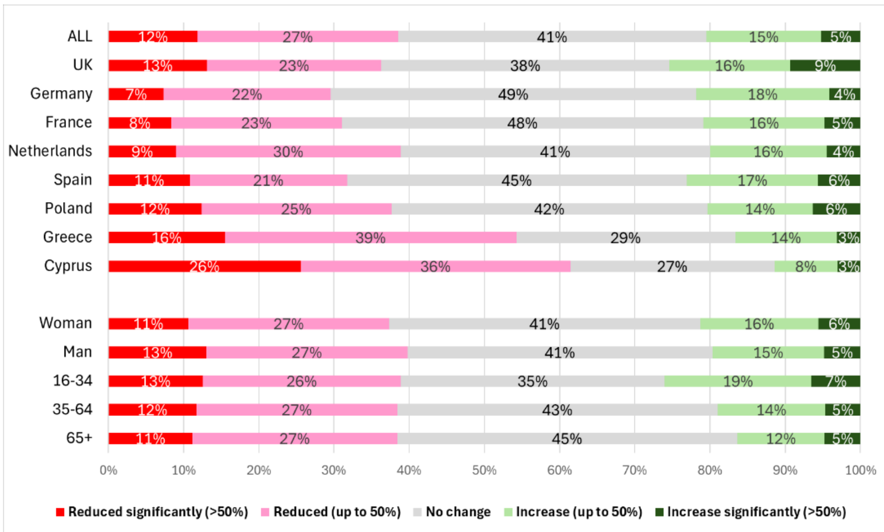


Figure 215. Impact on number of harassment events while travelling

5.14.10 Security

Finally, the following figures and table show the impact on the single indicator of security: number of cyber attacks related to the transport sector. This has been identified in previous literature, and previous activities of this project, as one of the main potential problems with self-driving vehicles. 15% of the sample think these attacks will increase significantly and a further 38% think they will increase. Only 12% think they will decrease or decrease significantly (Figure 205). This translates into a mean score, on a -2 to +2 scale of 0.53, i.e. roughly the middle point between “no change” and “increase” (Table 117).

The mean scores of this indicator are positive for all countries, in the range of 0.43-0.62 (Table 117). The proportions thinking cyber attacks will increase are above 50% or close to 50% in all countries (Figure 217). On average, men and individuals in the 35-64 age group are more likely to think that cyber attacks will increase than decrease, compared with other survey participants.

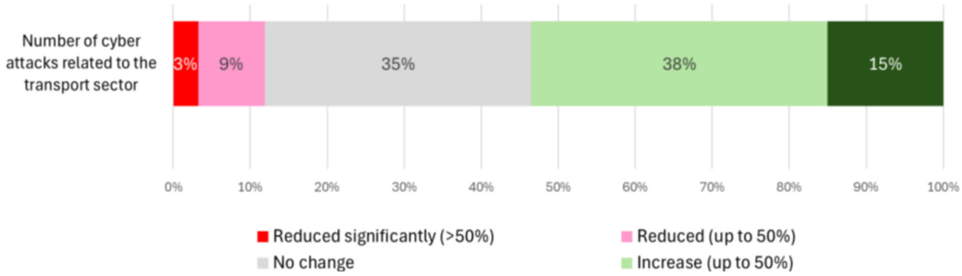


Figure 216. Impact on security indicators

Table 117. Average impacts on security

	Number of cyber attacks related to the transport sector
ALL	0.53
UK	0.57
Germany	0.59
France	0.44
Netherlands	0.61
Spain	0.62
Poland	0.45
Greece	0.51
Cyprus	0.43
Women	0.48
Men	0.59
18-34	0.50
35-64	0.57
65+	0.49

Notes: Scale from -2 to +2. Assumes equal importance of distances between the points on the 5-point ordinal scale shown to participants. Cyprus sample is 18-64 only and is not gender-balanced.

Figure 217. Impact on number of cyber-attacks related to the transport sector

5.14.11 Inter-relationships between impacts

The previous sections showed some similarities in the patterns followed by some indicators. This suggests they are inter-related. We ran a factor analysis to reduce the set of indicators of all dimensions (i.e. all indicators in the previous sections) to a smaller set of unobserved factors retaining most of the variance of the original data set. As the sample was split into two groups (both answering questions on mobility and a separate set of other questions), two analyses are needed, one for each group.

Some variables were excluded from the analysis after preliminary runs found that they did not fit patterns of correlations with other variables. These were: ownership of conventional private vehicles, ownership of self-driving vehicles, job losses, and cyber attacks related to transport.

Both analyses extracted two factors, both explaining 97% of the variance of the respective data. Figure 125 show the correlations between these factors and the original variables. Correlations above 0.40 are highlighted.

Table 118. Factor analyses

Impact	**Analysis 1**		**Analysis 2**	
	F1 Mobility resources	**F2 External effects**	**F3 Mobility benefits**	**F4 Mobility costs**
Citizens' number of trips	0.65	-0.01	0.41	0.50
Citizens' travel time	0.55	0.21	0.12	0.60
Travel costs for citizens' trips	0.56	0.22	0.03	0.65
Usage of self-driving shared services	0.60	-0.12	0.45	0.39
Citizens' number of trips for shopping	0.66	-0.03	0.41	0.50
Delivery costs	0.50	0.24	0.08	0.60
Number of vehicles on the network	0.62	0.27		
Traffic congestion	0.45	0.52		
Number of people who live in rural areas	0.52	0.10		
Number of people who live in the city centres	0.47	0.21		
Demand for parking spaces in the city centres	0.46	0.37		
Demand for redesigned transport infrastructure	0.60	0.10		
Transport sector's emissions	0.35	0.53		
Demand for electricity to charge vehicles	0.50	-0.01		
Noise pollution	0.22	0.62		
Economic growth			0.57	0.29
Investments			0.53	0.30
New skills requirements			0.40	0.25
Accessibility of general population			0.67	0.13
Accessibility of people with special mobility needs			0.78	0.06
Accessibility of older people			0.79	0.04
Accessibility of families with children			0.74	0.08
Employment opportunities			0.38	0.16
Stress related to travelling			-0.03	0.38
Access to health care			0.54	0.30
Emergency response			0.51	0.24
Number of traffic accidents	0.08	0.75		
Number of traffic fatalities	0.01	0.83		
Number of traffic violations and tickets	-0.02	0.81		
Number of harassment events while travelling	0.04	0.73		
Number of observations	3425		3461	
% of variance explained	66	31	77	20

In the first group of data, the first factor (F1) explains 66% of the variance of the original set of indicators. We label this factor *Mobility Resources*, as it is related to an increase in mobility (more and longer trips, and residence relocation) and in the resources to support that mobility, including financial ones (i.e., travel and delivery costs), parking space, redesigned infrastructure, and electricity.

The second factor (F2) explains 31% of the variance. We label this factor *External Effects*. It is associated with negative social and environmental effects: emissions, noise, accidents and fatalities, traffic violations, and harassment

In the second group of data, the first factor (F3) explains 77% of the variance of the original set of indicators. We label this factor *Mobility Benefits*. It is related to increases in mobility (number of trips) and their benefits in term accessibility, and economic dynamism.

The second factor (F4) explains 20% of the variance. We label this factor *Mobility Costs*. It is related to mobility and associated increases in travel and delivery costs. The factor partially covers the same aspects as F1 in the first analysis.

5.14.12 Models of wider impacts

This section estimates statistical models to identify the variables related to the factors extracted above. The dependent variables are Factors 1 to 3. Factor 4 is not modelled because it overlaps with Factor 1, partially capturing the same aspects.

The objective of the models is to determine whether specific participants characteristics and other variables are significantly related to these factors, when controlling for other relevant variables. The groups of explanatory variables are the same as in the models of impacts on individual behaviour shown in previous sections: participant demographic characteristics and current travel context and behaviour, attitude in relation to technology adoption, level of previous awareness of self-driving vehicles, and location. It also includes the impacts that participants expect that self-driving vehicles would have in their individual behaviour (i.e. the dependent variables of the models in previous sections). Linear models were used. Variables were removed from the models when they were not significant at the 10% level in any of the three models. We report only the signs of the significant variables. Appendix 12 contains the full models.

Table 119 shows the results. In the F1 (*Mobility Resources*) model, women have a positive coefficient i.e. women are more likely than men to think that self-driving vehicles will increase mobility together with an increase of resources to support that mobility. Higher levels of awareness of self-driving vehicles are also associated with stronger views that mobility will increase and will require resources. People living in villages, and those who label themselves as "innovators" are associated with weaker views. As expected, *Mobility Resources,* which aggregates a series of wider impacts on mobility and resources (i.e. impacts at the level of the whole region), is associated with the corresponding impacts at the individual level (i.e. increases in individual number of trips, parking needs, and delivery costs, as well as relocation to central areas).

In the F2 (*External Effects*) model, women, the 18-34 group, and individuals who do not have a driving licence have a positive coefficient, i.e., these participants are more likely than others to think that self-driving vehicles will have negative social and environmental effects. Individuals with no car are more likely to think these effects will not occur. Awareness of self-driving vehicles is not significant. People living in richer regions, and those who label themselves as "laggards" in terms of technology adoption are associated with weaker views. *External Effects* is also associated with expected positive impacts on individual parking needs and delivery costs and with expected negative impacts on delivery orders

In the F3 (*Mobility Benefits*) model, individuals without car have a positive coefficient, i.e. they are more likely to think self-driving vehicles will have wider benefits, while both the 18-34 and 65+ age groups are less likely to have that view. Higher levels of technology adoption and of awareness of self-driving vehicles are also associated with stronger views that mobility will have wider benefits. *Mobility Benefits* is also associated with expected positive impacts on number of trips and delivery costs, negative impacts on travel time, and relocation to city centre. It is related to both positive and negative impacts on parking needs (compared with no impacts].

Table 119. Models of wider impact of self-driving vehicles

	F1 Mobility resources	F2 External effects	F3 Mobility benefits
Woman	+	+	
Age: 18-34		+	-
Age: 65+			-
No driving licence		+	
No car		-	+
Technology: "innovator"	-		
Technology: "late majority"			-
Technology: "laggard"		+	-
Not aware of self-driving vehicles	-		
Aware of self-driving vehicles	+		+
Well aware of self-driving vehicles	+		+
Village	-		
Region: Income per capita (log)		+	
Impact on travel time: negative		-	+
Impact on travel time: positive			
Impact on number of trips: negative			
Impact on number of trips: positive	+		+
Impact on parking needs: negative	-	-	+
Impact on parking needs: positive	+	+	+
Relocate to rural	-		
Relocate to suburban			
Relocate to city centre	+		+
Impact on number of delivery orders: negative	-	+	-
Impact on number of delivery orders: positive			
Impact on number of delivery costs: negative	-	-	
Impact on number of delivery costs: positive	+	+	+

Notes: Table shows only the sign of significant variables. Appendix 12 contains full models.

5.15 Other impacts

Participants were asked to indicate any other impact of self-driving vehicles not included in the previous questions. The answers were translated into English for analysis. The translated answers included a total of 48,564 words, i.e. an average of 6.1 words per participant.

Most participants provide either a variation of "I don't know" or "nothing to add" or a variation of the indicators they were asked about in the previous questions (especially safety and jobs). Others gave their general opinion about self-driving vehicles (often polarised, i.e. strong support or opposition) or their opinions about the timeline for deployment (with many participants saying they will probably not be alive when self-driving vehicles are implemented). Others talked about their own propensity (or reluctance) to use self-driving vehicles, or that of people in their region or country.

Figure 218 is a word cloud with the most common 50 words in all answers. Words related to the subject in question (e.g. “self-driving”, “vehicle”, “autonomous”), the opinion process (e.g. “think”, “believe”), and evolution (“e.g. “change”, “increase”, “reduce”, “possible”) were removed. The most common word was “accidents”. This was accompanied by frequent references to related terms such as “safe”, “safety”, “dangerous”, “risk”, “errors”, “fear”, “malfunctions”, and “failure”. This is consistent with the results of the qualitative assessment in Chapter 2: possible technology failure was a concern identified in citizen discussions about all passenger and freight use cases.

Another topic frequently mentioned is the implications of the implementation of self-driving vehicles for humans (e.g., “drivers”, “driving”, “people”).

Other concerns include dependence on “technology”, “costs”, effects on “jobs” (plus “unemployment” and “work”), pollution, and (traffic) jams. There is a mix of optimism (“improve”, “positive”, “better”, “easier”, “trust”) and pessimism (“problems”, “difficult”, “issues”, “lack”, “loss”).

The word clouds for men and women are not very different. The ones for age groups have some differences (Figure 219). While all have high frequencies of the words “accidents” and “dangerous”, “safety and ”safe”), these are more frequent for the oldest age group (65+). This age group also has more frequent negative words, especially “problems”, but also “concerns” and “difficult”. In addition, “trust” and “confidence” are more important for this age group (often mentioned in answers in the negative, i.e. lack of trust or confidence).

Note: Created with https://tagcrowd.com. Only 50 most frequent words shown. Removed common words of English grammar as well as other general words related to the process of giving an opinion and to the subject matter (self-driving vehicles).

Figure 218. Word cloud of answers to open-ended questions on other impacts

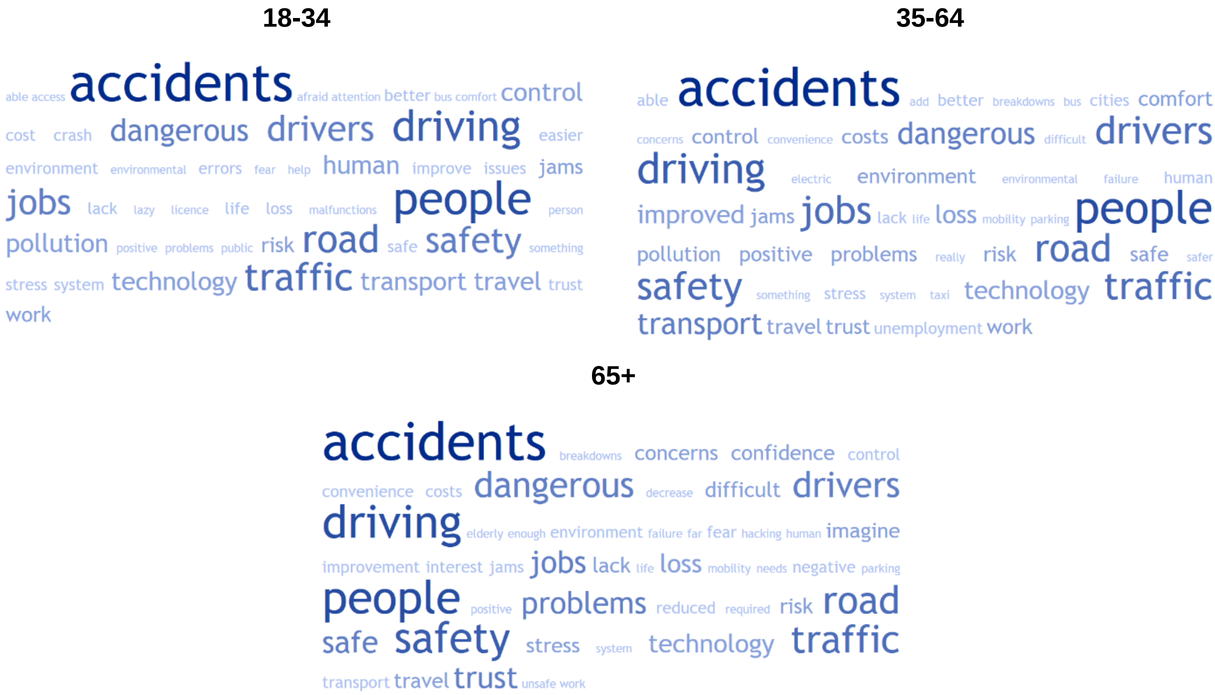


Figure 219. Word clouds of answers to open-ended questions on other impacts, by age group

We then coded all answers, to identify only impacts, and only impacts that were indeed new (as this was the main objective of the question), rather than impacts already covered in the previous questions (such as safety, congestion, pollution).

Table 120 shows impacts mentioned by at least 10 participants (i.e. 0.2% of the sample). The most common impacts were more vehicle breakdowns and software failure (1.6%), more freedom and independence (1.3%), more laziness and obesity (0.8%), and more dependence on technology (0.8%).

Some of the impacts mentioned are further indicators of the dimensions covered in the survey, such as mobility, equity, public health, safety, and security. Other impacts do not fit in those dimensions, but rather on dimensions linked to social (“dependence on technology”. “less social interaction”, “more spare time”), cultural (“dependence on technology”), legal (“legal issues”), and psychological (“loss of driving pleasure”) aspects.

The impacts cover a mix of positive and negative aspects. It should be noted that opinions differ, for a given impact. For example, while the most frequent opinions were “more freedom and independence” and “less social interaction”, there were also participants thinking there would be less freedom and independence or more social interaction (not reported in Table 120, as they were less frequent).

The last column of Table 120 shows the countries where the proportion of participants mentioning a given impact was more than double the proportion in the overall sample. All countries except France were overrepresented in at least one impact. For example, compared to participants in other countries, those in the Netherlands had more a double propensity to mention social, equity, and security impacts such as “more laziness and obesity”, “less social interaction”, “more crime in public transport”, “more income inequality”, and “more vandalism”.

Other impacts, not shown in the table include more ethical problems, more alcohol consumption, less public transport use, less walking, more theft of goods, more use of natural resources, and more visual pollution.

Table 120. Other impacts of self-driving vehicles mentioned by survey participants

Impact	Dimension	Participants		Countries with more double %
		n	%	
More vehicle breakdowns/software failure	Mobility	128	1.6%	
More freedom and independence	Equity	105	1.3%	
More laziness and obesity	Public health	67	0.8%	Netherlands
More dependence on technology	Other	63	0.8%	
More travel convenience	Mobility	53	0.7%	Poland
More travel comfort	Mobility	49	0.6%	Spain, Greece
More legal issues	Other	39	0.5%	Germany
More use of travel time for other activities	Mobility	38	0.5%	Germany
Loss of driving pleasure	Other	32	0.4%	Germany
Less social interaction	Other	26	0.3%	Netherlands, Cyprus
More crime in public transport	Security	26	0.3%	Netherlands
More spare time	Other	20	0.3%	United Kingdom
Less pedestrian safety	Safety	18	0.2%	U. Kingdom, Poland
More wayfinding problems	Mobility	15	0.2%	Poland
More income inequality	Equity	14	0.2%	Netherlands
More spatial inequality (urban vs rural)	Equity	14	0.2%	France
More vandalism	Security	14	0.2%	Netherlands, Spain
More surveillance/data privacy problems	Security	13	0.2%	Germany
More vehicle theft	Security	12	0.2%	Poland

Table 121 disaggregates the results by gender and age. Women and men had similar propensities to mention almost all the impacts. However, women were 0.5% more likely than men to mention “more freedom and independence”. Results by age group are also broadly similar. However, the 18-34 group were more likely to mention “more laziness and obesity” (1.4%) than other age groups did (0.6-0.7%). Those aged 65+ had a very small propensity to mention “more travel comfort” and “more use of travel time for other activities”, unlike younger age groups.

Table 121. Other impacts of self-driving vehicles, by gender and age

Impact	All	Women	Men	18-34	35-64	65+
More vehicle breakdowns and software failure	1.6%	1.9%	1.4%	1.8%	1.5%	1.7%
More freedom and independence	1.3%	1.8%	0.9%	1.5%	1.2%	1.3%
More laziness and obesity	0.8%	0.9%	0.9%	1.4%	0.7%	0.6%
More dependence on technology	0.8%	0.9%	0.6%	0.9%	0.7%	0.7%
More travel convenience	0.7%	0.7%	0.7%	0.6%	0.7%	0.9%
More travel comfort	0.6%	0.5%	0.8%	0.7%	0.8%	0.2%
More legal issues	0.5%	0.3%	0.7%	0.4%	0.5%	0.8%
More use of travel time for other activities	0.5%	0.4%	0.7%	0.6%	0.6%	0.1%
Loss of driving pleasure	0.4%	0.4%	0.4%	0.3%	0.5%	0.4%
Less social interaction	0.3%	0.4%	0.2%	0.3%	0.3%	0.3%
More crime in public transport	0.3%	0.4%	0.3%	0.2%	0.4%	0.4%
More spare time	0.3%	0.2%	0.3%	0.3%	0.2%	0.3%
Less pedestrian safety	0.2%	0.3%	0.1%	0.3%	0.2%	0.3%
More wayfinding problems	0.2%	0.2%	0.1%	0.2%	0.2%	0.3%
More income inequality	0.2%	0.2%	0.1%	0.1%	0.2%	0.1%
More spatial inequality (urban vs rural)	0.2%	0.2%	0.2%	0.0%	0.2%	0.3%
More vandalism	0.2%	0.2%	0.2%	0.0%	0.2%	0.3%
More surveillance and data privacy problems	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
More vehicle theft	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%

5.16 Conclusions

This section collects the key conclusions from the Pan-European survey, organised of terms of the six objectives stated in the introduction to the chapter. The survey was implemented in eight countries covering all parts of Europe (North, South, East, West). Samples were representative of region, gender, and age in all countries except Cyprus, were the sample covered only the 18-64 age group and had a disproportionate proportion of women. The Greek and Cyprus samples also had larger proportions of individuals with a university degree, in households with children and with cars, and self-assessing as having a faster degree of adoption of technologies than in other countries.

5.16.1 Citizens' current travel patterns across Europe

Two main conclusions can be derived from the survey results on current travel patterns: 1) on average, people in Europe have a high degree of mobility and travel frequently, and 2) travel in Europe is still car-based. Table 122 gives more detail on key results leading to these conclusions.

Table 122. Conclusions of Pan-European survey: current travel behaviour

Travel	• People make an average of 16 trips per week. The average trip is 30 minutes long and less than 10% of the trips are less than 10 minutes long. • The most frequent trip for the majority of people of working age is still going to work. • Almost all individuals who have children escort their children to school or other activities every day • While a few people (~15%) make online delivery orders a few times per week, a larger number (37%) make deliveries only a few times per year or never. Shopping is the most frequent trip purpose for 20% of the sample. • Travel time is the most important factor determining travel mode choice

Car travel	• Close to 90% of the individuals surveyed have a driving licence and live in a household with cars • Half of all trips are made by car, with more than half of these being single-occupant • Citizens spend more than four times as much in car travel than in public transport • This pattern masks some geographic and demographic variations: car travel is particularly predominant in Greece and Cyprus and less predominant in the Netherlands and among people aged 65+. • Public transport (especially rail) and non-motorised modes (especially cycling) represent only a marginal proportion of all trips.

5.16.2 Citizens' intentions, needs, and requirements regarding self-driving vehicles

On striking result of this survey is that one fifth of the individuals interviewed were not aware of self-driving vehicles.

In addition, intentions regarding these vehicles were mixed, as detailed in Table 123. Enthusiasm about self-driving vehicles is mild, with considerable proportions of people thinking they will never be implemented, and weak average intentions of buying or using one, and lower willingness to pay for using one than what individuals currently spend on travel. Some of the intentions signal a possible reinforcement of private car travel.

Table 123. Conclusions of Pan-European survey: intentions

Likelihood of buying or using	• The average individual is roughly between "neutral" and "somewhat unlikely" to buy a self-driving car or to use a delivery robot. The likelihood of using a self-driving car, bus, taxi, or drone is slightly higher • Only a quarter of individuals surveyed are likely to buy a self-driving car, but more are likely to use one, especially to escort children (43%).
Willingness to pay	• On average, Europeans are willing to pay €24,276 to buy for a self-driving car (less than the current price of the average car) and €100 per month to use and maintain it (less than what they currently spend today on car travel (€115) • They are willing to pay €7.6 for a 3-km trip on a self-driving taxi and €5.6 for a one-way bus trip of an unspecified distance. • Mean willingness to pay values are higher in countries with higher income per capita.
Willingness to share	• Only half of people would share a self-driving taxi with strangers
Needs and requirements	• Private car is the most preferred self-driving vehicle • The most preferred activities while travelling in self-driving vehicles are surf the web, talk on the phone, and focus on the road
Perceived timeline	• 11-14% of participants think all types of self-driving vehicles will be implemented before 2030 • In contrast, 17-22% think none will ever be implemented

5.16.3 Citizens' perceptions about the possible impact of self-driving vehicles

Table 124 shows the conclusions on personal impacts of self-driving passenger and freight vehicles. Citizens expect an increase in mobility, translated into more and longer trips. Opinions on change in delivery orders, parking needs, and residence relocation are split. Again, there are signals of a possible reinforcement of private car use. Self-driving freight vehicles are expected to have a weaker impact than passenger vehicles.

Table 124. Conclusions of Pan-European survey: personal impacts

Travel time	• The availability of passenger self-driving vehicles is expected to increase travel time by 5% to 13%, depending on the vehicle.
Trips	• Self-driving passenger vehicles are expected to increase the number of trips individuals make by 4 to 9%, depending on the vehicle. • Number of trips is expected to increase more in countries with lower income per capita (Spain, Cyprus, Poland, and Greece) compared with those with higher income per capita (Netherlands, Germany, France, United Kingdom). • Self-driving passenger vehicles could substitute almost 40% of trips currently made by car or public transport • Possible reinforcement of car dominance: 17% would substitute most of their current car trips with self-driving bus, but 27% would substitute most of their current bus strips with a self-driving car. • Possible reduction in active modes: self-driving vehicles could substitute 31% of trips currently made by walking and cycling. • Self-driving freight vehicles are not expected to change number of trips
Delivery orders	• On average, self-driving vehicles would result in only a minor increase in delivery orders • Similarly to the case of trips, delivery orders will increase more in countries with lower income per capita. • Self-driving robots or drones could substitute about a third of orders currently delivered with conventional vehicles.
Delivery costs	• Opinions are divided: almost same proportions of people think parking needs will increase and decrease. Overall estimated effect almost neutral.
Parking needs	• Opinions are divided, in the case of passenger vehicles: almost same proportions of people think parking needs will increase and decrease. The overall estimated effect is almost neutral. • Stronger belief in a reduction of parking needs in the case of self-driving taxis and buses, compared with self-driving cars. • Self-driving delivery vehicles is expected to slightly reduce parking needs.
Residence location	• Some movement towards more central areas: 2-3% of people would relocate to the city centre and around 10% to places closer to the centre. • But there is also the possibility of some movement to less central areas: 3-5% would relocate to rural areas and 6% to suburbs.

Table 124 shows the conclusions on wider impacts of self-driving passenger and freight vehicles. Citizens expect some improvements in mobility in their regions without increasing congestion, more comfort and convenience, but also at a higher price. Most other perceived impacts are benefits, rather than costs, e.g. increase in accessibility and economic dynamism and reduction in environmental harms and safety problems. There is also belief that self-driving vehicles will require resources such as electricity and redesigned infrastructure. Opinions about changes in land use (such as parking space and residence location), employment opportunities and job losses, and travel stress, are split. Possible detrimental impacts are the increase in cyber attacks, vehicle breakdown, obesity, dependence on technology, and legal issues.

Table 125. Conclusions of Pan-European survey: wider impacts

Mobility	• On average, people think self-driving vehicles will increase number of trips in their region (general and for shopping), and use of self-driving shared services. • About 60% of participants think that ownership of conventional vehicles will increase. • On average, people believe travel costs in their region will increase but travel time and delivery costs are not expected to change much (this contrasts with the positive effect on personal travel time as shown in Table 124).

Transport network	• On average, people think that the number of vehicles on the network will increase but without creating more congestion.
Land use	• Split opinions: some think parking needs in the city centre will increase, others think they will decrease, some think there will be a move to more central areas, others think the move will be to less central areas. • Belief that the demand for redesigned infrastructure will increase.
Environment	• Belief that emissions and noise will decrease. • Even stronger belief that demand for electricity will increase.
Economy	• Belief that economic growth, investments, and new skills requirements will increase. • Split opinions: some think job losses will increase, others think they will decrease. On average, the perception is almost neutral.
Equity	• Belief that accessibility will increase, especially for specific groups (people with mobility needs, older people, families with children). • Split opinions about employment opportunities, on average the perception is that they will change little.
Public health	• Almost neutral view on change in travel stress. • Belief that access to healthcare and emergency response will increase.
Safety	• Belief that traffic fatalities, violations and tickets, and harassment will decrease and, to a lesser extent, that the number of accidents will also decrease.
Security	• Belief that number of cyber attacks will increase.
Other impacts	• Positive impacts mentioned by survey participants in an open-ended question include more freedom and independence and more travel convenience and comfort. • Negative impacts include more vehicle breakdowns, laziness and obesity, dependence on technology, and legal issues.

5.16.4 Comparison of perceptions across countries, regions, age groups, and genders

Table 126 lists the main differences across the eight countries surveyed. The table lists only the aspects where the country differs strikingly from the overall sample average. In the table, comparative adjectives (e.g. “more”, “less”, “stronger”) mean that that the country is considerably above or below the average of the eight countries. Superlative adjectives (e.g. “most”, “least”, “strongest”) mean that the country has the maximum or minimum values for the variable in question, while also being considerably above or below the average. Some of the impacts were assessed at the personal and regional (wider) level. In the table below, we identify the latter with the word “regional”. Impacts without that qualifier are personal impacts.

Cyprus, and to a lesser extent also Greece, are the countries that differ the most from the average: in these countries, there is more enthusiasm for self-driving vehicles and more optimism that they will increase mobility without increasing costs, while also bringing social and environmental benefits (but not economic ones). In Cyprus, these differences from the sample average are partly explained by the fact that the sample only includes individuals aged 35-64, and two thirds of them are women. But the fact that both countries share many of the patterns differing from the other six countries signals that some geographic, economic, social, and cultural issues may also have an influence.

Spain and Poland also tend to anticipate increases in mobility, accompanied by relocation to more central areas. However, in Poland there are also doubts that some environmental and social problems will be solved. In the other countries, there is a mix of opinions, with average perceived impacts close to neutral. There are also regional differences inside those countries.

Table 126. Conclusions of Pan-European survey: country differences

UK	• High levels of awareness of self-driving vehicles • Strongest belief that road congestion will increase • Strongest belief that the demand for electricity will increase
Germany	• Regional variations: the former East Germany has low levels of awareness and likelihood of using passenger self-driving vehicles • Stronger belief that employment opportunities will increase
France	• Stronger belief that mobility will increase less and at a higher cost
Netherlands	• Lowest expected increase in number of trips • Lowest proportion of delivery orders substituted by delivery robots or drones • Strongest belief that investment will grow but also that job losses will grow
Spain	• Higher expected increase in number of trips • Higher proportion of trips substituted with self-driving vehicles • Belief that delivery costs will increase • Strongest belief that self-driving vehicles are useful for work • More likely to relocate to more central areas and to think others in their region will also do so • Most optimistic regarding timeline of implementation of self-driving vehicles
Poland	• Low levels of awareness of self-driving vehicles • Highest expected increase in number of trips • Higher proportion of trips and deliveries substituted with self-driving vehicles • Belief that delivery costs will increase • More likely to relocate to more central areas and to think others will also do so • No expectation that emissions will decrease, unlike all other countries • Only country where travel stress in expected to increase
Greece	• More likely to buy or use a self-driving passenger or freight vehicle • High expected increase in (personal and regional) number of trips • More likely to believe that regional travel costs will decrease and (personal and regional) delivery costs will decrease • More likely to believe that travel time and congestion will decrease • More likely to believe that (personal and regional) parking needs will decrease • More likely to relocate to less central areas • Stronger preference to use self-driving travel time to work or study • Stronger belief that emissions, noise, travel stress, and traffic incidents will decrease and weaker belief that demand for electricity and redesigned infrastructure will increase • Weaker belief that economic growth will increase and weakest belief that employment opportunities will increase
Cyprus	• Low levels of awareness of self-driving vehicles • More likely to buy or use a self-driving passenger or freight vehicle • Only country where, on average, citizens expect travel time to decrease • Strongest believe that congestion will decrease • High expected increase in (personal and regional) number of trips • Lowest proportion of trips substituted with self-driving cars, but highest proportion of delivery orders substituted with delivery drones • Most likely to believe that regional travel costs will decrease and (personal and regional) delivery costs will decrease • Strongest belief that (personal and regional) parking needs will decrease • More likely to relocate to less central areas and to think others will also do so. • Strongest preference to use self-driving travel time to work or study • Strongest belief that emissions, noise, travel stress, and traffic incidents will decrease and weaker belief that demand for electricity and for redesigned infrastructure will increase • Weakest belief that economic growth will increase and weaker belief that employment opportunities will increase

Gender is related to only some of the variables studied. In contrast, many of the variables have a distinct age pattern, with their values correlated with age (Table 127).

Table 127. Conclusions of Pan-European survey: gender and age differences

Gender	In comparison to women, men: • Have higher levels of awareness of self-driving vehicles • Have higher willingness to pay to buy or use a self-driving car, but lower willingness to pay to use a self-driving taxi. • Are more likely to share a self-driving taxi with strangers • Are more likely to think that travel time will increase • Are less likely to use travel time in self-driving vehicles to focus on the road • Are less likely to think delivery costs will decrease • Are more likely to think employment opportunities will increase and that emissions and noise will decrease • Are more likely to think cyber attacks will increase

Age	• The 35-64 group would pay more to buy a self-driving car, but the 18-34 would pay more to use a self-driving car, taxi, or bus.
	• The following variables decrease with age:
	  ○ Level of awareness of self-driving vehicles
	  ○ Likelihood of buying or using self-driving passenger or freight vehicles
	  ○ Perceived utility of self-driving freight vehicles for work
	  ○ Expected change in personal and regional travel time and number of trips and in regional travel costs
	  ○ Degree of substitution of current trips and delivery orders with self-driving vehicles
	  ○ Expected change in personal and regional delivery orders and delivery costs
	  ○ Expected change in (personal and regional) parking needs
	  ○ Intention to relocate to more central areas and belief that other people will relocate either to more or less central areas
	  ○ Use of travel time in self-driving vehicles to do smartphone-related activities
	  ○ Belief that self-driving vehicles will be implemented at some point in the future (rather than never be implemented)
	  ○ Belief that number of vehicles on the network, congestion, emissions, noise, and job losses will increase
	  ○ Belief that accessibility and employment opportunities will increase and that access to healthcare and emergency response will improve
	  ○ Belief that traffic accidents, fatalities, violations and tickets and harassment events will increase

5.16.5 Relationships between intentions and impacts

Some of the perceived intentions and impacts are correlated (Table 128)

Table 128. Conclusions of Pan-European survey: inter-relationships

Intentions and impacts for passenger vehicles	• The likelihoods of buying a self-driving car and using a self-driving car, taxi, or bus, are strongly correlated • The likelihoods of buying or using a self-driving vehicle for commuting, non-commuting, and escort children, are strongly correlated • Willingness to pay to use different types of vehicles are not strongly correlated among themselves or with the likelihood of using those vehicles. • The perceived impacts on various aspects (travel time, number of trips, parking needs, and residence location) are not strongly correlated • The perceived impacts of self-driving-cars, taxis, and buses, are also not strongly correlated • Likelihood of using a passenger self-driving vehicle is related to the impact that citizens perceive that would have in their travel time, number of trips, and parking needs. • Likelihood of using a freight self-driving vehicle is related to the impact people perceive it would have in the number of their delivery orders.
Intentions and impacts for freight vehicles	• The impact on number of delivery orders is strongly and positively correlated with the impact on number of trips – which suggests that delivery orders are not substitutes of shopping (or other) trips.
Passenger vs freight	• The likelihood of using a self-driving passenger vehicle is only moderately related to the likelihood of using self-driving freight vehicle. • The impacts of self-driving passenger and freight vehicles are only weakly or moderately correlated

Wider impacts	• There are three main types of correlation in people's perceptions of the wider impacts of self-driving vehicles:
	    ○ More mobility is related with more resource use, including financial ones (i.e. travel and delivery costs), parking space, redesigned infrastructure, and electricity.
	    ○ More mobility is related with more accessibility and economic dynamism
	    ○ Negative environmental impacts (emissions and noise) and related to social ones (accidents, fatalities, traffic violations, and harassment)

Wider vs personal impacts	• Expected wider (regional) impacts tend to be related with expected personal impacts.

5.16.6 Relationships with participant and travel characteristics

As shown in Table 129, the key variables explaining intentions and impacts of self-driving vehicles are age, having children, residence location (city centre or not), regional income, how mobility people are (e.g. number and duration of trips), level of technology adoption, and awareness of self-driving vehicles. Gender explains only some of the differences among the sample.

Table 129. Conclusions of Pan-European survey: relationships between intentions and impacts with participant and travel characteristics

Likelihood of using vehicle	• Likelihood of using self-driving passenger vehicle is higher for people who live in the city centre, are younger, have children, concern about travel cost and parking availability and currently make more and longer trips • Likelihood of using self-driving freight vehicle higher for almost the same groups: people who live in the city centre, are younger, have children, currently make more trips, and whose main trip purpose is shopping. • Both increases with level of technology adoption and awareness of self-driving vehicles
Willingness to pay	• Higher in richer regions and among people who have children and currently make more and longer trips • The gender and age effects depend on the type of vehicle (see Table 127) • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on travel time	• Younger people, those with children or with no health issue, who live in cities and in richer regions, and those who currently make and longer trips expect more increases in travel time • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on number of trips	• Women, younger people, those with children, who live in cities, and those who currently make and longer trips expect more increases in number of trips • Living in richer regions is linked with lower increases in number of trips • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on delivery orders	• Higher for men, younger people, and those with children, who live in the city centre, and in richer regions. • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on delivery costs	• Higher for women, younger people, and those with children, who live in the city centre, and in poorer regions. • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on parking needs	• Younger people and those with children and who currently make more trips are more likely to report an increase in parking needs • Increases with level of technology adoption and awareness of self-driving vehicles
Impact on residence location	• Younger people and those with children, with no health issue, and who currently make more and longer trips are more likely to report relocation to more central areas • Increases with level of technology adoption and awareness of self-driving vehicles
Wider impacts	• The view that mobility requires resource use is higher among women and those more aware of self-driving vehicles • The view that self-driving vehicles will have negative social and environmental impacts is higher among women, the youngest age group, people in richer areas, and those with lower levels of adoption of technology • The view that mobility is associated with accessibility and economic benefits is higher among the 35-64 age group, and individuals who currently do not own a car and those who are keener to accept technology and more aware of self-driving vehicles.

5.16.7 Final remarks

Overall, this chapter showed that the impacts of self-driving vehicles tend to be perceived slightly beneficial. Mobility and accessibility will increase and may or may not have associated increases in costs but will probably require the use of more resources such as electricity and, according to some citizens, also parking space. Self-driving vehicles are also expected to deliver some economic, social, and environmental benefits, especially in the four countries with lower income per capita (Spain, Cyprus, Poland, and Greece) but also in the other four countries analysed with higher income per capita (Netherlands, Germany, France, and United Kingdom).

However, there are two risks in delivering these benefits:

- The risk that the mobility system will become even more based on private car use than already is
- The risk that benefits will accrue mostly to younger people or to city residents.

6. Survey on impact of self-driving freight vehicles

6.1 Overview

An online survey was implemented in the UK about the impact of self-driving freight vehicles on customers and road users, involving 700 participants. The survey had three objectives:

- To assess customers' attitudes, preferences, and willingness to pay to use self-driving freight vehicles, from the point of view of customers ordering deliveries
- To assess road users' attitudes towards those vehicles
- To capture perceptions about the impact of these vehicles on several dimensions of people's lives

This survey provides an opportunity for understanding the adoption of delivery solutions based on self-driving freight vehicles. It can also provide information from the point of view of different stakeholders, including not only customers ordering deliveries but also road users who would share roads with those vehicles.

The rest of this chapter is organised as follows.

- Sections 6.2 and 6.3 describe the **methods** used in this survey and the **characteristics** of participants
- Section 6.4 analyses **customer attitudes** towards self-driving freight vehicles
- Section 6.5 analyses customer **preferences** and **willingness to pay** to use those vehicles
- Section 6.6 analyses **road user attitudes** towards self-driving freight vehicles
- Section 6.7 analyse perceived **impacts** of those vehicles
- Section 6.8 summarises the **key results** of the survey

6.2 Methods

6.2.1 Questionnaire

Appendix 8 contains the questionnaire used. The anticipated duration was 15 minutes. The questionnaire was structured into five parts:

Part 1 captured the **characteristics** of participants and their online shopping behaviour, including:

- Region
- Age (in years)
- Gender
- Educational level
- Employment situation
- Self-identified profile in terms of technology adoption, on a 5-point scale from "like to try new technologies" to "cautious about adopting new technologies".
- Self-identified awareness about self-driving delivery vehicles such as delivery robots, self-driving vans, and delivery drones, on a 4-point scale from "not aware" to "well aware"
- Frequency of making orders for deliveries
- Ranking of factors affecting the choice of delivery options
- Frequency of experiencing delivery problems (delays, stolen goods, and damages)

Part 2 of the questionnaire captured **customers' preferences and attitudes** towards self-driving freight vehicles. Participants were first introduced to four types of delivery vehicles: self-driving vans, delivery robots, and delivery drones. They then completed a choice experiment, composed of six questions asking which vehicle they would choose for deliveries, given specific characteristics of the delivery service. This experiment will be described later in Section 6.5.1. Participants were then shown the same vehicles and were asked if they agreed or disagreed with a series of statements, on a 5-point scale. The statements include:

- Chance of deliveries by self-driving freight vehicles having problems, including being stolen, delayed, damaged by someone, damaged by the vehicle, injuring someone, delivering to the wrong address, and failing to deliver in bad weather.
- Opinion about the convenience, speed, and punctuality of the vehicle, compared with conventional vehicles
- Intention to use the vehicle to order and return goods

Part 3 of the questionnaire captured **road users' attitudes** towards self-driving freight vehicles. Participants were asked to imagine a scenario in the future when half of the vehicles on the road are self-driving. Then they are presented with specific situations and asked questions about how comfortable on a 5-point scale. The situations are:

- Being a passenger on a self-driving bus and a delivery robot getting on the bus
- Being a pedestrian or cyclist and a delivery robot or self-driving van driving past
- Being a driver in a conventional car and a delivery robot or self-driving van driving past
- Being a passenger in a self-driving vehicle and a self-driving van driving past
- A drone flying above them with a small parcel

They were then asked about their concern about possible situations, on a 5-point scale, including:

- Self-driving freight vehicles causing traffic jams and travel delays
- Delivery robot and/or its content on the bus causing harm to passengers
- Self-driving freight vehicles crashing with other vehicles or people
- Cameras or sensors on these vehicles capturing information about people on the street

Part 5 of the questionnaire captured **impacts** of self-driving freight vehicles on people's lives on a 5-point scale, including:

- Likelihood of working from home
- Meeting more people in person
- Stress
- Frequency of shopping in-person
- Frequency of taking public transport

6.2.2 Participant recruitment

The target sample size was 700 participants, which was deemed to be essential to obtain precise results and to ensure that the sample accurately represents the country's gender, age, and regional demographics. Participants were recruited through a market research company. Only individuals aged 18 or above were recruited. Quotas were imposed on sex, age groups (18-34, 35-64, 65+), and regions according to the NUTS1 classification for the UK. Participants who stated that they did not live in the UK did not proceed with the questionnaire.

6.2.3 Ethics

The study received ethical approval from the Bartlett School of Environment, Energy and Resources at the University College of London (ID: 20231120_EI_ST_ETH_ Move2CCAM). Participants were provided with an information sheet before they were asked to agree to take part in the survey. This sheet was similar to the one used in the pan-European survey described in the previous chapter. Participants gave their consent by confirming (ticking a box) that they understand what the research involves and what is expected of them.

6.3 Participant characteristics

Table 1 shows that the gender, age, and regional distributions of the sample closely match that of the population of the UK.

Table 130. Gender, age, and region: sample vs. population (%)

	Sample	Population
Gender		
Male	48	49
Female	51	51
Age		
18-34	29	28
35-64	49	49
65+	22	23
Region		
North East	5	4
North West	11	11
Yorkshire and Humber	8	8
East Midlands	7	7
West Midlands	9	9
East of England	9	9
London	14	13
South East	14	14
South West	8	8
Wales	5	5
Scotland	8	8
Northern Ireland	1	3

Note: Excludes participants not providing gender information (2 individuals, i.e. 0.29% of the sample).

Table 2 shows other demographic characteristics of participants. Half of participants have completed secondary school or vocational education, 29% have a university degree, and 16% have a university degree. About half of participants are currently working.

Table 131. Other sample characteristics (%)

Educational level	
No formal education	1
Primary school	1
Secondary school or vocational education	51
University degree or equivalent professional qualification	29
Higher university degree (e.g. Master's, MBA, doctorate)	16
Still in full-time education	1
Employment status	
Currently not working	11
Working part-time	19
Working full-time	39
Student	3
Retired	19
Homemaker	8

19% of participants like to try new technologies as soon as they are available, and another 19% embrace them relatively early (Table 132). The majority of respondents had some level of awareness of self-driving delivery vehicles, Only 17% of respondents were not aware of self-driving delivery vehicles at all.

Table 132. Technology adoption and awareness of self-driving vehicles (%)

Technology adoption	
Likes to try new technologies and innovations as soon as they are available.	22
Embraces new technologies and innovations relatively early in their lifecycle.	21
Prefers to adopt technologies and innovations once they have become well-established.	32
Adopts technologies and innovations only after they have become widely accepted	14
Cautious about adopting new technologies and innovations	11
Awareness of self-driving vehicles	
Not aware of self-driving delivery vehicles	7
Have only listened about self-driving delivery vehicles, but I do not know much	44
Aware of self-driving delivery vehicles	29
Well aware of self-driving delivery vehicles	20

Participants make an average of 6.1 deliveries per month for households and personal items, 4.4 for clothes, 4.1 for supermarket orders, and 3.3 for other items. Table 4 shows the factor identified by participants as the most determinant to choose the method to deliver their orders. Cost and time are the two key determinants, mentioned by 89% of participants.

Table 133. Factors affecting delivery options

Factors	% of times each factor was ranked #1
Cost	48
Time from order to delivery	41
Delivery location	3
Chance of delivery problems	2
Flexible delivery slots	2
Delivery time window	2
Human interaction	1
Flexible delivery address	0

Figure 2 shows the frequency of experiencing delivery problems within the last six months. 60% have experiencing delivery delays at least once. 44% have received damaged goods, and 28% have had deliveries stolen.

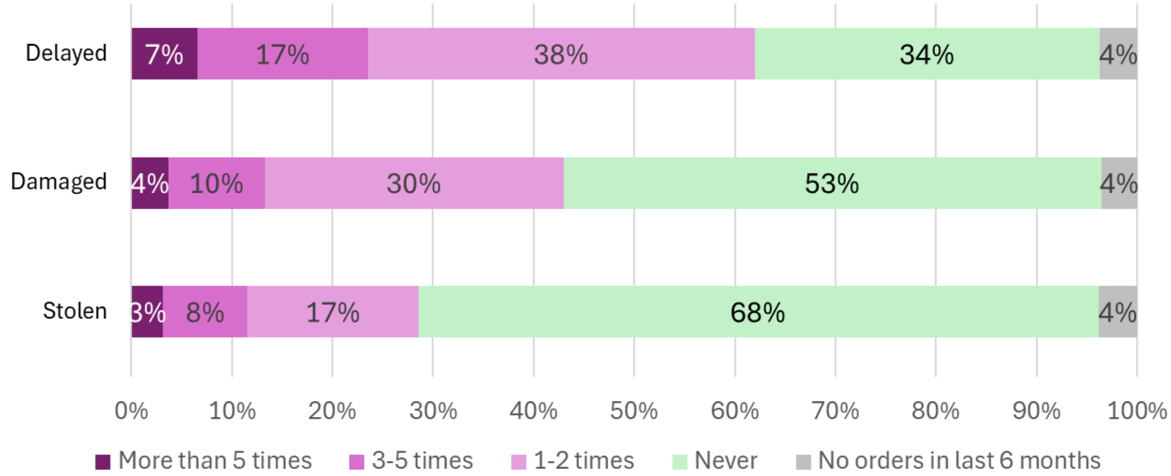


Figure 220: Frequency of delivery problems

6.4 Customer attitudes towards self-driving delivery vehicles

This section shows the results on customer attitudes towards self-driving delivery vehicles. Between 41% and 56% agreed that self-driving vans could cause problems, including failing to delivery in bad weather, delivering to a wrong address, injuring someone, damaging the package, taking too long, being damaged by someone, or be stolen (Figure 221). The main concerns were the van injuring someone (56%) and the van and its contents being damaged by someone (55%). However, 33-45% of participants also had positive views about self-driving vans: deliveries will be more punctual, faster, and more convenient. 32-33% of participants agreed they would use a self-driving van to order or return deliveries. Slightly higher proportions (35-36%) disagreed.

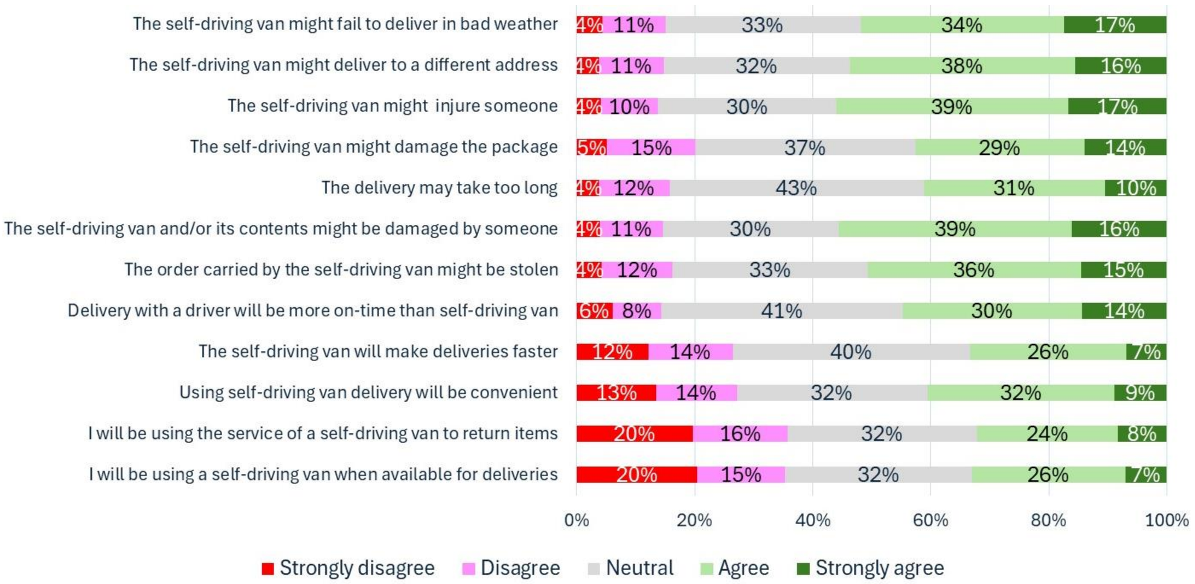


Figure 221: Customer attitudes towards self-driving vans

There were more concerns for the delivery robot than for the self-driving van (Figure 222). The proportions agreeing that the robot will cause problems vary between 41% and 61%. The main concerns were failing in bad weather (60%), the contents being stolen (61%), or the robot or the contents being damaged by someone (60%). Positive views were similar to the ones expressed for the self-driving van. 31% agree that they will be using a delivery robot to order goods and 28% to return goods, values slightly lower than for self-driving vans. However, the proportions disagreeing with those statements are higher than in the case of self-driving vans, at 41-42%.

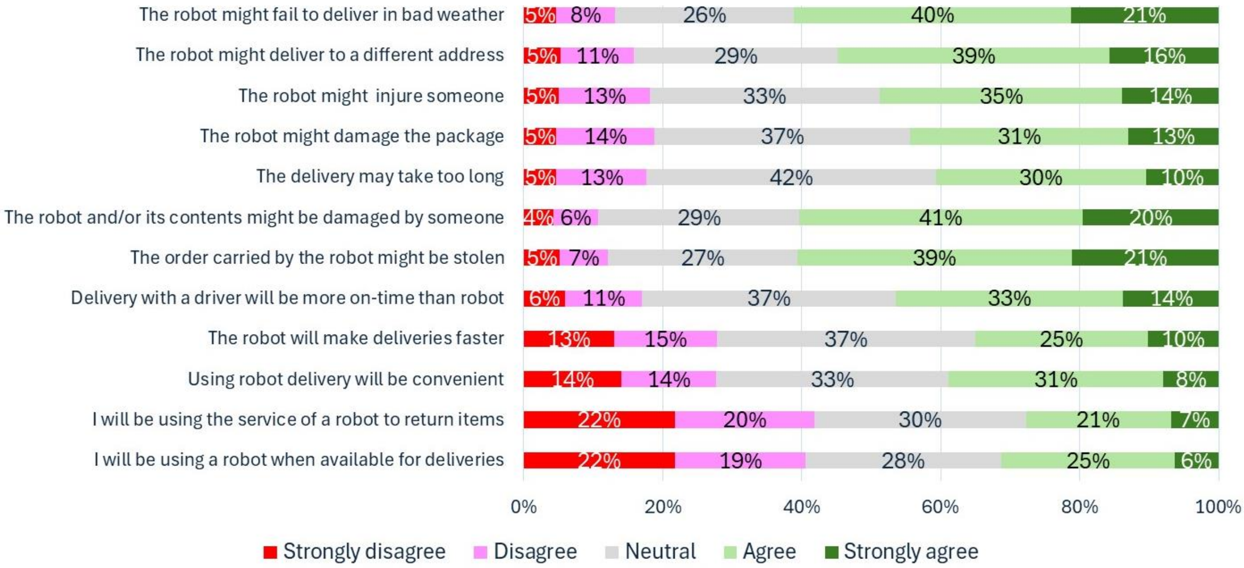


Figure 222: Customer attitudes towards delivery robots

The proportions agreeing that the delivery drone will cause problems vary from 38% to 66% (Figure 223). The main concerns were failing in bad weather (66%), delivering to a wrong address (58%), and the robot or the contents being damaged by someone (57%). Positive views were similar to the ones for the other vehicles. 34% agree that they will be using a delivery robot to order goods and 29% to return goods. The proportions disagreeing with those statements were higher than in the case of self-driving vans but lower than the case of drones, at 37-41%.

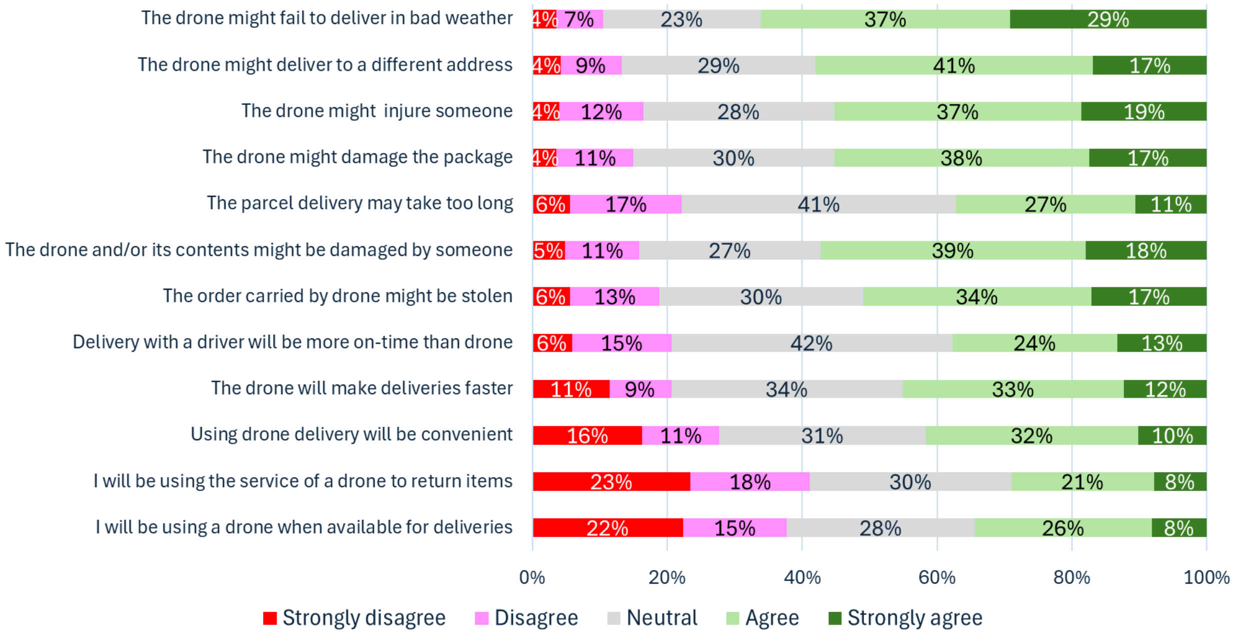


Figure 223: Customer attitudes towards delivery drones

Figure 224 shows the participants' general concerns about self-driving freight vehicles. 42% is concerned a bit or very much that the vehicle will record them on audio and video, 53% that someone will track their location, 52% that hacking might cause accidents, and 51% that the vehicle technology may fail. The proportions who are only slightly or not at all concerned are much smaller.

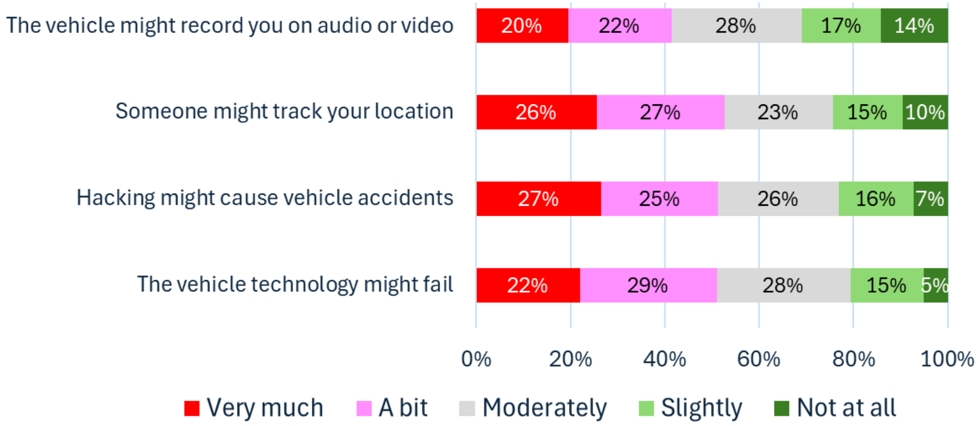


Figure 224: Customer concerns about self-driving delivery vehicles

6.5 Customer preferences and willingness to pay

6.5.1 Methods

The questionnaire included a choice experiment, i.e., a group of six questions where participants were asked to choose among four options for a hypothetical delivery of household goods that are needed as soon as possible. The options were deliveries by conventional van, self-driving van, delivery robot, and delivery drone. Each option was characterized by six attributes, which assumed different levels from question to question. Table 134 shows the attributes and levels and Figure 225 shows an example of the questions that participants answered

Table 134. Choice experiment: attributes and levels

<table>
<tr><th></th><th>Conventional van</th><th>Self-driving van</th><th>Delivery robot</th><th>Delivery drone</th></tr>
<tr><td>Delivery location</td><td colspan="3">• Front door
• Walk to vehicle (up to 3 minutes)</td><td>• Front door
• Walk to vehicle (up to 3 minutes)
• Garden or terrace</td></tr>
<tr><td>Human interaction</td><td>Driver</td><td colspan="3">• No interaction
• Contact company by phone</td></tr>
<tr><td>Time from order to delivery</td><td colspan="4">1, 2, 3 days</td></tr>
<tr><td>Chance of delivery problems</td><td colspan="4">5%, 10%, 15%</td></tr>
<tr><td>Delivery time window</td><td colspan="4">0.5, 1, 2 hours</td></tr>
<tr><td>Cost</td><td colspan="4">£2, £4, £6</td></tr>
</table>

	Conventional van	Self-driving van	Delivery robot	Delivery drone
Delivery location	Front door	Walk to vehicle (up to 3 minutes)	Front door	Front door
Human interaction	Driver	Delivery company via telephone	No	No
Time from order to delivery (days)	3 days	1 day	1 day	2 days
Delivery time window (hours)	2 hours	2 hours	1 hour	2 hours
Delivery problems (%)	10%	5%	10%	5%
Cost (£)	4	2	2	4

Which option would you choose?

Figure 225: Example of question in choice experiment

6.5.2 Model results

Table 135 shows the frequency of choices for each type of vehicle. More than half of all choices were for the conventional van. This proportion is not much different across genders, but it increases with age. Two thirds of all choices by participants aged 65+ were for the conventional van.

Table 135. Frequency of choices (%)

	Conventional van	Self-driving van	Delivery robot	Delivery drone
All	53%	17%	14%	16%
Male	55%	14%	14%	16%
Female	51%	19%	14%	16%
18-34	36%	25%	18%	21%
35-64	57%	14%	13%	16%
65+	66%	12%	12%	10%

We then modelled all the choices using a mixed logit model. This model estimates how the odds of choosing a given option (i.e., a vehicle) are associated with each attribute value. The model accounts for the fact that each person have different preferences. Hence, the model estimates coefficients for each participant.

The variables of the model are:

- Cost, time, delivery time window, and delivery problems, all entered as quantitative variables
- Dummy variables representing two of the possible values of delivery location (walk to vehicle and garden/terrace). The omitted value is “front door”, i.e., results for the two dummy variables are in relation to delivery to customers’ front door
- Dummy variables representing one possible value (telephone) for human interaction in deliveries made by self-driving vehicle. The omitted value is “no interaction”
- Dummy variables representing options for each of the three self-driving vehicles. The omitted value is conventional van

Table 136 shows the mean of the coefficients for each participant and respective significant levels (p value). The table also reports the significance of the standard deviations of the coefficients. This is an indicator of whether preferences for each attribute level do differ across the sample.

The estimated model shows that:

- The cost, time, and delivery problems coefficients are negative and significant, i.e., participants prefer cheaper, faster, and less problematic deliveries, as expected
- The coefficient for time window is insignificant, i.e. participants are indifferent between longer and shorter time windows
- The “walk to vehicle” coefficient is negative and significant, i.e., participants prefer the omitted value (delivery at front door) than walking to vehicle, as expected
- The garden/terrace coefficient (which applies only to drone deliveries) is insignificant. This shows that participants are indifferent between drone deliveries in their garden/terrace or at their front door
- The three dummies representing self-driving vehicles are all negative. This means people prefer conventional vans than self-driving vehicles, after accounting for all attributes (i.e., cost, time, delivery time window, delivery problems, and delivery location)

Table 136. Model of choices for delivery vehicle

	Mean of coefficients		Standard deviation of coefficients
	Estimate	**p-value**	**p-value**
Cost	-0.20	<0.01	<0.01
Time from order to delivery	-0.05	<0.01	0.10
Delivery time window	0.00	0.95	0.03
Delivery problems	-0.04	<0.01	<0.01
Delivery location: walk to vehicle	-0.21	<0.01	<0.01
Delivery location: garden/terrace	0.09	0.44	0.21
Human interaction: telephone	-0.02	0.78	<0.01
Self-driving van	-1.72	<0.01	<0.01
Delivery robot	-1.94	<0.01	<0.01
Delivery drone	-2.10	<0.01	<0.01

Participants were also asked to provide the reasons for their choice, after the first choice situation. The question was open ended. We coded all the answers. Table 137 shows the results. The stars identify the reasons that correspond to attributes of the choice experiment. The main reason to choose the conventional van was human interaction (20%), followed by safety, trust, and familiarity. The main reason to choose the self-driving van was convenience (15%), followed by time from order to delivery, safety, and cost. For the delivery robot, the main reasons were cost (31%), time from order to delivery, and technology adoption. For drones, the main reasons were time from order to delivery (29%), cost, delivery problems, technology adoption, and delivery adoption.

Overall, attributes of the experiment such as cost, delivery problems, time from order to delivery, and delivery location, were more important in the choice of the self-driving options. Human interaction was more important in the choice of the conventional van. The other attribute (delivery time window) was seldom given as a reason, which is consistent with the results of the model, as this attribute was insignificant.

Table 137. Reasons for choices (%)

	Conventional van	Self-driving van	Delivery robot	Delivery drone
Human interaction*	20%	5%	0%	0%
Safety	12%	12%	2%	5%
Trust	12%	7%	0%	0%
Familiarity	11%	1%	0%	0%
Cost*	7%	11%	31%	21%
Support employment	7%	0%	0%	0%
Reliability	6%	3%	0%	3%
Delivery problems*	5%	5%	1%	15%
Convenience	5%	15%	9%	7%
Time from order to delivery*	4%	14%	24%	29%
Delivery location*	1%	7%	2%	10%
Delivery time window*	1%	0%	3%	1%
Efficiency	1%	4%	1%	4%
Interest in technology	0%	4%	15%	12%
Other	21%	26%	25%	15%
Number of answers	**354**	**74**	**88**	**73**

Note: Some respondents provided two or three reasons in their answers, so the proportions can add to more than 100%. *: attributes of the choice experiment.

6.5.3 Willingness to pay

Table 10 shows willingness to pay for various delivery service attributes. The table does not show willingness to pay for changes in attributes that were insignificant in the model. Willingness to pay values were estimated for each participant as the ratio between the coefficients of each attribute and the coefficient of cost. We then took the median of the participants' willingness to pay values.

The table shows that median consumer is willing to pay £0.22 for reducing delivery time by one day, £0.17 to reduce the chance of delivery problems by 1%, and £0.94 to have deliveries made directly to their front door, instead of walking up to 3 minutes.

The willingness to pay for deliveries made with self-driving vehicles is negative. This means that consumers will only use delivery methods if they are cheaper than deliveries with a conventional van. In other words, the values are willingness to accept deliveries by self-driving vehicle, not willingness to pay. The median consumer is willing to accept deliveries by self-driving vans, delivery robots, and delivery drones if they are £8.16, £8.65, and £9.96 cheaper than deliveries by conventional van.

Table 138. Willingness to pay (£)

Delivery time: 1 day less	0.22
Chance of delivery problem: 1% less	0.17
Delivery location: Front door (vs walk to vehicle up to 3 mins)	0.94
Vehicle: Conventional van (vs. self-driving van)	8.16
Vehicle: Conventional van (vs. Delivery robot)	8.65
Vehicle: Conventional van (vs. Delivery drone)	9.96

6.6 Road user attitudes towards self-driving delivery vehicles

This section analyses road users' attitudes towards self-driving delivery vehicles. Figure 226 shows the results for self-driving vans. The degree of comfort is similar for situations involving cars and pedestrians, with 31% feeling comfortable or somewhat comfortable and 37% feeling uncomfortable. Surprisingly, there is slightly less discomfort when the situation involves cyclists.

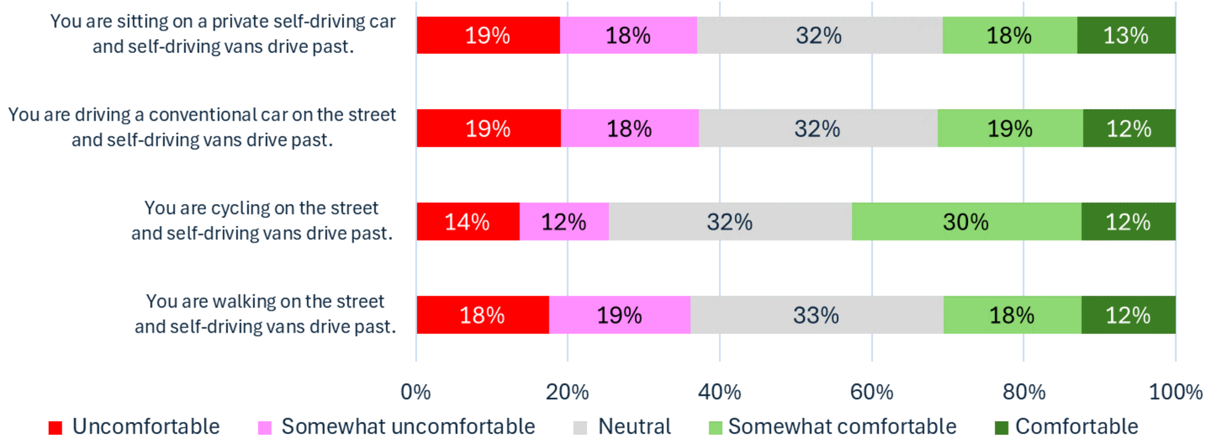


Figure 226: Road user attitudes towards self-driving vans

Figure 227 shows the results for delivery robots, which mirror closely the ones obtained for self-driving vans. The situations generate the same distribution of opinions as the ones in the case of self-driving vans. In addition, situations involving cycling again generate less discomfort.

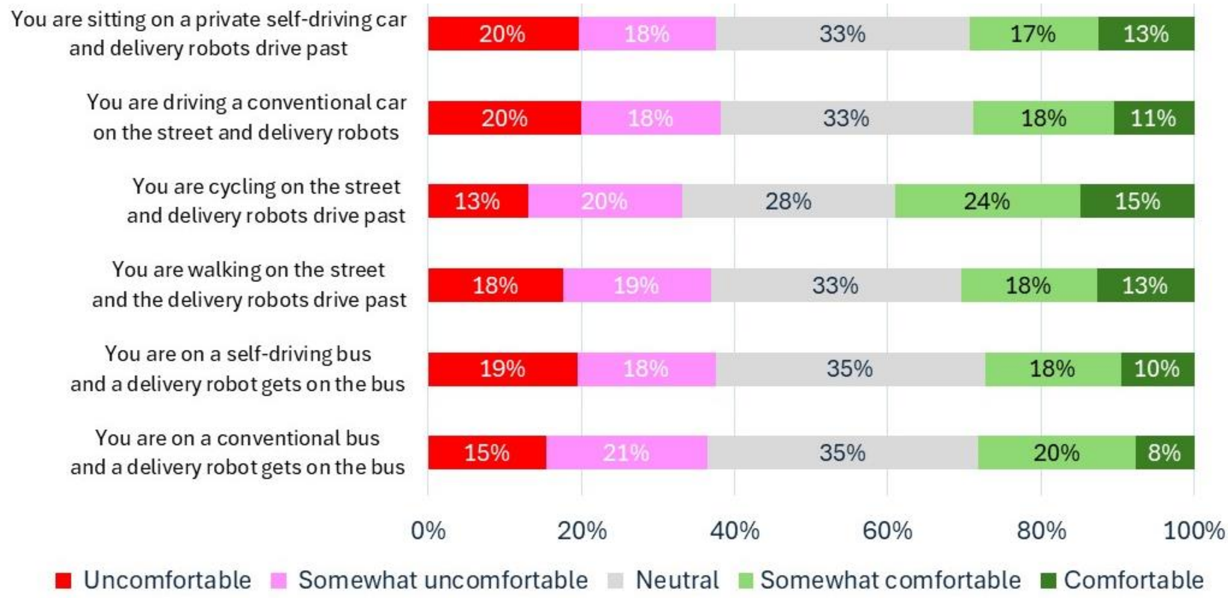


Figure 227: Road user attitudes towards delivery robots

Figure 9 shows the results for drones. The situation shown generates the same distribution of opinions as the other vehicles.

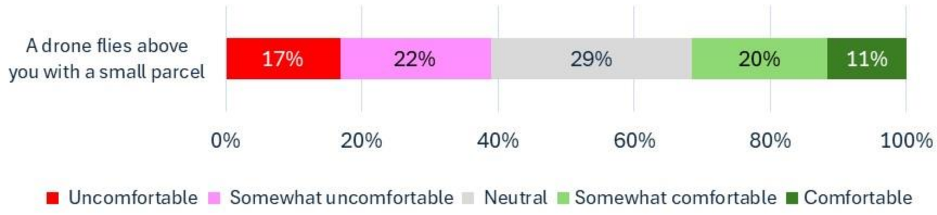


Figure 228: Road user attitudes towards drones

Figure 10 shows participants' general concerns about self-driving delivery vehicles, from the point of view of road users. The four situations have similar distributions, in terms of concerns. The sample is fairly equally distributed, with the proportions of participants concerned with the situations being almost the same as the proportions of those not concerned.

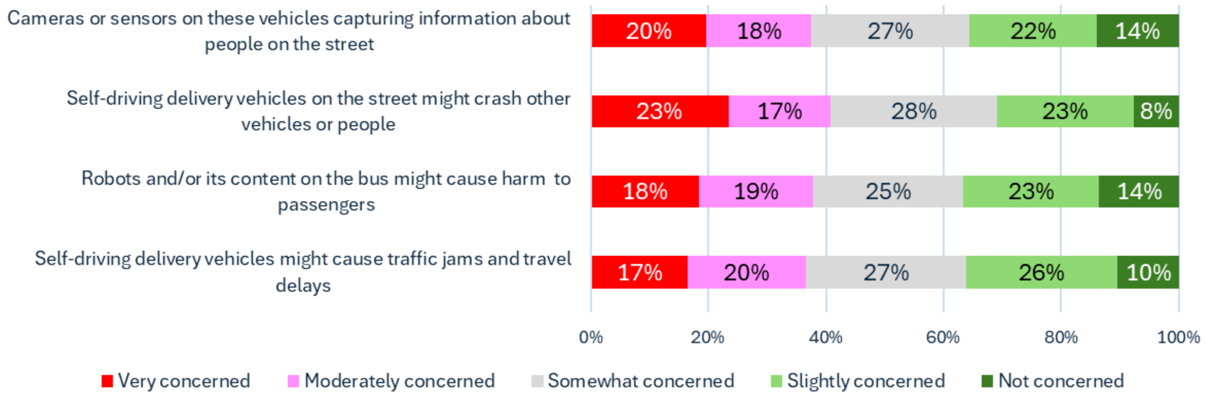


Figure 229: Road user general concerns about self-driving delivery vehicles

6.7 Impact of self-driving delivery vehicles

Figure 230 shows the results regarding the potential impact of self-driving vehicles on people's lives. 35-43% of participants reported neutral impacts. The impacts more likely to happen are working more from home (33% of participants somewhat or strongly agreed with this) and having more spare time (32%), followed by more stress (30%). The impacts less likely to happen are those involving social interaction: meeting more people in person (24%), taking more public transport (26%), and going out for shopping more often (24%).

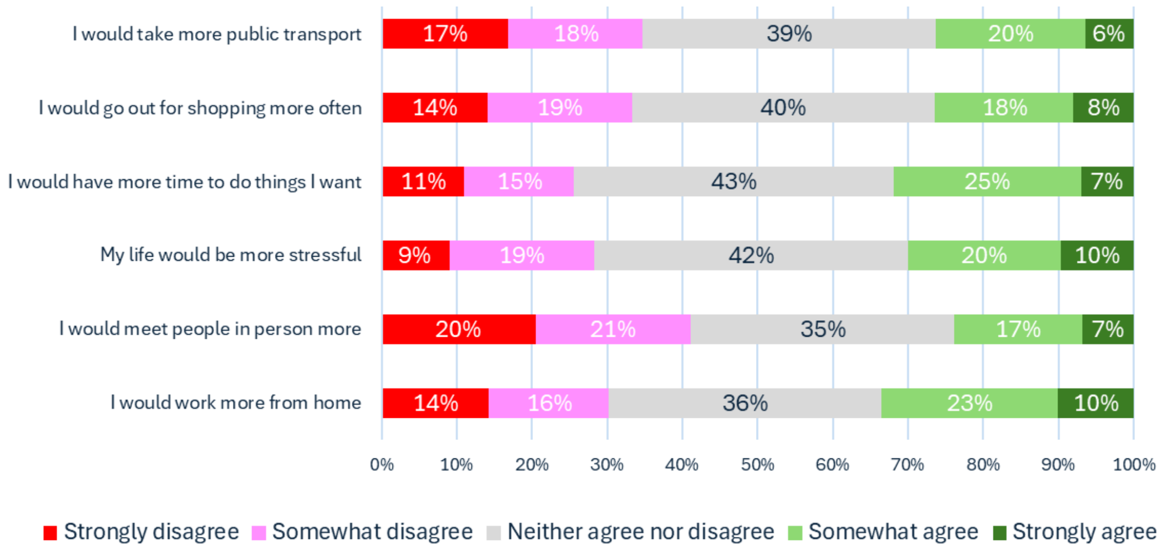


Figure 230: Impacts of self-driving delivery vehicles on people's lives

6.8 Conclusions

This survey analysed attitudes, preferences, and willingness to pay of citizens in the UK towards self-driving delivery vehicles, focusing on self-driving vans, delivery robots, and delivery drones. It also looked at the potential impact of these vehicles on people's lives. The main conclusions are as follows:

- Citizens in the UK prefer conventional vans to self-driving freight vehicles, after accounting for differences in cost, time, and other delivery characteristics. This preference increases with age
- They would only use self-driving freight vehicles if they were cheaper or faster
- Some people are concerned with the reliability of these vehicles in face of unexpected situations or security issues
- Others think deliveries with self-driving vehicles can be faster, reliable (in terms of punctuality), and convenient
- Road users have a variety of concerns about sharing roads with self-driving vehicles

Overall, the results of the survey show that while there is interest towards deliveries made with self-driving vehicles, conventional vans remain the preferred choice, as citizens are familiar with them and value human interaction. The adoption of self-driving vehicles will depend on finding an alternative for the loss of human interaction as well as addressing consumer concerns related to reliability and trust. Measures to protect other road users are also needed.

7. Conclusions of Part 1 – Impact on citizens

Part 1 of the deliverable analysed the impact of self-driving passenger and freight vehicles on citizens. A variety of data types was collected, in activities involving citizens in eight countries in Europe. This included qualitative assessments using focus groups (Chapter 2), a demonstration of self-driving vehicles (Chapter 3), virtual reality experiments (Chapter 4), a pan-European survey (Chapter 5), and a survey in the United Kingdom on self-driving freight vehicles (Chapter 6). This final chapter of Part 1 compares the main conclusions from these activities, using the same eight-impact structure assessed in each of the chapters.

Table 35 shows the results. A common conclusion is that self-driving vehicles can enhance citizens' **mobility**. Some activities concluded that travel will be cheaper, others that travel will be more expensive. Travel will be more comfortable and allow for productive or leisure uses of time. It is likely that the number of trips may increase, especially by private modes. Shopping trips may decrease.

The increase in mobility is likely to increase road traffic levels, although this will not necessarily increase congestion in the **transport network** if vehicles are more reliable in dealing with unexpected events and bottlenecks.

Regarding **land use**, the effect on parking is uncertain. It is possible that authorities invest more in improving public realm, as the view from vehicles will be a possible use of travel time when driving is no longer necessary.

It is likely that the **environment** will improve, as emissions and noise decrease. However, citizens expressed concern in some activities about the implications of relying on electric vehicles, as demand for electricity will increase, and battery disposal may become a problem.

Regarding perceived impacts on the **economy**, citizens were consistent across activities that there will be both job creation and job destruction. There is a high degree of uncertainty on whether the net effect is positive or negative. Some activities also concluded that productivity could increase because travel time will be more reliable (so employees can arrive on time to work or business appointments), while also allowing for working while travelling. There is also a concern about customer resistance to new solutions, especially the ones relying on self-driving freight delivery vehicles. These freight solutions may also be vulnerable to new problems such as theft and vulnerability to some weather conditions.

The perceived impacts on **equity** were consistent across all activities that focused on this impact: there was a strong concern about whether self-driving vehicles can meet the needs of people with disabilities. There was also concern about price-related exclusion, although accessibility can increase in areas currently not served by public transport, such as rural or outer suburban areas.

The impacts on **public health** were also consistent: there will be better air quality, but the impact on traveller stress is uncertain: it can increase or decrease.

Again, the perceived impacts on **safety** were consistent: travel will be safer, with fewer collisions, but there was a strong concern about emergencies that the vehicles may not be able to handle.

The strongest concern, however, was **personal security**. This was a conclusion about all the activities: travelling in public transport without a human driver or assistant may create fear of crime and harassment. Freight deliveries by self-driving vehicle are also vulnerable to theft. On top of these concerns, vehicles can be hacked, and citizen data can be abused by transport companies or governments, or stolen with malicious intent.

Table 139. Comparison of impacts on self-driving vehicles on citizens

	Qualitative assessment	Demonstration	Virtual reality	Pan-European survey	Freight survey
Mobility	• Can enhance mobility	• Can enhance mobility • Cheaper • Smooth and comfortable • Narrow	• Cheaper • Comfortable • Satisfaction depends on speed, and security • Productive and leisure uses of travel time	• Increase in number of trips • Increase in travel costs	• Fewer shopping trips • Reduced use of public transport
Transport network	• Reduces congestion only if traffic decreases		• Traffic levels can increase.	• Increase in traffic levels	• More traffic conflicts
Land use			• Parking needs may decrease in residential areas • View is important, so possible road aesthetic improvement	• Split opinions on effect on parking	
Environment	• Better air quality only if traffic decreases • Problem of disposal of batteries	• Quiet and environmentally-friendly		• Reduced emissions and noise • Increased demand for electricity	
Economy	• Fear of job losses • More jobs and industries can be created		• Use of travel time to work can increase productivity • Congestion and delays may decrease	• Economic growth, investment, and new skills requirements • Split opinions on net effect on jobs	• Customer resistance to deliveries with self-driving vehicles • Split opinions about reliability of freight delivery
Equity	• Can improve mobility of those with low (spatial) accessibility • Concerns about people with disabilities • Price-related exclusion	• Concerns about people with disabilities	• Concerns about people with disabilities	• Increases accessibility for people with special mobility needs, older people, families with children	
Public health	• Better air quality only if traffic decreases	• Reduces stress	• May increase stress due to security concerns or congestion	• Split opinions on effect on travel stress • Improved accessibility to healthcare and emergency response	• Split opinions about effect of self-driving vehicles on stress • Fewer social interactions

Safety	• Fewer collisions • Concerns about emergencies • Concerns about weather conditions • Liability issues	• Safe in all situations and for all road users • Concern about emergencies	• Safer	• Traffic fatalities will decrease	• Concern about collisions with other road users
Security	• Concern with passenger and freight security (crime) • Concern about hacking	• Concern with passenger and freight security (crime)	• Concern with passenger security (crime)	• Concern about cyber attacks	• Concern with freight security (damage, theft) • Concern about cyber attacks and data privacy

PART 2

IMPACT OF SELF-DRIVING VEHICLES ON ORGANISATIONS

Part 2 - IMPACT OF SELF-DRIVING VEHICLES ON ORGANISATIONS

Part 2 reports the results of analyses of European-based organisations' perceived impacts of passenger and freight transport self-driving vehicles on the organisation and on their regions where they live.

Chapter 8: Qualitative assessment of impact, through discussions and other group activities involving organisations

Chapter 9: Citizens' feedback on a demonstration of a passenger self-driving vehicle in Katowice, Poland

Chapter 10: Detailed case studies, based on in-depth interviews, of the impact of self-driving vehicles on organisations

Chapter 11: Conclusions of the analyses above

8. Qualitative assessment of impacts - organisations

8.1 Overview

The qualitative impact assessment focused on exploring organisations' perceptions of the potential impacts of self-driving vehicle use cases co-created with citizens and organisations in earlier activities.

In seven regions (all excluding France), participants took part in an online or in-person workshop. In-person workshops were held in the prototypical regions (Helmond, North Aegean Region, Metropolis GZM).

In each region, four use cases were examined in detail, aiming to understand perceptions of impact across the eight MOVE2CCAM domains: mobility; safety; public health; environment; transport network; economy; land use; and equity. Use cases in each region were selected according to relevance, based on the results of earlier activities with these participants.

The specific objectives of the online platform and workshop discussions were to understand:

- How organisations view the potential role of the selected use cases in their everyday lives and under what circumstances they might benefit from these use cases (or not)
- What positive and negative impacts organisations imagine might arise from the proposed use cases and which impacts are most important to them
- How certain they are about the range of impacts discussed, when they think use cases might be rolled out, and where they agree and disagree with one another.

A main output from these sessions has been a set of causal effect diagrams, co-created with organisations and citizens (in separate workshops) for each use case. These diagrams have formed the basis of the causal-loop diagrams used to develop the CCAM impact assessment tool.

This chapter is organised as follows:

- Section 8.2 describes the methods used to assess perceived impacts of use cases across domains
- Section 8.3 describes the sample make-up and characteristics
- Section 8.4 reports the results of the engagement activities
- Section 8.5 draws conclusions

8.2 Methods

8.2.1 Organisations' face-to-face activities

Organisations in the Netherlands, Poland and Greece took part in 2-hour face to face workshops following the format of the citizens' workshops (see section 2.2). While organisations did not complete the online engagement platform citizens took part in (this was determined to be unnecessary due to their existing expertise and lack of time), they received the use cases via email in order to familiarise themselves with them and start forming views on their potential impacts ahead of the workshops.

8.2.2 Organisations' online activities

Organisations in the UK, Spain, Germany, and Cyprus also took part in 2-hour online workshops following the same structure as face-to-face workshops.

8.2.3 Sample overview

Table 140 shows the sample sizes obtained in the workshops at country level. Table 141 shows sample sizes by type of organisation. A good spread of different types of organisations was achieved across workshops. However, the overall sample size was smaller than initially proposed

Table 140: Qualitative assessment (organisations) – sample sizes by country

All	**87**
United Kingdom	9
Germany	16
Netherlands	15
Spain	16
Poland	10
Greece	8
Cyprus	11

Table 141: Qualitative assessment (organisations) – sample sizes by type oof organisation

Authorities and regulatory bodies	16
Research/Higher Education	15
CCAM partners and NGOs	10
Vehicle developers and manufacturers	7
Deployers/passenger transport operators	6
Transport infrastructure operators	5
Transport/urban planning consultancy	3
AV demonstration sites	2
Food and drink/hospitality	2
Health	1
Telecommunications and cyber	1
TV and radio	1

8.3 Results by use case: passenger-carrying services

8.3.1 Self-driving e-hailing

Table 142: Self-driving e-hailing use case (organisations)

Description	The self-driving e-hailing service is a platform that uses self-driving vehicles to provide on-demand rides to passengers. It allows passengers to go to any location within a 10km radius in the city/area, similar to e-hailing services now but without a driver.
Countries tested	Cyprus, Germany, Greece, Netherlands, Poland, Spain, United Kingdom

The issues of mobility and parking stood out most to organisations in this use case. On the former, participants felt that this technology could improve the mobility and independence of certain groups, such as older and younger people. On parking, some in the UK raised the issue of where these vehicles would be stored when not in use, as the added storage (particularly in cities) may negate benefits from reducing congestion, for example.

Safety also stood out as a key issue. Many agreed that this use case would lead to fewer traffic-related accidents, but they were broadly sceptical of how safe this service would be in practice for passengers. Data security was also a concern, and there was debate around whether this use case would lead to increased or decreased congestion on roads (depending on whether self-driving vehicles would replace, or merely add to, private vehicles).

Organisations in Cyprus were keen to point out that those who are digitally excluded may struggle to use this service, and organisations in Spain thought the service could be too expensive for some to use regularly.

Table 143: Self-driving e-hailing use case: results of qualitative assessment (organisations)

Mobility	• Widespread attention was given to the potential benefits in this domain; Greece, Germany, and the Netherlands in particular indicated how this technology could improve the mobility and independence of certain groups, such as older and younger people, particularly in the context of an ageing population. • They felt there was potential for this factor to significantly increase the adoption rate of the use case.
Public health	• Organisations did not explore this theme in depth; most health concerns related to this use case were seen as more closely aligned with the Safety domain. • However, organisations in Spain expressed concerns about the technology potentially reducing active mobility (e.g., walking) among the population, which could have a negative effect on public health in the long term.
Land use	• Parking was a salient topic for organisations across most countries. They discussed the need for new parking strategies to accommodate this technology, as this may lead to fewer private vehicles on the road and less space given over to parking. • Organisations in the UK raised the issue of where these vehicles would be stored when not in use, as the added storage (particularly in cities) may negate any tangible benefit to having them and this would not lead to increased uptake. • German organisations felt the vehicles might encourage more electric charging infrastructure, which may in turn promote uptake of self-driving technology.
Safety	• As among citizens, safety was discussed in detail by organisations in all countries. Many agreed that this use case would lead to fewer traffic-related accidents. • However, they were broadly sceptical of how safe this service would be in practice for its passengers; organisations in the Netherlands, Poland, and UK all discussed the implications of not having a driver present as a buffer between passengers, with Poland suggesting that initiatives such as female-only vehicles may emerge. • Additionally, German organisations raised doubts about the ability of a self-driving vehicle to safely navigate complex traffic situations. Data security was also a large concern, raised especially in Spain and Greece, with the latter advocating for a government department dedicated to self-driving vehicle/citizen safety issues and regulatory laws to prevent the theft or misuse of personal data.
Transport network	• Overall, the countries were unsure of the net benefits in this domain • In the UK, Germany, Cyprus and the Netherlands, there were doubts that this service would improve congestion; some felt it would likely increase if the service does not replace private car use, with harmful effects on the environment. • Organisations in the Netherlands believed that outcomes would likely depend on how often these vehicles were shared or used by individuals. • Meanwhile, Spain was more optimistic that this technology could reduce traffic congestion, though still conceding that this may not apply during peak travel times.

Environment	• Although Environment was not a salient point for organisations overall, they felt that reduced levels of private vehicle ownership could lead to less air pollution – if indeed the service would have this effect on private ownership.
Economy	• There was general agreement that self-driving e-hailing services could generate new jobs, businesses, and stimulate competition with pre-existing ridesharing services. • However, organisations in Greece and Germany expressed concerns that this technology could lead to job losses for those already employed by providing similar services. Spain had similar sentiments but felt that the number of jobs created would offset this figure.
Equity	• Organisations in the UK suggested this service had the potential to be beneficial to low-income families; similarly, some in the Netherlands believed this may supplant the need for a second car. • On the other hand, Greek organisations felt that this service may be expensive from the outset, hindering uptake. Similarly, some groups in the UK and Spain were concerned about the service only being available to affluent people. Cyprus suggested that digitally excluded groups may struggle to benefit from this service.
Timeline	• Organisations across most countries were fairly cautious, expecting rollout to be at around 50% by 2050 (organisations in the Netherlands were particularly so, estimating 35%). For Germany, this was due to concerns around the pace of regulation and social acceptance. • Spain and Poland were more optimistic, with Spain in particular envisioning 90% deployment by 2050, if public trust is present.

8.3.2 Self-driving car

Table 144: Self-driving car use case (organisations)

Description	This car is completely self-driving. The owners can use it to go anywhere at any time, just like a private car today but without the need for a driver.
Countries tested	Greece, Cyprus

Similar to the self-driving e-hailing use case, organisations felt that this use case had benefits for the mobility, public health, and equity. These included increased access for people with disabilities and mobility issues (plus those in rural areas) and lower levels of pollution and stress for drivers.

However, there were questions over whether self-driving cars would lead to increased or decreased congestion, and whether they would be unaffordable to the majority. Cyprus and Greece were divided in their assessments of the economic impacts of this use case, as well as on their predicted timelines for this technology to be rolled out.

Table 145: Self-driving car: results of qualitative assessment (organisations)

Mobility	• Organisations in both countries felt that this use case would significantly help those with mobility issues and health problems. However, despite this positive, those in Cyprus felt it would also lead to an increase in traffic congestion.
Public health	• There was agreement across both countries that public health could benefit from a reduction in both road accidents and air pollution, assuming that the self-driving vehicles are electric, and that self-driving technology will reduce human error. • Organisations in Cyprus in particular felt that self-driving vehicles could lower the number of traffic-related accidents, while those in Greece were more sceptical, but ultimately did not think this would prevent uptake of self-driving vehicles. • Organisations in both countries mentioned that not having to drive would lead to a reduction in stress, and therefore better quality of life, for many people. They also thought that lower levels of noise pollution would have positive impacts on quality of life.
Land use	• Although not a prominent area of discussion, there was consensus that self-driving technology could lead to fewer available parking spaces. However, this was connected to the potentially positive impact of increased green space. • On a separate note, Greece felt that the upgrade in infrastructure needed to roll out self-driving vehicles presented an opportunity to improve infrastructure for bicycles at the same time.
Safety	• Safety was a salient issue for organisations in both countries, specifically the reduction in traffic-related accidents, directly connected to the lack of human control (though for Greece, this was predicated upon speed limiters and well-connected GPS). Both countries expressed concern for the handling of personal data due to worries about unauthorised use.
Transport network	• Transport network efficiency was not discussed in detail by organisations. However, those in Cyprus raised the possibility of lowered demand for public transport, seeing this as a negative, while organisations in Greece felt that self-driving vehicles would have no effect on public transport in this way.
Environment	• Organisations highlighted the potential for reduced noise pollution in this use case, which they directly connected to a better quality of life for citizens (see Public health). • Both Greece and Cyprus claimed this would lead to positive perceptions of self-driving vehicles, encouraging their uptake.
Economy	• Organisations in Cyprus were more optimistic towards the economic impacts of this use case, citing increased productivity, likely stemming from the infrastructure and jobs created to support the technology. • Organisations in Greece, meanwhile, were less convinced of the economic benefits; while agreeing that the use case would create new industry needs and therefore more jobs, they also felt that the economy would experience 'growing pains' associated with self-driving vehicle uptake and the required infrastructure upgrades.
Equity	• Organisations from both countries were concerned that not everyone would be able to afford these vehicles. Greece felt they could fill gaps in transport provision for those with disabilities, provided funding was made available to support vulnerable groups to use them. In Cyprus, organisations felt they would lead to greater levels of connectivity for citizens n rural areas.
Timeline	• Greek organisations felt that by 2050 penetration would be at around 30-35%. Organisations in Cyprus provided a lower rate, estimating 10-35%, on the basis that Cypriots are culturally less inclined to stop driving.

8.3.3 Emergency shuttle pod

Table 146: Emergency shuttle pod use case (organisations)

Description	The Emergency shuttle pod is a dedicated service that is able to pick people up in medical emergencies and take them to the nearest hospital. It is a bit like an ambulance but with no driver or medical professional on board.
Countries tested	Germany, Poland

Polish organisations felt that faster emergency response times and support for existing ambulance services would be the key benefits of this use case. However, there were concerns about Equity; organisations felt that without a driver, some vulnerable passengers would not be able to use the service, and all users would be helpless in the case of vehicle breakdown. Organisations also felt that if this were a private service, it would increase inequality of accessing medical care at a hospital.

Table 147: Emergency shuttle pod: results of qualitative assessment (organisations)

Mobility	• Organisations saw this service as sitting alongside the existing ambulance service, as it would not be suitable for all people and situations. There was some concern about who would have priority use of the emergency shuttle pods, potentially from the assumption among Polish organisations that this would be a private service rather than a public one. (See also Equity)
Public health	• Polish organisations saw clear positive impacts to public health from this use case, such as the ability to treat injuries and provide non-emergency medical transport. • They felt that medical professionals should still be present to provide on-site care for severe injuries such as heart attacks and strokes; they also pointed out that uptake will rely upon this technology performing at the highest possible level to build the required trust. • In Germany, there was an expectation that this use case was more suited to minor injuries and non-emergencies, but could make a difference, provided public trust was present.
Land use	• Organisations felt that the pods could improve land use by reducing the need for parking spaces overall and increasing parking access at the hospital as there would be a reduced need for private vehicles. • However, they also suggested there would need to be an update to infrastructure in order to avoid congestion around hospitals. (See also Transport network).
Safety	• Organisations in Poland raised doubts about the ability to repair faults that occur in the course of attending/providing care. • As among citizens, there were concerns about privacy if the location of the pods were to be shared, as well as the possibility of losing control of personal data. In Germany, organisations added privacy concerns related to the shared use of pods. • There was also concern for passenger safety if the pod were to lose data connection.
Transport network	• Organisations cited faster emergency responses as a positive impact of this use case and suggested that the pod could also work as a highway support vehicle to take people away from dangerous roadside environments. • However, they were concerned that if self-driving vehicles were privatised then they could add to congestion around hospitals (see also Equity).
Environment	• Organisations in Poland felt that there was potential for this use case to reduce air and noise pollution.

Economy	• Organisations in Poland agreed that this use case could lead to the emergence of new professions, such as service technicians and programmers, however they felt that this would be difficult to predict.
Equity	• Polish organisations raised concerns that without a driver or other onboard assistance, some vulnerable passengers would not be able to use the service, as they might need physical assistance. They also felt that if this was a private service, it would increase inequality of accessing medical care at a hospital.
Timeline	• Polish organisations were not specific on their penetration estimates, though there was optimism that this technology would be taken up quickly. • In Germany, deployment expectations varied, with some participants optimistic about near-term use in specific scenarios (minor injuries, patient transport) and others cautious due to safety, regulatory, and technological challenges.

8.3.4 Mobility bus on demand

Table 148: Mobility bus on demand use case (organisations)

Description	This vehicle will transport passengers to their destination with onboarding and security features that will ensure a controlled ride for everyone.
Countries tested	Netherlands

Organisations felt that a mobility bus on demand would only lead to significant improvements in domains including mobility and public health if the service was truly integrated with other services and accessible to anyone. Many questions remained as to how this would be better than existing services.

Table 149: Mobility bus on demand: results of qualitative assessment (organisations)

Mobility	• Organisations did not highlight any added mobility benefits beyond existing services.
Public health	• Organisations in the Netherlands focussed on the issue particulate matter from tyres, which they felt would still be a problem (especially when brakes will be used more often due to the strict safety measures taken for autonomous vehicles to prevent accidents). • Vehicles will also be heavier, which will further increase the wear of the tyres, resulting in further pollution.
Land use	• There were questions over how this service would interact with emergency services and whether it would be able to clear the road for them, especially during boarding and alighting from the vehicle. • If the trend towards mobility services on demand continues, it may mean less road space is needed overall, leading to a better and safer environment for people with a disability.
Safety	• There was an expectation that more accidents may happen as a result of this service and that attention was needed to safety on the pavements and bicycle lanes.
Transport network	• Organisations felt that efficiency can only be reached by if the process is optimised, which will depend on the time needed to board and alight the vehicle, which is further dependent on the user. • They argued that there must be a focus on consolidation with other users: mobility should be available to anyone, specifying a use case for one user group only would not use the potential of the vehicle as much as possible. They suggested having several variants of size and usage of these kind of vehicles.
Environment	• Environmental benefits may be undermined by particulate matter from tyres.
Economy	• Organisations considered that self-driving technology might decrease the number of motor vehicle accidents and the severity of these accidents. If this happens, they will also expect a reduction in the associated costs of healthcare and emergency services.

Equity	• Beneficial equity outcomes will depend on whether the service is accessible to all and whether all have trust in it.
Timeline	• Most can see a 50% penetration rate by 2050.

8.3.5 Self-driving bus service

Table 150: Self-driving bus service use case (organisations)

Description	This self-driving bus service provides passengers with connection between local towns and villages at specific times from designated spots, much like a regular bus service but without a driver.
Countries tested	Netherlands, Spain, United Kingdom

The necessary updates to infrastructure were a key topic of discussion in relation to economy across all countries, with organisations feeling that that this use case would require significant investment in this area.

Organisations were more divided in their assessment of this use case's environmental impact. Some in Spain thought it would lead to lowered emissions and greater fuel efficiency, while particulate matter from tyre wear was a concern for others in the Netherlands. Meanwhile, organisations in the UK felt that a large fleet would be required to service peak times, increasing both congestion and pollution which would limit uptake of these self-driving vehicles.

The organisations of each country were also split on their expected timelines for this use case, with those in the UK anticipating a much quicker rollout than those in the Netherlands.

Table 151: Self-driving bus service: results of qualitative assessment (organisations)

Mobility	• This domain was not discussed in detail by the organisation's groups. This suggests that, from an organisational perspective, there may not be any perceived benefits to mobility that do not already exist with current bus services, for example such as increased mobility for those who do not or cannot drive.
Public health	• Organisations in the UK identified the potential for better air quality in this use case, as a result of reduced fossil fuel use. They also felt that if the service was popular, it could provide an opportunity for increased mental health, through increased interactions for lonely or vulnerable people using the service. Meanwhile, organisations in the Netherlands had concerns that the service might replace journeys made by active transport (i.e. walking and cycling), and that this could in turn negatively impact public health.
Land use	• Some organisations felt that this use case had the potential to reduce private vehicle use, leading to secondary benefits to land use, such as more green space and less congestion. However, UK groups were m**ore** sceptical that public self-driving vehicles would have much of an impact on land use.
Safety	• Many organisations felt that this service would reduce the number of traffic-related accidents through reduced human error, though some in the Netherlands were more sceptical of this. Organisations in the UK felt that if a negative incident became highly publicised, this could be disruptive for rollout.
Transport network	• Organisations in the UK and the Netherlands felt that this service needs to work within and alongside current transport infrastructure. For the UK, this was seen as a way of reducing wastage of the current fleet.

Environment	• Organisations were more diverse in their opinions of the environmental impacts of this service. Those in Spain were more optimistic that this service would lead to lowered emissions and greater fuel efficiency, which would positively impact the environment. However, the Netherlands felt that particulate matter from tyre wear would be a concern. Organisations in the UK, on the other hand, felt that a large fleet would be required to service peak times, increasing both congestion and pollution which would limit uptake of these self-driving vehicles. There was also concern that the fleet would need regular updates, in which case disposal would need to be considered carefully.
Economy	• Similar to concerns around transport network efficiency, organisations across countries felt that this use case would require significant investments to infrastructure. However, organisations in the UK saw this as a way for Government to demonstrate commitment to the technology, building trust and encouraging uptake. The groups felt that the creation and loss of jobs would ultimately balance out, as people move from one type of career to another. Organisations in Spain were less concerned about the loss of driving jobs as culturally, there is little interest in those roles, particularly among young people. Additionally, organisations present this as an opportunity to get people into less dangerous and healthier jobs.
Equity	• Organisations across countries saw potential for this service to support accessibility of vulnerable groups such as the elderly, if the necessary provisions were made (see also Mobility). However, organisations in every country were unsure to what extent this service could include those who are digitally excluded or at risk (such as women travelling alone at night) due to the lack of safety and support from a driver.
Timeline	• Organisations across countries were split in their estimates. The Netherlands felt that diffusion will stand anywhere between 25% and 80% by 2050; meanwhile, the UK believed that by 2035, every town will have a flagship autonomous fleet. • Spanish organisations were mixed in their estimates but believed that there would need to be a transitionary period (where both self-driving and traditional buses are in operation), as well as new regulations implemented, before full take-up of this use case.

8.4 Results by use case: freight services

8.4.1 Consolidated delivery bot

Table 152: Consolidated delivery bot use case (organisations)

Description	A consolidated delivery bot transports packages like products or food items from several companies to people in their homes, much like a private courier service, e.g., DPD Courier.
Countries tested	Cyprus, Germany, Greece, Netherlands, Poland, Spain, United Kingdom

Organisations across countries expressed doubts that this technology would work with their current infrastructure; most believed that significant investments would be needed for only marginal improvements to transport network efficiency under this use case. As such, organisations felt that, in the short term at least, penetration of this technology would remain low.

In terms of safety, data privacy was an area of debate among organisations in Greece, who expressed concern about the potential misuse of personal data. Other concerns from organisations in general related to pedestrians having to share pavements with bots (leading to accidents), loss of jobs for couriers, and the reduction in face-to-face social interaction that citizens would have if couriers were replaced by bots.

Organisations in Spain were particularly positive about this use case's potential to reduce the number of delivery vans in cities, which they feel are currently causing traffic jams. They were also more likely to think that the bots would be secure against theft of goods.

Table 153: Consolidated delivery bot: results of qualitative assessment (organisations)

Mobility	• Organisations across countries were sceptical about positive impacts to mobility in this use case. Generally, they felt that consolidated delivery bots would increase congestion on the pavements where pedestrians walk, leading to negative perceptions of them and limiting their uptake.
Public health	• Some mentioned that this use case could benefit those in isolated and rural locations by bringing deliveries such as medical supplies straight to them (see also Equity). Organisations in Poland and Cyprus were concerned about the impact of getting rid of human couriers on social isolation. (Also see Safety for insight about accidents)
Land use	• Organisations across countries expressed doubts that this technology would work with their current infrastructure. Pavements are felt to be too narrow and heavily used by pedestrians to accommodate this use case and, according to organisations in Poland in particular, significant investments would be needed to sufficiently upgrade current pavements. Meanwhile organisations in Spain and the Netherlands were unsure of how this technology would navigate European cities which have old and narrow streets.
Safety	• Organisations showed variation across countries on the extent to which safety would be impacted. Most were concerned about theft of goods from the bot, however organisations in Spain in particular were more optimistic that bots would be very secure. For organisations in Greece, the most important aspect of safety was to protect personal data from being stolen. Sharing pavements with bots was a concern for organisations in Cyprus and the Netherlands in particular, who felt this could lead to accidents involving pedestrians and children, negatively affecting public acceptance of this technology.
Transport network	• Organisations felt that significant investments would be needed for only marginal improvements to transport network efficiency, because of the limited space and infrastructure in many European cities. However, many also felt that the consolidation of deliveries could work to limit traffic congestion, which Spain in particular felt was a significant problem currently facing their urban areas.
Environment	• Organisations had differing opinions about the potential for noise pollution in this use case. In Spain, for example, organisations felt that this technology would increase noise pollution, as it would need some sort of siren to alert people to its presence, while in Greece they felt it would be quieter than what is currently used.
Economy	• Organisations across all countries thought that this use case might lower transport costs, leading to savings for consumers and profits for businesses. However, all felt this would lead to job losses for couriers and delivery companies which might negatively impact the perception self-driving vehicles. However, organisations in Spain felt new opportunities may be created in the process.
Equity	• Some organisations were positive about accessibility, believing the bot could improve access for people in rural, isolated locations, but only if they are able to navigate terrain better than traditional delivery vans. However, organisations in the Netherlands in particular were more sceptical about improved accessibility, given that the deliveries are not brought directly to the recipient's door as opposed to deliveries by hand – thereby making this use case even less equitable for those with mobility impairments.
Timeline	• Organisations felt that, in the short term, penetration of this technology would remain low. Poland in particular did not expect this use case to be adopted at all due to infrastructure restrictions. However, in the long term, most organisations felt similar to citizens with penetration predicted to be over 50% by 2050. Spain and Cyprus predicted 80-100% penetration by 2050.

8.4.2 Single supplier delivery bot

Table 154: Single-supplier delivery bot use case (organisations)

Description	The single supplier delivery service replaces a retailer's previous fleet of delivery vans and drivers. Depending on the retailer, the delivery service can operate nationwide.
Countries tested	Greece

Organisations did see the potential for several benefits from this use case (in theory), such as reduced congestion on roads, lower frequency of road accidents, shorter delivery times, and reduced air pollution.

However, as with the consolidated delivery bot (See 2.4.1), they felt that current infrastructure is not suitable for this technology to be rolled out in the short term, and that considerable investment to local infrastructure would need to be made for this use case to be successful. Here, organisations also pointed out that the high upfront cost associated with getting the infrastructure ready would likely increase the cost of the service to customers, possibly inhibiting uptake.

Table 155: Single-supplier delivery bot: results of qualitative assessment (organisations)

Mobility	• Organisations felt this use case could reduce **road** congestion and therefore support better mobility, increasing positive perceptions of self-driving vehicles. However, they foresaw needing control centres to support facilitation of this. They also felt that the use case could reduce delivery times for packages.
Public health	• Organisations agreed that autonomous vehicles being electric could have a positive effect on public health from reduced air pollution, and that advanced traffic management from self-driving technology could also support this goal through more efficient driving. They also felt that there would be a reduction in road accidents caused by human error. However, they felt there could be an increased likelihood of accidents for pedestrians with the increased pavement congestion (see also Safety).
Land use	• Organisations were concerned that current infrastructure is unsuitable, with congested roads and narrow pavements leading to accidents and low trust in the bots. In order to make this technology feasible, participants felt that considerable investment to local infrastructure would need to be made.
Safety	• Organisations expressed concern about the handling of personal data and its potential misuse. They also felt that the bots would need a camera to help prevent accidents and citizens would need training in how to handle the bots.
Transport network	• Organisations felt this use case would increase the amount of traffic on pavements, leaving less room for pedestrians, and felt that new regulations and laws would be needed to govern where they can go.
Environment	• Some organisations felt there was potential for the bots to reduce the number of traditional delivery vehicles on the road. This would reduce fuel used – and therefore emissions created – by traditional delivery vehicles, resulting in positive perceptions of self-driving vehicles. Some thoughts bots would also lead to a reduction in noise and air pollution.
Economy	• Organisations pointed out that the high cost associated with getting the infrastructure ready would increase the cost of the service to customers, possibly inhibiting uptake.
Equity	• Like citizens, organisations were unsure about whether this use case would increase access for people who have limited digital capabilities. They also wondered whether bots might struggle to navigate rural areas, due to lack of connectivity and uneven terrain.
Timeline	• All organisations felt there would be very limited uptake in the near future but were more varied in their estimates for 2050. Most settled on 30%, while others were more optimistic with figures between 65% and 70%.

8.4.3 Medical delivery drone

Table 156: Medical delivery drone use case (organisations)

Description	Self-driving delivery drones designed to transport medicines and healthcare products to people with reduced mobility.
Countries tested	Poland, Spain

Polish and Spanish organisations could see positive impacts in public health with the potential for increased medical access, particularly in rural areas and for people with limited mobility.

However, both countries had concerns regarding economy, as they foresaw a need for substantial training in the operation of drones, and did not envision a large positive impact on jobs due to the assumption that the manufacture would be overseas. They were also worried about the impact of any incidents on the uptake of the use case, potentially negatively impacting businesses.

When discussing the transport network, there was uncertainty as to whether this use case would lower traffic congestion. Spanish organisations were sceptical, whereas Polish organisations felt that the use case would need considerable infrastructure development such as distribution centres for the use case to meet coverage demands.

Table 157: Medical delivery drone use case: results of qualitative assessment (organisations)

Mobility	• Organisations in Poland saw the potential for night-time deliveries as a positive but were unsure of how the use case would work in bad weather. They also felt that the service could be quite inefficient if each drone was limited to one delivery at a time. Meanwhile, organisations in Spain felt that the use case could improve accessibility to medicines in rural areas but did not believe it would reduce congestion overall (see also Transport Network).
Public health	• Organisations in both Spain and Poland agreed that access to medicine and treatment would be improved as a result of this service, particularly for groups with limited mobility or who live in remote areas. Polish participants suggested that the delivery of medicine would be faster and will show people first-hand the benefits of self-driving vehicles, increasing their acceptability and therefore their uptake (see also Equity).
Land use	• In Spain, organisations thought that this use case could make use of existing infrastructure and that they would lead to less road use. Polish organisations agreed but foresaw a need for new infrastructure, such as vertiports, and were concerned about where these might be located.
Safety	• Organisations in both countries raised concerns about the potential theft of medication from the drones, and organisations in Poland shared citizen concerns about accidents and data security.
Transport network	• Polish organisations agreed that this use case had the potential to reduce road congestion, assuming a distribution network that could meet demand and reach remote areas. Organisations in Spain, on the other hand, did not feel the use case would have much of an effect on road congestion but did think it could make for a more reliable service than what is currently available.
Environment	• Organisations in Poland were concerned about a potential harmful impact on birds but saw the potential of less air pollution as a positive. Spanish organisations were concerned about greater levels of noise and visual pollution.

Economy	• Organisations in both countries were less optimistic about economic impacts. • Spanish organisations assumed the drones would be manufactured overseas, thereby limiting the domestic impact, and agreed that any new jobs would need to be accompanied by the necessary training opportunities. • Organisations in Spain also felt that this service would be unnecessary if replacing delivery vans in rural areas altogether, since people in rural areas have alternatives that work, including going to the pharmacy by car, asking for support from family, or using pharmacies which use vans to distribute medicines. They thought that most economic benefits of this use case would come from a collaborative approach where both vans and drones are used • Polish organisations were concerned that any incidents involving the drones would result in economic losses for businesses through public distrust – however they were optimistic about the potential for new services, investment, and jobs.
Equity	• While organisations in both countries acknowledged increased access for some, such as those in rural areas, they felt that others, particularly users with limited digital capability, would struggle to benefit from this service.
Timeline	• Organisations in both countries were unsure of exact timelines but did not appear convinced that this technology would have any meaningful diffusion before 2040 or 2050, because of legal restrictions and a perceived lack of economic incentive.

8.4.4 Long-distance truck

Table 158: Long-distance truck use case (organisations)

Description	This long-distance truck transports goods efficiently and safely, eliminating the need for drivers. The truck navigates routes, delivers cargo, and optimises supply chains, ensuring timely and reliable freight transportation.
Countries tested	Germany, United Kingdom

Organisations had a broadly positive outlook about this use case. Those in the UK, in particular, were optimistic that any safety issues would be rectified before the technology was rolled out and that they would therefore be safer than traditional driven trucks. Under Land use, both countries' organisations shared optimism that space could be reclaimed from current rest stops and parking spaces. They also felt that transport network efficiency stands to improve with fully automated vehicles, as traffic flow could be controlled remotely to maximise efficiency.

There were however some concerns, for example around unsupervised dangerous cargo, cybersecurity, noise pollution and particulate pollution from tyres. Organisations also felt that improvements to infrastructure, such as dedicated motorway lanes, would need to be made to support the rollout of this use case, with high associated costs. Therefore, their estimations for the timelines were cautious overall – a maximum of 50% rollout by 2050.

Table 159: Long-distance truck: results of qualitative assessment (organisations)

Mobility	• For UK organisations, the possibility of introducing truck-only driving corridors felt like an opportunity for controlled traffic; they thought this would improve perceptions of autonomous vehicles amongst other road users if lorries safely occupied their own lanes. • German organisations also saw opportunities for increased traffic control if lorries could be contained in one lane but were concerned that this use case would lead to more lorries overall.
Public health	• UK organisations felt confident that this technology would not be deployed unless its safety was certain, so this was not a concerning domain for them. German organisations however did have reservations about the management of dangerous cargo but, much like citizens, they recognised the opportunities for better air quality leading to better public health.

Land use	• Both German and UK organisations shared optimism that space could be reclaimed from rest stops and parking seeing the impact of this being new development or a return to nature, positively impacting the environment (see also Environment). UK organisations also felt there would be a need for central hubs or distribution centres to manage capacity (see also Transport network).
Safety	• UK organisations were more optimistic about safety as they did not believe that this technology would be introduced if safety was not guaranteed. However, they acknowledged that public perceptions might be different and could negatively impact uptake. They also had some concerns about unsupervised dangerous cargo, as well as cybersecurity, but again they felt confident that there would be systems in place to address this. German organisations also shared concerns about unsupervised cargo as well as risks of theft and connection issues, but they were less optimistic about these issues being resolved before the technology is used, leading to low trust in the use case.
Transport network	• Both UK and German organisations felt that transport network efficiency stands to improve with fully automated vehicles, as traffic flow could be controlled remotely to maximise efficiency. Additionally, lorries could travel across the country in dedicated lanes without needing to stop, with reduced human error, vastly improving delivery times and allowing for more accurate estimates. However, they acknowledged the upshot of a network operating at peak capacity all the time could cause stress to people and infrastructure. Although there was some debate in Germany about the potential for increased traffic, the perception would be a decrease due to deliveries being done 24/7 so journeys can be distributed across the day.
Environment	• UK organisations raised concerns about environmental impacts, mentioning noise pollution and particulate pollution from tyres. They felt this could be offset with distribution centres and hubs, limiting heavy goods vehicles and the impact of pollution in urban areas. They agreed that the driverless vehicles in this use case should be more efficient, since they are powered from hydrogen, using less energy for the same level of productivity. • German organisations largely agreed that self-driving trucks could lead to reduced traffic congestion, as well as lower emissions, and better fuel efficiency due to being hydrogen powered. Some also mentioned reduced littering from truck drivers. All of these benefits were felt to contribute positively to environmental sustainability.
Economy	• Organisations in the UK were less concerned about job losses as a result of this technology being introduced, as the UK is currently experiencing a driver shortage. Furthermore, they saw new job creation in the facilitation of this technology such as distribution centres. German organisations agreed there could be potential job losses for drivers, which could have significant economic implications. However, they saw potential for optimising supply chains through automation, for example no rest periods for drivers would be necessary. There were however concerns about the initial high costs of implementing self-driving technology, such as creating dedicated lanes on motorways.
Equity	• German organisations agreed with German citizens, who were worried about impacts to smaller businesses that may be priced out of using this technology. UK organisations felt that this technology could make the delivery process easier and cheaper, therefore making some goods more accessible for consumers. Additionally, the possibility of remote driving may open up job opportunities for disabled employees or those with limited mobility.
Timeline	• UK organisations were more conservative on their estimations, predicting up to 40% diffusion of this technology by 2050. German organisations were also conservative, predicting 0 to 10% deployment by 2025, 20 to 35% by 2035 and 50% by 2050. This was mostly due to a perceived lack of infrastructure available to support the rollout of these vehicles.

8.4.5 Delivery drone

Table 160: Delivery drone use case (organisations)

Description	The drone will pick up your package and navigate on its own, delivering it to a specified location within its area of coverage. It operates on-demand, and will transport products, goods, or food items.
Countries tested	Cyprus

Cypriot organisations could see the potential for this use case to decrease the number of large delivery vehicles on the road, and provide benefits associated with that (e.g., reduced congestion and accidents on roads, reduced air pollution, increased space in urban areas). However, they also felt that these benefits might be offset by accidents caused by drone malfunctions in the sky, as well as more noise and visual pollution from an increase in low air traffic.

Further concerns raised were consistent with other use cases tested, namely: environmental harm from EV battery manufacturing; risks to businesses if the technology were to malfunction and/or lose public trust; lack of human support compared to traditional delivery services, potentially excluding vulnerable groups.

Table 161: Delivery drone: results of qualitative assessment (organisations)

Mobility	• Organisations felt that this use case would decrease the number of large delivery vehicles on the road, and their associated trips, thereby reducing congestion and increasing positive perceptions of self-driving vehicles.
Public health	• Organisations felt that delivery drones could reduce the number of traffic-related accidents as a result of fewer large vehicles on the road (see also Safety). They felt the drones had the potential to increase access to goods such as medical supplies, particularly in harder-to-reach areas, leading to positive perceptions of self-driving technology. However, others felt that delivery drones could generate a higher level of noise pollution – as well as causing accidents by colliding with objects and people on the ground – leading to a negative effect on public health and perceptions of self-driving vehicles.
Land use	• Consistent with citizens, organisations felt that decreased road congestion could have a positive effect on the amount of land given over to green space, particularly in urban areas.
Safety	• Organisations shared the perception that the reduced congestion brought about by this use case could lead to fewer accidents on roads. Malfunctioning technology was a central concern due to perceived high levels of distrust from citizens toward self-driving vehicles in Cyprus.
Transport network	• For organisations, reduced road congestion and the efficiency with which goods could be transported would improve public perception of this technology and lead to more significant uptake.
Environment	• This theme was important to organisations. They felt that the reduction of congestion would lead to less air pollution and better air quality. However, the manufacture of batteries to power this technology as well as increased noise pollution were significant concerns that participants felt could offset improvements to air quality.
Economy	• Organisations felt that this technology would lead to job losses for delivery drivers and couriers, though this negative impact would be offset by the new jobs and employment opportunities that would emerge with the new technology. Participants also identified risks to businesses if the technology were to malfunction and lose public trust.

Equity	• Organisations identified the potential for greater delivery coverage for isolated and rural areas, which could have a positive impact on public health, for example if the drones delivered food or medicine. However, they were concerned about the comparative lack of human support compared to traditional delivery services with a driver, potentially excluding people who are less mobile or digitally engaged from using the service.
Timeline	• Organisations felt that penetration rates for this use case would remain low in the short term at around 0-15% by 2026, but would be between 70-100% by 2050, indicating the belief that most small packages will eventually be delivered by drone.

8.5 Conclusions

The potential role and benefits of self-driving vehicles

Overall, organisations had a positive outlook on the use cases and could identify a number of benefits to self-driving vehicles' rollout. They were more likely than citizens to be able to envisage a world in which most transport is self-driving, with benefits to safety and transport network efficiency. They saw a role for self-driving technology across a range of functions and services.

Positive and negative impacts

Organisations were positive about the possibility of self-driving traffic flow being controlled remotely, in order to maximise reliability and transport network efficiency. Facilitating more night-time journeys and deliveries was an example of this. Similarly, in most use cases, organisations felt positive about self-driving vehicles increasing access to transport or goods for people with mobility issues or living in isolated areas. As with citizens, improving access for users with limited digital capability remains a concern.

While more pragmatic and optimistic than citizens, safety is a core concern for organisations. For example, as with citizens' groups, there were concerns around the potential theft of goods from driverless vehicles, dangerous or hazardous cargo being unsupervised, and issues around cybersecurity. However, organisations did not believe that this technology would be introduced if safety was not guaranteed, and they imagined there would be multiple safeguards and regulations in place by point of rollout.

Other concerns raised by organisations were consistent with those raised by citizens, for example:

- Environmental impacts of battery manufacture, and in some cases particulate pollution from tyres and breaks
- Overall congestion not reducing, but instead moving from roads to the pavement or air
- Ability of self-driving vehicles to drive in bad weather, uneven terrains, and areas of poor connectivity
- Affordability of using the technology (and possible inequity here)
- Levels of noise pollution and visual pollution (in the case of drones) increasing

Certainty about impacts

Infrastructure is a key barrier to implementation for organisations, who believe that it is currently not suitable to support rolling out self-driving technology. They believe that significant improvements to infrastructure need to be made to support the rollout of the use cases, and that this would have high associated costs that could ultimately be passed onto users. Should improvements to infrastructure be made, organisations can see the potential for self-driving vehicles to improve reliability of service and increased access.

Organisations are undecided about whether jobs, overall, would be positively or negatively impacted by self-driving vehicles. Consistent with findings from the citizens research, potential job losses for delivery and public transport drivers are frequently raised as a concern. However, this is often mentioned in the same breath as an expectation that more jobs, industries and investment will be created in the rollout of self-driving vehicles. As a whole, organisations did not strongly lean one way or the other here. The need for to give people skills and training was mentioned, but only by a small number of organisations across the countries.

While positive about the use cases overall, organisations from the seven European countries involved feel that there is still a lot of uncertainty which makes it difficult to estimate impact. They felt that the interdependence between the different domains leads to many unknowns. It is not clear to organisations that the benefits will happen necessarily, and it is difficult for participants to know confidently either way. As with citizens, one of the main questions raised by these use cases is: will this technology lead to fewer vehicles on the road? If yes, then there are many perceived benefits which follow, most notably: reduced road congestion; fewer road accidents; reduced air pollution; increased space in urban areas. But these benefits are not considered a given.

9. Demonstration of self-driving vehicles - organisations

9.1 Overview

A demonstration of a self-driving mini-bus was organised in Katowice, Poland, involving 20 representatives of organisations related to transport planning and provision. The demonstration had four objectives:

- To capture participants' feelings and opinions about self-driving vehicles after using one
- To assess whether using a self-driving mini-bus changes opinions, compared with those expressed before the event
- To assess how participants compare self-driving and human-driven buses
- To assess whether results differ from the ones obtained in a demonstration with citizens (described in Chapter 3 of this report).

The demonstration in Poland provides a good opportunity to gather additional data, by proving participants with the same questionnaire used in the Move2CCAM demonstration involving citizens (in the Netherlands). This can provide insights on how organisations perceive the possible impact of those vehicles on their activities and on the lives of citizens in their regions.

The demonstration had a small group of participants. As such, the analysis of this chapter is descriptive. Unlike in the case of the demonstration in the Netherlands, we do not analyse how intentions are related to opinions about the vehicles or how both relate to the participant characteristics.

Where possible, we compare the results of the demonstration with organisations in Poland, which featured a self-driving mini-bus, with those of the demonstration of the mini-shuttle in the Netherlands (the vehicle most similar to the one used in Poland). The comparisons have the caveat of being based on small samples (especially the one in Poland) and that the demonstrations took place in different countries and in different times of year (winter in Netherlands, summer in Poland).

The rest of this chapter is organised as follows

- Section 9.2 describes the **methods** used to organise the demonstration and in data collection and analysis, including ethics considerations.
- Section 9.3 describe the **characteristics** of the organisations and their opinions **before the demonstration**
- Section 9.4 describe the organisations opinions and intentions **after the demonstration**
- Section 9.5 synthesises the key **conclusions** of the demonstration

9.2 Methods

9.2.1 Design of the demonstration and participant recruitment

The event was organised by Metropolis GZM on 6 June 2024. Participants were recruited from GZM's contacts among organisations related to the transport sector. 20 participants joined the event. The event had other participants (joining as citizens, rather than organisation representatives). This chapter reports only the results for participants representing organisations.

The demonstration featured a self-driving mini-bus sourced from BLEES, a Polish-based vehicle developer (Table 162). The journey was on public roads, used by other vehicles. Safety measures were in place. A safety driver was in the bus, ready to take over the vehicle in case of an emergency. The route was about 3.5 km long. The average speed of the bus was 24km/hour. A dummy representing a pedestrian was placed on the vehicle path to show participants how the vehicle handled this situation. Figure 231 shows various aspects of the demonstration.

Table 162. Vehicle used in the demonstration in Poland - specifications

	Bus
	
Name	Blees mini-bus
Type	Electric mini-bus
Size	Small (unknown specifications)
Seats	15 seats
Web	https://blees.co/en/vehicle

Figure 231. Aspects of the demonstration in Poland

9.2.2 Pre-event questionnaire

Participants answered a questionnaire before the event. This was done online, through the Qualtrics platform. The questionnaire was in Polish. Appendix 9 contains the English version of this questionnaire. It includes questions about organisation type (from a list of 12 types of organisations), geographical coverage, and opinions regarding self-driving vehicles, including:

- Awareness of these vehicles
- General view about them (positive, negative, or uncertain)
- Three main concerns
- Perceived likelihood that specific groups would benefit from these vehicles: individuals who cannot drive because of age or disability, those who do not want to drive or do not have a driving licence, high and low income groups, tourists, companies delivering goods, and consumers receiving those goods.
- The three most influential actors in the deployment of self-driving vehicles, from the same list of 12 types of organisations shown before.

9.2.3 Post-event questionnaire

Participants answered a questionnaire where they expressed their views after the demonstration. The questionnaire was filled in Polish in a paper format.

This questionnaire was identical to the self-driving bus section of the one used in the demonstration with citizens in the Netherlands, probing about participants' feelings, what they liked and disliked about the vehicle, how safe they felt, how self-driving mini-buses will compare human driven ones, concerns, and intention to use them. At the end there was also a question on whether participants would buy a vehicle not featured in the demonstration: a self-driving car. See Section 3.2.4 and Appendix 4 for more details on this questionnaire.

9.2.4 Ethics

Safety measures were in place. Participants were provided with an information sheet with details about the event, use of personal data, capture of photos and video recordings of the event, reporting, and other ethics-related information. They then filled a consent form, prior to joining the event. The information sheet and consent form were included as appendices in a previous report of this project (Deliverable 3.3., Appendix 19).

The pre- and post-event questionnaires did not capture any information that could identify individuals. Participants were identified through an ID number. The data was analysed by University College London, which did not have access to the file matching ID numbers with participant contact details. Only the event organiser (GZM) had access to this file.

9.3 Organisation characteristics and prior opinions

Figure 232 shows the characteristics of the organisations. There was a mix of authorities and public transport operators, with a regional or city reach.

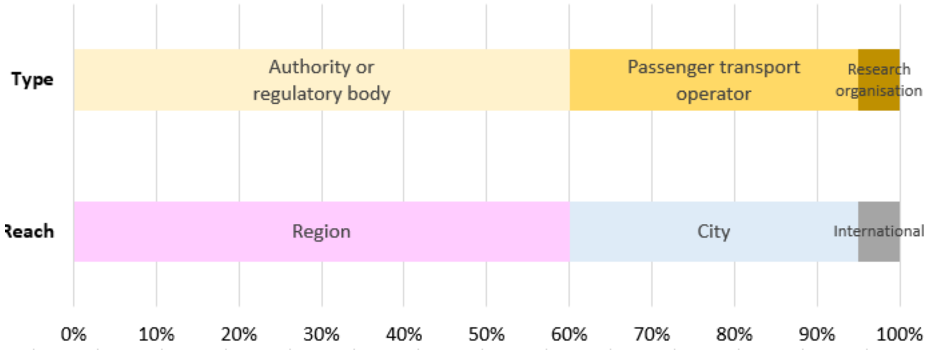


Figure 232. Demonstration of self-driving vehicles – organisation characteristics

Participants stated their levels of awareness of self-driving vehicles in pre-event questionnaire. Almost all participants said they were aware of these vehicles and have been following developments (Figure 233). In the post-event questionnaire, participants stated whether they had previous experience involving fully self-driving vehicles. Half of them had experienced some type of self-driving vehicles. Most participants have a (somewhat or extremely) positive view of these vehicles.

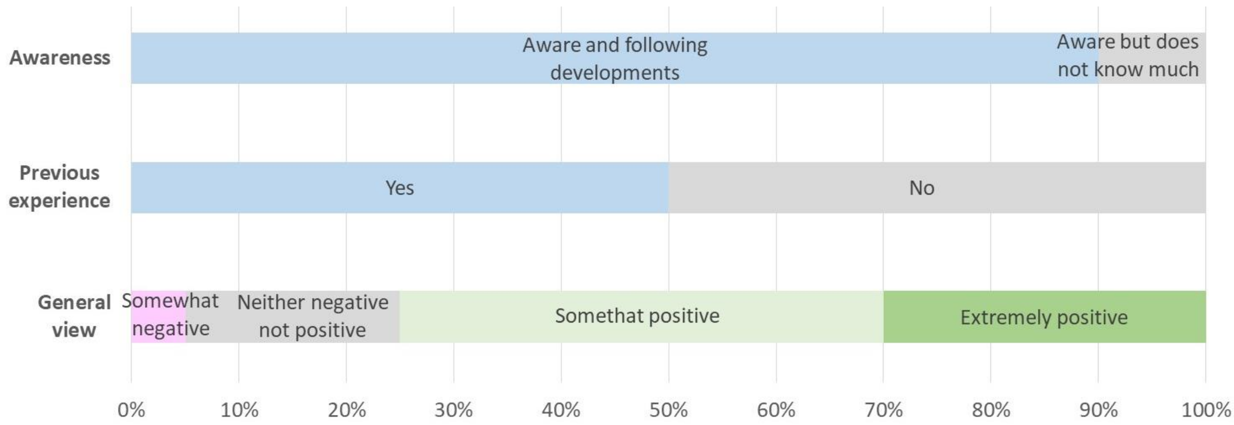
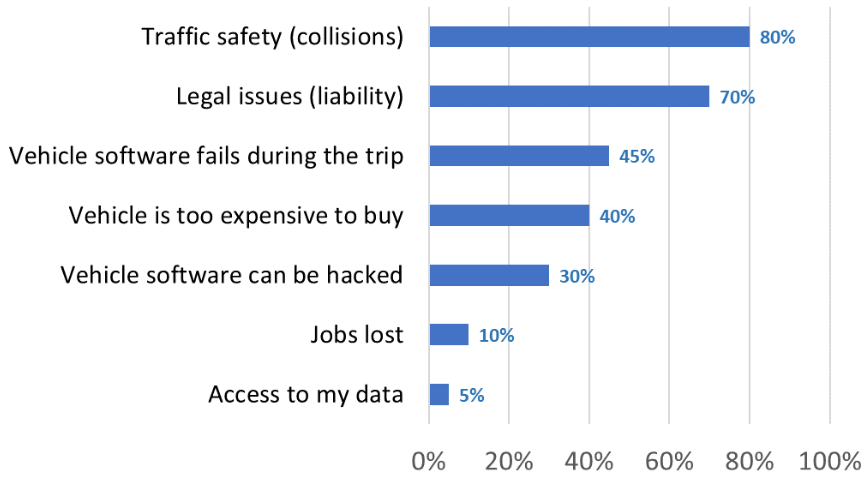


Figure 233. Prior awareness, experience, and views about self-driving vehicles

Organisations in Poland ranked concerns in almost the same order as citizens did in the Netherlands (compare Figure 234 below with Figure 28 in Chapter 3). Traffic safety was the number one concern, followed by legal issues, technology failure, and cost.



Note: participants could indicate up to three concerns

Figure 234. Prior concerns of organisation about self-driving vehicles

Figure 235 shows the organisations' opinions about the likelihood of different groups benefiting from self-driving vehicles. The proportions saying that a group is likely or extremely likely to benefit range from 15% (tourists) to 35% (individuals with low income and customers receiving goods). Participants had roughly similar opinions about the benefits for older or disabled people and for those who do not have a driving licence, and about the benefits for companies sending goods and for customers receiving them. In general, low-income groups were thought to benefit more than high-income ones. Tourists are the groups less likely to benefit (for reference, Katowice is not one of the main tourist spots in Poland).

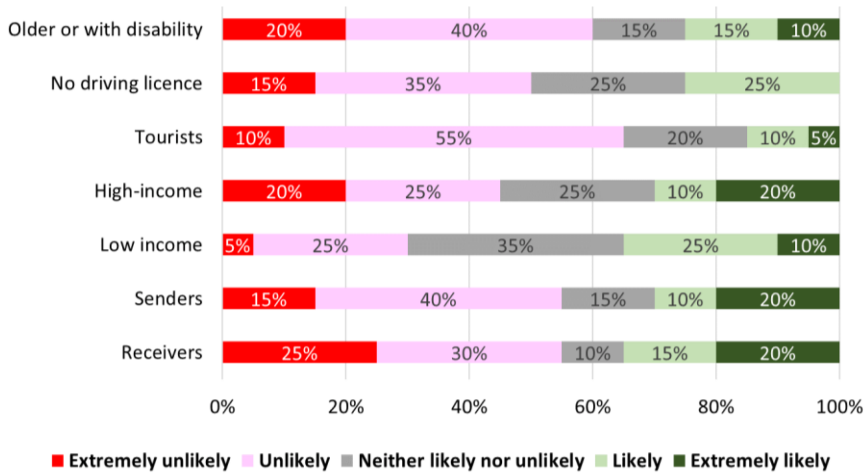
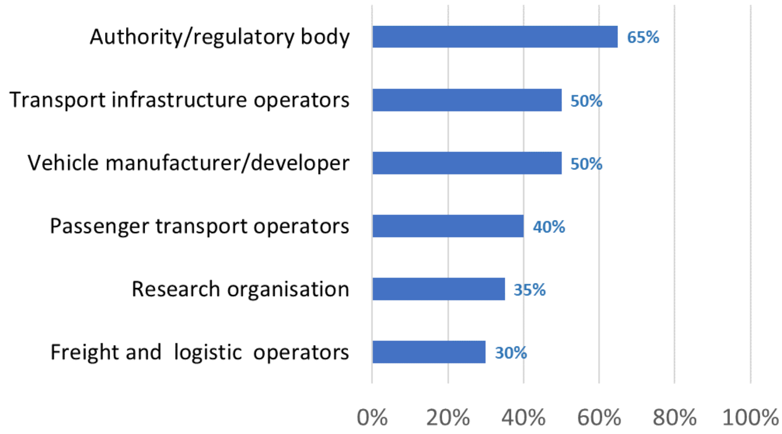


Figure 235. Perceptions about benefits of self-driving vehicles

Figure 236 shows who participants perceive to be the most influential actors in the deployment of self-driving vehicles. The chart shows only organisation types mentioned by at least five (i.e. 25%) of participants. Authorities and regulatory bodies were seen by 65% as the most influential type of organisation. This is a similar proportion as the one that this type of organisations represents in the sample (60%). Other influential actors are transport infrastructure operators (50%), vehicle manufacturers/developers (50%) and passenger operators (40%, which compares with a proportion of 35% that they represent in the sample).



Note: participants could indicate more than one actor

Figure 236. Perceived most influential actors in deployment of self-driving vehicles

9.4 Opinions after the event

This section reports all the results of the post-event questionnaire, including aspects participants liked and disliked (sub-section 9.4.1), feelings (9.4.2), safety perceptions (9.4.3), comparison between self-driving and human-driven vehicles (9.4.4), main concerns (9.4.5), and intentions (9.4.6).

9.4.1 Aspects participants liked and disliked

Participants were asked open ended questions about the three aspects they liked and disliked about the vehicle. We coded all the answers. Answers stating that participants did not have anything to report (e.g. "nothing", or "I liked everything" when the question was about "dislikes") were removed from further analysis. The table below shows the number of valid responses across the sample, after excluding those mentioned above. Participants provided an almost complete set of "likes" and "dislikes" (2.6 and 2.4 per person, out of a maximum of 3). These numbers are higher than in the demonstration with citizens.

Table 163. Aspects participants liked and disliked about self-driving vehicles: responses

Like		Dislike	
Responses	**Responses per participant**	**Responses**	**Responses per participant**
51	2.6	48	2.4

Notes: Each participant could indicate up to three aspects. Table shows valid responses only

Figure 237 shows the aspects mentioned by at least two participants (i.e., by at least 10% of the sample). The main aspect that organisations liked was the innovative character of the vehicle. This was mentioned by 60% of the sample, a number much higher than the one obtained in the demonstration with citizens in the Netherlands (9%) - compare with Figure 17 in Section 3.4.1.

Organisations mentioned a variety of other aspects that they liked (the figure below accounts for only 59% of the comments). Some aspects mentioned were in common with citizens in the Netherlands, such as comfort, quiet, response to events, and safety. However, safety was mentioned only by 15% of organisations, comparing with 34% of citizens.

The major "dislikes" were lack or poor air conditioning (the demonstration was on a warm day) and the low speed of the vehicle. Other dislikes were lack of enough space (this had been the major dislike for citizens in the Netherlands) and lack of handles inside the bus which passengers could grab.

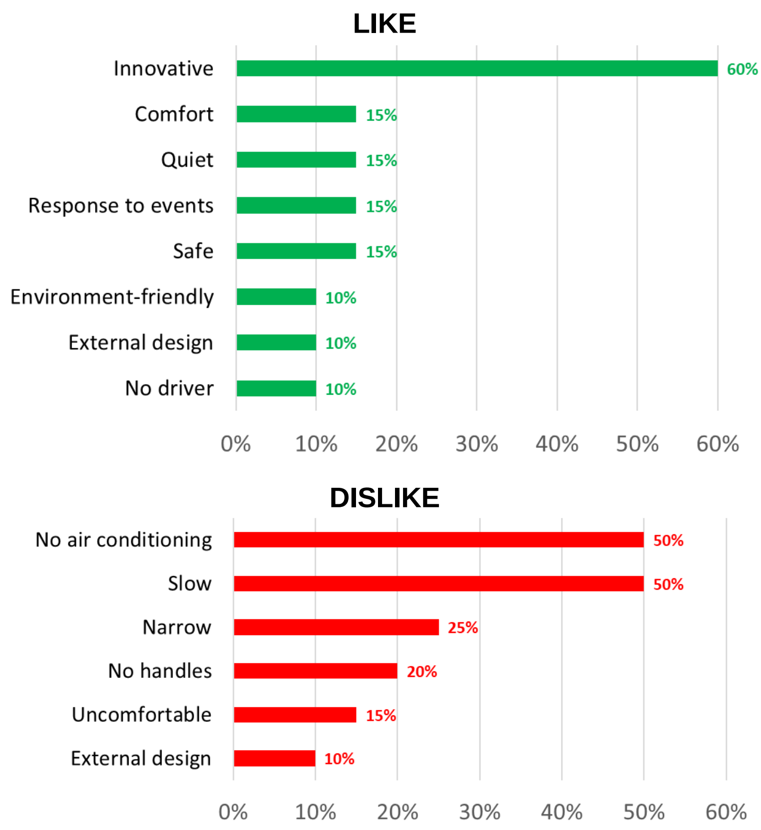


Figure 237. Self-driving mini-bus: main aspects participants liked and disliked

9.4.2 Feelings

Figure 238 shows the feelings that organisations reported regarding their experience while riding the self-driving bus. For comparison, the chart also shows the feelings that citizens reported about the mini-shuttle in the Netherlands. The feelings are sorted in descending order of their frequency among the whole sample in the demonstration with organisations in Poland. The four most common feelings were “alert”, “active”, “safe”, and “content”, mentioned by 30% or more of participants. However, 30% (i.e. 6 participants) also reported feeling bored. Other negative feelings were mentioned by only one or two participants (i.e. 5 or 10% of the sample).

Overall, the results point to a positive experience, although organisations did not show the same enthusiasm as citizens did, with considerably smaller proportions reporting feeling safe, content, in control, and motivated. In contrast, organisations felt more alert and active than citizens, but also more bored.

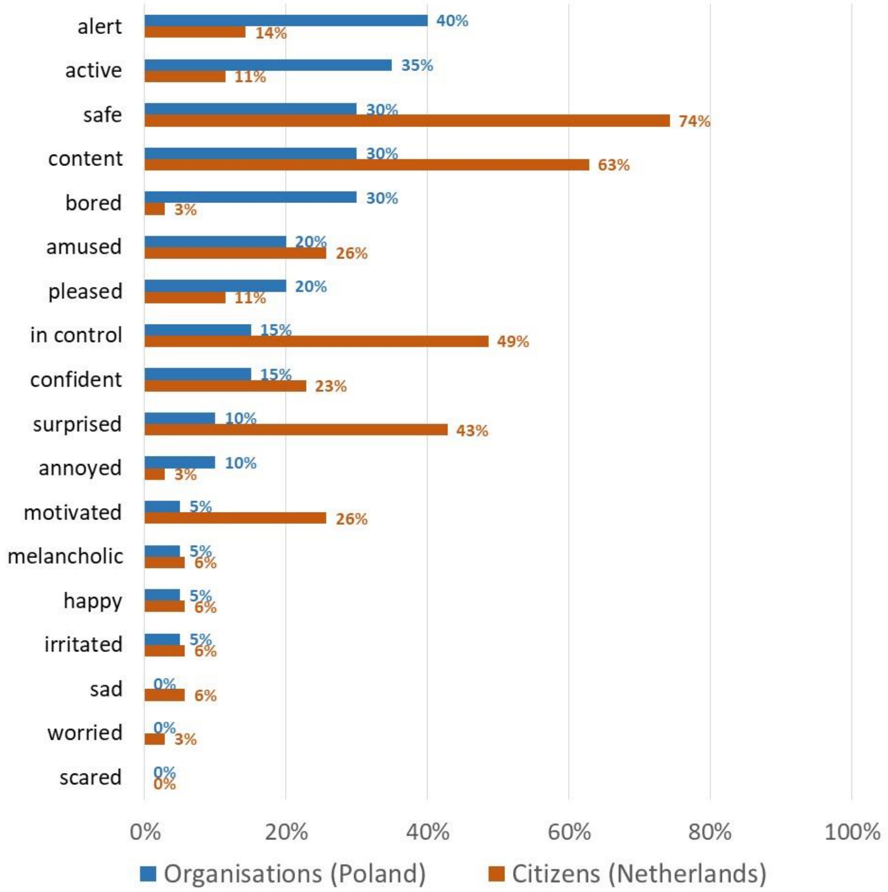


Figure 238. Feelings while riding in the self-driving mini-bus/shuttle

9.4.3 Safety perceptions

The results on safety perceptions are positive, in all situations (Figure 239). The proportions of participants reporting feeling safe or very safe range between 60% and 80%, depending on the situation (Figure 239) – these are numbers below the ones obtained in the demonstration with citizens. Only one participant reported feeling unsafe in some situations and none reported feeling very unsafe.

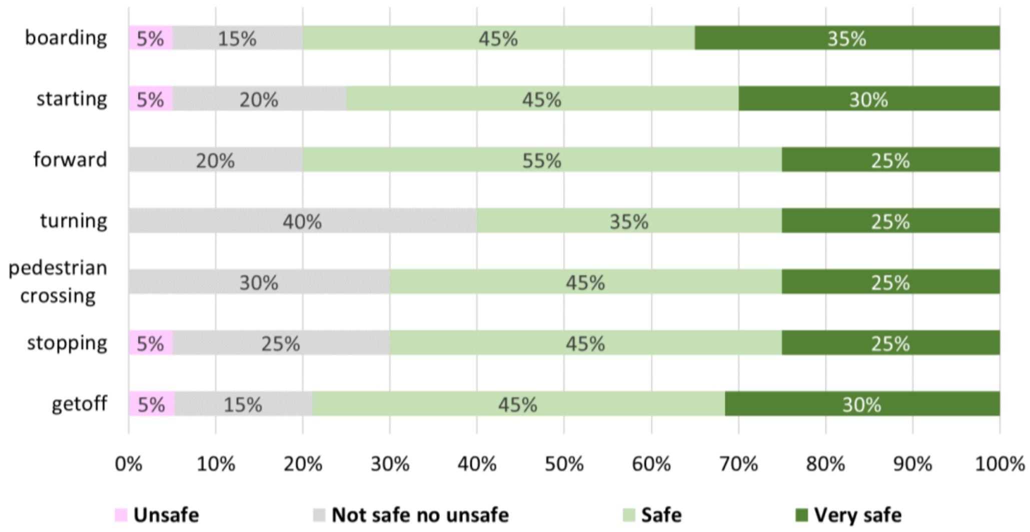


Figure 239. Safety perceptions (mini-bus)

The mini-bus was also generally perceived to be safe from the perspective of pedestrians and cyclists (Figure 240), although safety perceptions were slightly less positive as the ones from the perspective of the mini-bus users, as reported above. The proportions of participants reporting that it will be safe or very safe for pedestrians and cyclists to use streets used by self-driving vehicles were 65% and 45%, respectively. No participants reported any perception of unsafety.

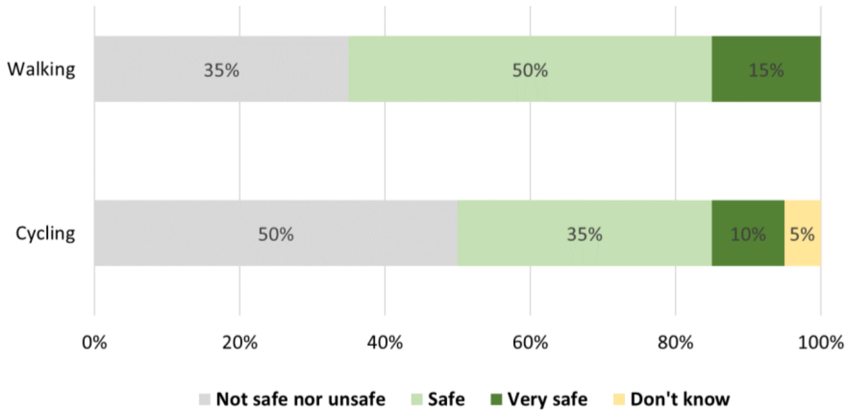


Figure 240. Safety of walking and cycling in streets used by self-driving mini-buses

9.4.4 Assessment of self-driving vs. human-driven mini-buses

Figure 241 shows how participants compared self-driving mini-buses to human-driven ones. On average, self-driven ones are judged to be slower, more stressful, and more insecure (in terms of crime) than human-driven ones. No participants thought self-driving mini-buses will be faster.

The sample was equally or almost equally divided when it comes to which vehicle is more interesting, cheaper, more comfortable, or more dangerous in terms of accidents.

Overall, the assessment is less optimistic than the one that citizens made in the demonstration in the Netherlands, where they thought self-driving mini-shuttles will be more interesting, cheaper, less stressful, and more comfortable.

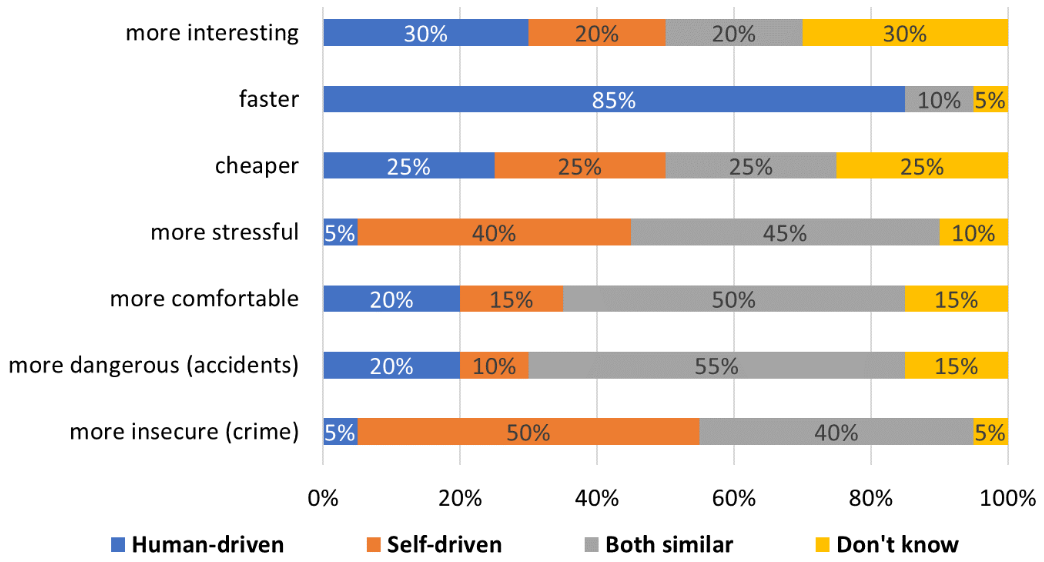


Figure 241. Assessment of self-driving vs. human-driven mini-bus

9.4.5 Main concerns

Participants were asked to state their three main concerns about using the self-driving mini-bus. We then coded all the answers. Answers stating that they did not have anything to report (e.g. "nothing") were removed from further analysis. There were 49 valid responses across the sample (2.5 per person). Figure 242 shows the concerns mentioned by at least two participants (i.e., by at least 10% of the sample). The main concerns are safety, crime and anti-social behaviour from other passengers, and what happens in unexpected emergency situations. These were concerns also mentioned by citizens in the demonstration in the Netherlands. However, safety was mentioned by more organisations (40%) than citizens (14% - see Figure 26 in Section 3.4.5). Cost was mentioned by 25% of organisations in Poland but was not mentioned by any citizen in the Netherlands.

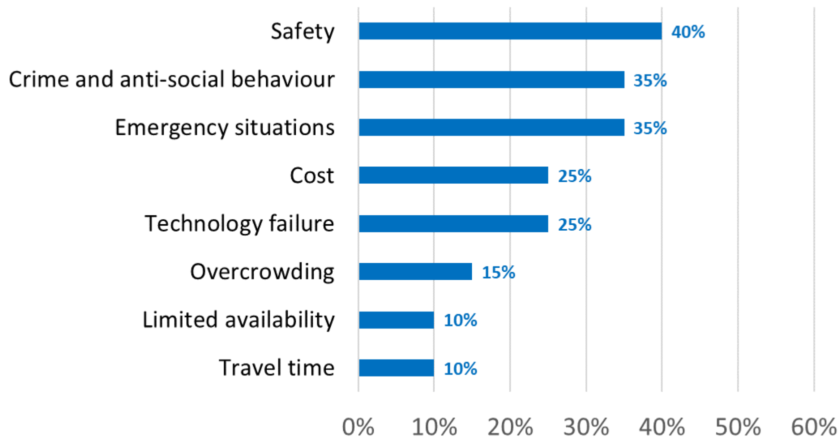


Figure 242. Main concerns about the self-driving mini-bus, after experiencing it

A rough comparison is possible between the results above, which capture the concerns that participants expressed after the demonstration, and the concerns they had previously expressed in the pre-event questionnaire, as shown previously in Figure 234.

The results after the event are consistent with the ones before the event, as traffic safety had also been ranked as the number one concern. Legal issues were ranked number two before the event but were only mentioned by one participant after the event. This could be because the question in the pre-event questionnaire was about self-driving vehicles in general and participants were thinking in terms of liability for private car owners, and not for mini-bus operators.

Cost and technology failures were in the rank of the main concerns after the event. They had also been mentioned by a considerable proportion of participants (40%) before the event.

The second main concern expressed after the event (i.e. security issues related to crime and anti-social behaviour or stolen goods) had not been mentioned by any participant in the open ended box of the pre-event questionnaire.

9.4.6 Intention to use

Finally, participants were asked if they would use the vehicle they experienced (self-driving mini-bus) and one that they did not experience (self-driving car) (Figure 243). The intentions regarding the mini-bus are overwhelmingly positive: 18 of the 20 participants (90%) intends to use it. The intentions regarding buying a car are mainly negative: half of the sample do not intend to buy one. Only 15% (i.e., three participants) said they intend to buy one.

The intentions regarding using the mini-bus are positive and the ones regarding buying the car are more negative than the ones that citizens expressed in the Netherlands.

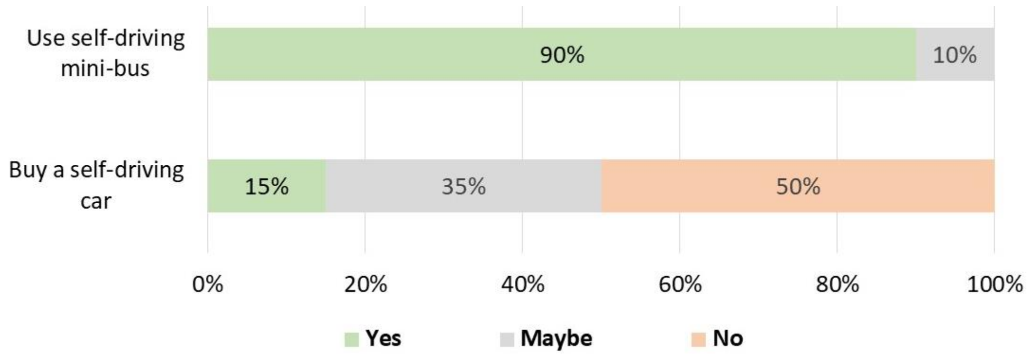


Figure 243. Intention to use or buy self-driving vehicles

9.5 Conclusions

This section collects the key conclusions from the demonstration of the mini-bus in Katowice, an event joined by organisations related to the transport sector (authorities/regulatory bodies and passenger transport operators). Participants had a good level of prior awareness of self-driving vehicles and experience using them. Prior opinions about self-driving vehicles were mainly positive, but there was concern about safety. The conclusions that follow are organised of terms of the four objectives stated in the introduction to the chapter.

9.5.1 Feelings and opinions about self-driving vehicles after using them

Table 164 maps the key results of the demonstration onto the nine Move2CCAM impact dimensions.

Table 164. Conclusions of demonstration: feelings and opinions

Mobility	• The mini-bus was perceived as an innovative method to enhance mobility. • The vehicle was perceived as slow • Mixed opinions on whether the vehicle is more comfortable or cheaper to use than a human-driven one.
Transport network	• Almost no participant expressed opinions about impacts on congestion or other transport network indicators
Land use	• Almost no participant expressed opinions about impacts on land use
Environment	• Only a few participants mentioned that the vehicle is quiet and environmentally-friendly
Economy	• Almost no participant expressed opinions about economic aspects
Equity	• Almost no participant expressed opinions about equity aspects
Public health	• Tendency to think that self-driving vehicles will increase stress
Safety	• The majority thought that the vehicle was safe, in terms of traffic collisions, in all situations, both for vehicle users and for other road users (pedestrians and cyclists) • Some concern about what can happen in emergency situations
Security	• Concern about crime and anti-social behaviour

9.5.2 Change in concerns

Table 165 shows how participants' concerns compared before and after the event.

Table 165. Conclusions of demonstration: change in concerns

Concerns	• Safety remained the most important concern • Cost and technology failures remain main concerns • Crime and anti-social behaviour emerged as a main concern after the demonstration • Legal issues were a major prior concern but were hardly mentioned after the demonstration

9.5.3 Comparison between self-driving and human-driven vehicles

On average, organisations thought self-driving mini-buses are worse than human-driven ones with regards to speed, stress, and security (in terms of crime), as shown in Table 166. It should be noted that the table does not imply that all participants have the opinions shown, but only that more participants have these opinions than those who have opposite ones. Cases where the majority of the sample has the opinion shown are marked with asterisk.

There were mixed opinions in whether which type of vehicles is more interesting, cheaper, more comfortable and safer (in terms of accidents).

Table 166. Conclusions of demonstration: comparison with human-driven vehicles

	Self-driving vehicles	Human-driven vehicles
Positive	None	• Faster* • Less stressful • More secure (crime)*
Negative	• Slower* • More stressful • More dangerous (crime) *	None

Note: *: opinion held by more than 50% of participants

9.5.4 Final remarks

This chapter showed that organisations tend to think that self-driving mini-buses are safe both for their users and for other road users, although not necessarily safer than human-driven ones. Safety remains a concern after the demonstration. Organisations also think that self-driving mini-buses are worse than human-driven vehicles in other aspects, especially speed and security in terms of crime. There is also some concern about cost.

Despite these concerns, organisations expressed an overwhelmingly positive intention to use the self-driving mini-bus in the future.

10. Case studies of organisations

10.1 Overview

Detailed case studies were conducted with 11 organisations, covering various sectors and countries. The aim was to examine the impact that self-driving vehicles may have on the operations and other aspects of the organisations' work. Detailed case studies can produce insights on the motivations and concerns of organisations at a level of detail that cannot be collected in workshops with several participants, such as the ones described in the previous chapter.

The objectives of the case studies were to understand:

- The perceptions and intentions of organisations about self-driving vehicles
- Their needs in relation to using these vehicles
- The potential impacts of the vehicles on the organisation
- The view of the organisation on broader impacts affecting their region

We aimed to select a diversity of organisations, to capture different perspectives, as these are likely to depend on the size, sector, and other characteristics of the organisations.

Project partners in seven countries (United Kingdom, Germany, Netherlands, Poland, Spain, Greece, and Cyprus) interviewed representatives of the organisations, using a semi-structured approach. The interviews were conducted online in March and April 2024 and had a duration of 30 to 60 minutes.

Information from the interviews was complemented with the review of public documents released by the organisations, available from their websites.

The rest of this chapter is organised as follows

- Section 10.2 describes the **methods** used to conduct the interviews and analyse the resulting data
- Section 10.3 is a collection of **information sheets** for each organisation, with standardised information about the characteristics of the organisations and their perceptions, intentions, needs, and perceived impacts related to self-driving vehicles
- Section 10.4 triangulates the results of all interviews to derive insights on the **impacts** of self-driving vehicles on several aspects of the **organisation**'s performance
- Section 10.5 triangulates the results of all interviews to derive insights on the **wider impacts** of self-driving vehicles on **regions**
- Section 10.6 synthesizes the key **conclusions** of this chapter

10.2 Methods

10.2.1 Participant selection

The organisations were selected from the ones that have participated in previous activities of the Move2CCAM project. The target was to study 10 organisations. The selection criteria were:

- At least one organisation from each of the seven countries mentioned above
- At least one organisation in the following broad groups: passenger transport providers, non-passenger transport providers (including freight), large organisations using transport, and the self-driving vehicle industry (vehicle or software developers).

Each partner in the seven countries suggested two organisations – a total of 14 organisations. Eleven organisations were selected from this list in order to fulfil the criteria mentioned above.

Table 167 lists the organisations, their broad group, and sector. Two organisations could fit into more than one sector. Organisation D is a transport authority but provided information mostly from the point of view of the bus transport operators it oversees. Organisation H is a local government but provided information mostly from the point of view of a large organisation using passenger and freight transport. However, both organisations also provided information about their work as regulators.

The interviewees differed in the amount of information they produced, as seen by the size of the transcripts. Overall, the interviews produced a dataset with 42,754 words.

Table 167: Case study organisations

	Broad group	Sector	Transcript size (words)	Use case discussed
A	Passenger transport provider	Bus services	1819	Bus
B			4729	Bus
C			2317	Bus
D			5049	Bus
E	Non-passenger transport service provider	Freight transport services	1440	Truck
F		Medical product deliveries	6123	Drone
G		Waste collection	6346	Waste collection vehicle
H	Large organisation using transport	Local government	1907	Bus, drone
I		Educational institution	1234	Bus, van
J	Self-driving vehicle industry	Vehicle developer	7713	Bus
K		Software developer	4077	None

10.2.2 Interview topic guides

Interviews were conducted in the local language. A semi-structured interview format was used, following a topic guide (shared with interviewees in advance), but allowing for flexibility. Topic guides were customised for each of the eleven interviews, although the topic guides of the four passenger transport providers were broadly similar. The English versions of all topic guides are included in Appendix 10 of this report.

Where relevant for the organisation's sector, some parts of the interview focused on specific use cases, selected from those co-created by citizens and organisations in previous activities of the Move2CCAM project:

- The interviews with passenger transport providers (organisations A-D) and with the self-driving bus developer (H) focused on self-driving buses.
- The interview with the freight transport provider (E) asked the interviewee to choose one of three freight transport use cases: self-driving vans or trucks; delivery robots; and delivery drones. The interviewee chose the self-driving truck.
- The company delivering medical products (F) is already an example of a use case od self-driving vehicles, as it uses drones.

- The discussion with the waste collection company (G) focused on the replacement of current vehicles used for waste collection with self-driving vehicles.
- The interviews with the local government and educational institutions (H-I) asked the interviewees to choose one of two passenger transport use cases (self-driving bus or self-driving car) and one of two three freight transport use cases (self-driving van, delivery robot, or delivery drone). They both chose the self-driving bus as the passenger use case. H chose the van, and I chose the drone as freight use case.
- The discussion with the organisation involved in the development of software for self-driving vehicles (K) was not specific to any use case.

Each interviewee was told when citizens and organisations in their region expect that self-driving vehicles will be deployed. This information comes from the results of the workshops described in Chapters 2 and 8 of this report.

While the topic guides differed for all eleven organisations, the topics listed below were covered across all interviews, although with different variants and levels of detail

The interviews started with questions about the organisation and their current situation with regards to transport, including:

- **General characteristics**: sector, type of products/services offered, details about the service, business model
- **Workforce**: number of employees and jobs they perform
- **Current activity**: vehicle ownership and challenges faced in providing or using transport

The main part of the interviews introduced the topic of self-driving vehicles and asked about:

- **Perceptions**: general perceptions, and aspects of the vehicles that are attractive or unattractive to the organisation
- **Intentions**: Possible replacement of vehicle fleet with self-driving vehicles. If no: incentives needed. If yes: timing, intended use of the vehicle, possible shared ownership
- **General impact**: aspects of the organisation's operations that would be affected, opportunities and difficulties foreseen
- **Business model**: possible changes, offer of new products/services and/or stop offering others, possibility of expanding/narrowing the area covered.
- **Operational aspects**: If the organisation transports paying passengers: possible change in operation days/times. If organisation transports goods: possible change in number of trips and size of vehicles used. Other questions: possible improvement in problems of parking vehicles, picking up/dropping off passengers, loading/unloading goods, and other operational activities.

A series of questions followed about wider impacts, using the Move2CCAM impact dimensions used throughout the project and reported in previous chapters. Some questions were specific to the organisation's activities, others to the regions where they are based:

- **Mobility**: if it will be easier or more difficult to transport goods, passengers, and employees; if transport will be faster or slower, more or less reliable, if number of trips and transport users will increase or decrease
- **Transport network**: [asked only to authorities] changes in regulations on traffic management and control, road design, and vehicle parking, monitoring and enforcement of regulations, change in planning strategies
- **Land use**: possible relocation of some of the organisation sites
- **Environment**: would there be more or less pollution in the region

- **Economy (employment impacts)**: job security and possible new roles for drivers and other jobs, training or reskilling needed, new jobs that the organisation could offer
- **Economy (other impacts)**: would revenue increase or decrease; would transport and other costs increase or decrease
- **Equity**: if it will be easier or more difficult to have a gender-balanced workforce or to employ individuals with disabilities; if more entry-level job positions will be offered; if it will be easier or more difficult for younger/older employees to be productive and motivated
- **Public Health**: stress, other health impacts
- **Safety**: if transport will be safer or more dangerous (in terms of accidents)
- **Security**: if transport will be more or less secure (in terms of stolen goods or cyber attacks), other possible security aspects

Participants were then asked to think whether, from a society's point of view, self-driving vehicles will have a general positive or negative impact in their region.

Finally, participants were asked if there was anything about self-driving vehicles that had not been covered yet in the interview and they would like to comment on.

The interviews with organisation F, who is already using self-driving vehicles, and with organisations J and K, who are developing these vehicles had more specific questions related to their activities - see Appendix 10. These include questions about funding, partnerships, market potential, cost, regulatory barriers, risks, intellectual property, operational details, and safety measures applied to their products.

10.2.3 Ethics

The study received ethical approval from the Bartlett School of Environment, Energy and Resources at University College of London (ID: 20231120_EI_ST_ETH_ Move2CCAM).

Interviewees were provided with an information sheet and an informed consent form, which they filled before the interview started. The information sheet contained details about the contents of the interview, collection and use of data, and other ethics-related information. Participants gave they consent by confirming (by ticking a box) that they understood what the research involves and what was expected of them. The information sheet and consent form were included as appendices in a previous report of this project (Deliverable 3.3., Appendix 19).

To preserve anonymity, the individuals interviewed and the organisations they represent are not identified in this report. The country is also not identified, as it would be possible to identify some of the organisations by combining information about their sector and the region where the project partner is based in the country. Organisations are identified in the report only by letters (A-K). Interviewees were informed in the information sheet and before starting the interview that their information would be anonymised in this way.

A transcript was automatically produced by the online platform used (Microsoft Teams). The names of the interviewees were removed from the transcript by project partners. The institution analysing the data (University College London) had no access to the interviewee's names, only to the organisation they represent, and the job they hold in that organisation. No audio or video recordings were produced. The transcripts will be safely deleted after the project ends.

10.2.4 Analysis methods

The interview transcripts were cleaned by project partners and then translated into English. University College London then analysed the information in these cleaned transcripts, and complemented it with information publicly available, from the organisations' websites.

Three types of analysis were performed

- Classification of the information provided by each organisation into standardized categories: organisation characteristics, current situation with regards to transport, perceptions of self-driving vehicles, intentions, needs, and impacts. This classification is presented in the case study information sheets in Section 10.3
- A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis for each organisation, also included in the information sheets in Section 10.3
- Classification of impacts of each use case on the organisation, using standardized information for impacts on business models, and financial, operational, employment, regulatory, and safety aspects
- Classification of wider impacts on regions, using standardized information for the nine impact dimensions (mobility, transport network, land use, environment, economy, equity, public health, and security

10.3 Case study information sheets

This section presents all eleven case study information sheets, with standardized information extracted from the interviews. This was complemented with information from the organisation's websites (mostly to add detail on organisation characteristics).

The case studies in this section are presented without comments, as we believe they are self-explanatory. However, the SWOT analyses at the end of each case study synthesize the information. In addition, in the next two sections, we triangulate the information from all case studies and analyse the results, providing an overall assessment of how organisations will be affected by self-driving vehicles.

10.3.1 Organisation A – Passenger transport

Table 168: Organisation A - information sheet

Organisation characteristics
• Large group consisting of several companies, each serving a different region in a European country • Hierarchical structure: one central division, regional divisions, and sub-divisions • Alignment of strategies across the structure when it comes to innovation (such as self-driving vehicles) • Provider of bus services across a country, mostly in rural areas, but also some intercity services • Two business models: contractor and subcontractor • Apart from bus services, also developed a Mobility as a Service application combining their services with other transport options in the areas served
Current situation with regards to transport
• Difficult to recruit bus drivers • Has participated in research projects on digitalisation and automation of transport provision • Currently has two self-driving shuttle buses and is involved in trails of another 30-40 in the next three years. Safety drivers have been on board
Use case discussed in interview
Self-driving bus
Perceptions
• Self-driving buses have large potential • It is not certain that solutions involving self-driving buses will work • Procuring and operating self-driving buses is costly • The technology does not always operate without failure, and it needs to be developed further • Human assistants (safety drivers) will always be needed (further increasing costs) • Self-driving transport services need to be integrated with other modes; they should not be the only mode available • Passengers will be worried with being recorded while on-board
Intentions
• Engaged in a project to have 15 self-driving mini-buses and shuttles running in one region by 2028. These vehicles will be at Level 4 of automation (human override is still possible) • Some of the bus providers in the group will be early adopters, others will follow • The organisation has run an on-demand service for trips to healthcare facilities • It will take a long time to replace the larger buses with self-driving ones
Needs
• The organisation cannot invest their own funds in the adaptation for self-driving vehicles, it is too risky • Adaptation requires funding and involvement in research projects in order to best test and deploy these vehicles and reduce costs for the users • Also requires collaborations with vehicle developers so that vehicles meet the organisation's needs • Need for inter-modality. Self-driving bus services need to be integrated with train services • Users need to gain awareness and then trust in the technology • Concern about how people with disabilities will get on and off the bus and transport wheelchairs. This has currently been facilitated by a safety driver, but it will be difficult in a fully-automated scenario. Solutions include sensors and cameras to detect wheelchair users and automated audio messages advising passengers using them • Needs cooperation with regulators. Regulatory challenges were faced when providing services with self-driving buses. The provision of barrier-free entrances to the vehicles (e.g. ramps) was restricted by regulations on the minimum distance between bus and pedestrian pavement and height of pavement. • Need to reskill and motivate employees to adapt to the transformation. 90% of current employees have not experienced the self-driving vehicles that the organisation already owns

Impacts
• Services will be more efficient if the organisation could use on-demand self-driving mini-shuttles • Running buses will also be more environmentally friendly • Cost reduction or revenue increase will only be possible when the technology is further developed • It will still be difficult to recruit staff, even though the technology will solve some of the current problems recruiting drivers • New jobs will be needed, and training required: on-board safety drivers or human assistants, technical supervisors in control centres • Self-driving vehicles will not contribute to the growth of the organisation and expansion of the markets served, as there is already too much competition • But it is possible to strengthen position in the markets already served, by offering additional services at lower prices • There is a clear societal impact: bus users will have better access to local centres

Table 169: Organisation A - SWOT analysis

Strengths	**Weaknesses**
• Large company • Already has some self-driving vehicles • Participated in research projects	• Complex structure (divisions and sub-divisions) • Dependent on public funds for innovation • Difficult to recruit drivers
Opportunities	**Threats**
• Provide additional services such as on-demand services • Gain competitive position	• Thinks the bus sector in the country is in general not much receptive to innovation • Self-driving vehicles are costly and unreliable • Users may not be willing to use self-driving services • Problems in the service provided for some market segments, e.g., people with disabilities • Regulatory challenges • Difficult to motivate staff

10.3.2 Organisation B – Passenger transport

Table 170: Organisation B - information sheet

Organisation characteristics
• Large organisation providing mainly bus transport services but also services for other modes (rail, underground, tram, water transport, micromobility) • Provides bus services at all levels: urban, interurban, regional, national, and international • More than 15,000 employees • Operates in four countries • Links with other transport companies in several other countries, with same owners • Business model (in provision of bus services): bus ticket revenue
Current situation with regards to transport
• Owns more than 600 buses • More than 500 million passengers a year • A current challenge is how to reduce the environmental impacts of bus services • Already owns two self-driving buses, one of them operating in a public road. Both will connect specific locations (business/university campus) with more central locations.
Use case discussed in interview
Self-driving bus
Perceptions
• Automation can contribute to safer, more efficient, and more comfortable transport • Self-driving vehicles are costly • Technology needs to be further developed, especially when it comes to vehicle performance in long-distance trips • Lack of regulatory standards are a challenge • Human assistant (safety driver) will always be needed
Intentions
• The organisation has been incorporating vehicle automation into vehicles for a long time, such as driving assistance systems • Technology can become obsolete quickly, which is a barrier to acquiring more vehicles • Self-driving vehicles will complement self-driving ones, not completely replace them • Self-driving vehicles can be used for on-demand services
Needs
• Vehicles need to be cheaper • Regulation barriers need to overcome • Need to have on-board human assistants, especially for long-distance routes, to provide assistant to passengers but also to comply with regulations • Requires data centres to collect and analyse data in real time on the movement of vehicle and infrastructure conditions • Requires measures to ensure that the software and the data centres are protected from hacking
Impacts
• Vehicles will not be faster than existing ones, but will be more reliable, as the vehicle can use data to handle unforeseen events • Vehicles will be safer • Will not change the basics of the current business model • Will not provide new services but rather improve existing ones • Routes that are unprofitable will remain unprofitable, regardless of the type of vehicles • However, new on-demand services could be implemented in some of those routes • The organisation would not consider expanding to related markets (i.e., transport data management) • Ticket revenue will not necessarily increase. However, additional revenues could be made by expanding advertising surfaces outside or inside the buses, as automation will release some space

• Costs will rise, as vehicle costs will not be compensated by the cost reduction allowed by increased efficiency. Costs will only decrease if supply of self-driving vehicle technology increases • Adaptation requires new jobs related to the operation and maintenance of the vehicles and associated software. This can contribute to attract individuals who currently do not consider working for this organisation • However, no impact is expected on workforce gender equality, beyond the efforts the company is already putting on that issue • Requires training of existing workforce • Problems of lack of physical accessibility to buses, and social exclusion because of lack of access or knowledge about digital tools, will still remain, or even be aggravated when vehicles are self-driving. • The organisation would consider changing some of the garage locations, if the self-driving technology could assist the process of parking, refuelling, and cleaning of buses

Table 171: Organisation B - SWOT analysis

Strengths	**Weaknesses**
• Large company present in several countries and operating a variety of transport modes • Owns two self-driving buses, one of them already operating • Has been incorporating automation in vehicles for long time	• It is more difficult to automate long-distance bus services, one of the key services of the company
Opportunities	**Threats**
• Self-driving vehicles can be used for on-demand transport services • Self-driving vehicles will improve safety and reliability of services provided • Can recruit staff from groups that currently are not attracted to working in the organisation • Additional revenue could be raised from expanding advertising surfaces • Could optimize facilities, by changing location of some of the garages	• Technology can become obsolete soon, requiring more investment in new vehicles • Vehicles are costly • Regulatory challenges • Problems in the service provided for some market segments, e.g., people with disabilities, those at risk of digital exclusion

10.3.3 Organisation C – Passenger transport

Table 172: Organisation C - information sheet

Organisation characteristics
• Main operator of bus services in a mid-sided city • Provides regular city services and routes serving schools • Only 17% of the routes served are profitable • 70% of the revenue comes from public funding, 25% from ticket revenue, and 5% from advertising • 85% of the workforce are drivers and 86% of drivers are men
Current situation with regards to transport
• The organisation owns 50 large buses, 35 small buses, 67 mini-buses, and 22 tourist buses. It has the largest fleet of electric buses in the country • Traffic congestion is the main challenge • Another challenge is lack of suitable infrastructure and traffic management (bus lanes, bus stops, bus priority at junctions) • Difficult to recruit drivers • Need to meet increased demand for passenger travel
Use case discussed in interview
Self-driving bus
Perceptions
• The organisation is aware of self-driving vehicles and following developments • Self-driving vehicles are costly to acquire, but cheaper to operate than conventional vehicles (lower energy and maintenance costs). • Concern that users will not respond well to self-driving vehicles in the beginning but will eventually accept them • Self-driving vehicles still cannot handle unexpected situations well • Concern about whether the technology will meet the needs of passengers with disabilities
Intentions
• No intention to acquire self-driving buses in next five years • Receptive to idea of introducing these buses within a pilot scheme framework • Would consider acquiring self-driving buses in 10 years' time
Needs
• Requires improvement in physical infrastructure to ensure that bus circulation is safe • Requires solving restrictions about vehicle charging – a problem the organisation currently faces in relation to electric buses • Requires investment in data control and monitoring facilities • Requires vehicles that provide a suitable interface between passengers and the vehicle – for example, ensuring passenger can get off the bus when needed or that the bus stops when a passenger is waiting at a bus stop
Impacts
• Self-driving buses could help the organisation to meet increased demand for passenger travel without the need to recruit more drivers (which currently is a challenge) • They could service circular routes in city centre and those used by tourists • They could be used in night services, for which it is more difficult to recruit drivers • The organisation would not provide new services but rather improve existing ones, assuming that self-driving vehicles would come in tandem with an improvement in infrastructure and traffic management systems in the roads used • It could improve operational aspects, as currently they are restricted by regulations on number of hours the drivers can work and the timing of their breaks • Self-driving buses will reduce collisions but will not eliminate them as they cannot handle unexpected situations • They will also be faster, and more reliable in terms of observance of schedules, as they can communicate with the infrastructure (for example, allowing for smart signalling)

• Routes that currently are unprofitable will remain so • Could increase revenue, as services will be more reliable, and so attract more demand • Could reduce costs, as energy and maintenance costs will decrease • Driver costs will decrease, but this will be compensated by increase in costs of other staff • Need for new staff responsible for supervising and monitoring the system. Also, some scope to offer entry-level positions in these areas • Drivers will still be employed as not all routes will be able to use self-driving vehicles • It will be more difficult for the older staff to adapt to the changes • As depot facilities may require less space, they could be relocated to further away from congested areas

Table 173: Organisation C - SWOT analysis

Strengths	Weaknesses
• Little competition from other public transport providers in the areas served	• Most bus routes are unprofitable • Dependence on public funding • Difficult to recruit drivers • No gender balance: workforce is overwhelmingly male
Opportunities	**Threats**
• Self-driving vehicles are more reliable and can help meeting existing demand and increase revenue • They could mitigate problems recruiting drivers • They could reduce energy and maintenance costs • They could improve operational aspects • Possible relocation of some facilities to less congested areas	• Congested roads • Lack of suitable infrastructure and traffic management • Problems in the service provided for some market segments, e.g., people with disabilities • Unprofitable routes will remain so • Problems in engaging older staff

10.3.4 Organisation D – Passenger transport

Organisation D is a public transport authority, responsible for the concession of bus services in its region. The organisation has participated in the interview mostly by giving the points of view of the bus service operators and, where applicable, also the point of view of the authority

Table 174: Organisation D - information sheet

Organisation characteristics
• The public transport authority has three bus concessions in the region • Half of bus operators' revenue is from ticket sales, the other half is from subsidies • Several hundreds of employees, across all bus operators, with a range of different roles
Current situation with regards to transport
• The bus services include conventional buses and 8-seat vans driven by volunteers • More than 700 buses, across all bus operators • Planning to offer a "hub taxi" service to transport people from living in places with no bus services to main line bus stops • For new bus concessions, only electric buses should be bought • The main challenge is to recruit bus drivers. Most current drivers are approaching retirement • Fewer customers after Covid, as work patterns changed • Routes to villages are difficult to maintain, especially in evening and weekends • Vehicle maintenance and repair is expensive and complicated, it can cause service reduction
Use case discussed in interview
Self-driving bus
Perceptions
• Self-driving buses still require more technology developments • Expensive to buy but can reduce costs, especially labour costs • More reliable in sticking to schedules • Safer, as most collisions are due to human error, and buses will not go over the speed limit. But the system can fail or be hacked • More difficult to repair vehicles, or to solve problems during travel • More flexibility to create or modify bus routes • Can have more services in evenings, night-time, and weekends • Challenging to use self-driving buses in crowded areas with many pedestrians and cyclists • Due to investments needed, bus fares may have to increase • Customers may reject the idea of self-driving vehicles
Intentions
• Bus operators will be interested if they perceive self-driving buses as efficient • Self-driving buses may be necessary from 2030 as it will be difficult to recruit drivers • Operators may use self-driving community taxis or vans to link rural areas with main public transport services
Needs
• Requires large investment • Requires consideration of people's attitudes regarding self-driving buses • Requires measures to ensure accessibility to people with disabilities, and that these people are not afraid of using the buses. For example, measures to ensure they see, hear, or feel that the bus is approaching, and that the bus also "sees" them • The buses need suitable internal designs, e.g., with emergency buttons • Speed will have to be very low in crowded areas used by pedestrians and cyclists • Requires stewards at bus stations and on board • Requires changes in infrastructure (such as dedicated lanes for self-driving buses) and traffic management (to allow the bus to communicate with traffic signal systems) • Requires close monitoring of the whole transport system, because if one vehicle fails, it will affect the whole system

Impacts
• No changes foreseen in business models • Can solve problem of recruiting drivers • In the long term, it can reduce costs for operators • Because of investment, in the beginning, bus fares will increase • Bus travel will be faster outside crowded areas but only if buses can use dedicated lanes and have priority at traffic signals • Travel will also be more reliable as buses are driven by machines, but this also depends on the existence of dedicated lanes and signal priority • Travel will probably be safer, but self-driving buses are vulnerable to system failure or hacking • New routes and routes at different times of day or days of week increase accessibility to workplaces and leisure areas • Community and on-demand transport also improve accessibility, especially in rural areas • It can improve gender equality as it can allow for more flexible travel, e.g. escort children to school before going to work, a task currently performed by women • Customers can communicate with the system (e.g., booking taxis, vans, or buses via an app) • Bus-km offered by the operators will increase • With time, it will improve people's perceptions of bus travel, as self-driving services will be more reliable, so demand can increase • If self-driving cars are affordable, people may prefer them, rather than self-driving buses, as cars will also provide the opportunity to use travel time for productive or leisure uses (currently, human-driven buses provide this opportunity, but human-driven cars do not). • Some drivers could be retrained as stewards at bus stations, helping passengers getting on the right bus and assisting those with disabilities. However, most existing drivers will be retired by then • More technical staff will be needed to operate the system (maintaining the vehicles, monitoring and controlling the technology) and offering customer service for on-demand transport users • Gender equality in the workforce will be easier to achieve, as a range of new roles will be available • More entry-level positions could be offered, e.g., for stewards at bus stations • Older staff will face more challenges to adapt to the new job circumstances. Some may need to retire early if they cannot be re-assigned to new roles. • No changes anticipated in location of depots, as a new depot has recently been built. But new depots could be located in areas with cheaper land prices, away from the centre, if the self-driving buses can travel easily from them to the bus stations • It can reduce parking supply and demand in the city centre, as self-driving bus services could connect people from parking areas outside the centre. • Released parking space could be reallocated as green spaces, parklets, or outdoor cafés • Car ownership and use could decrease in urban areas but not necessarily in rural areas

Table 175: Organisation D - SWOT analysis

Strengths	**Weaknesses**
• Already has community transport in place and plans to extend it • Already has plans for decarbonisation of the bus fleet	• Half of revenue is from subsidies • Difficult to recruit bus drivers • Reduced demand after Covid • Difficult to maintain rural routes
Opportunities	**Threats**
• Can reduce labour costs and land costs of ne depots • Increased reliability can improve people's image of bus travel • Create new routes, offer more night and weekend services • Create more on-demand and community transport services • Contribute to better accessibility and reduction of parking space in the region	• Users may not be willing to use self-driving services • Users may prefer to use self-driving cars • Possible problems in service provided for people with disabilities • Challenges in crowded areas, bus speed may need to be low • Ticket prices may need to increase

10.3.5 Organisation E – Freight transport

Table 176: Organisation E - information sheet

Organisation characteristics
• Freight company operating in a country, part of a larger multinational company • Handles international and long distance deliveries but also regional and local delivers • Uses a hub-and-spoke system, collecting deliveries during the day, which are then sorted in the hub, loaded onto trucks to be transported to their destinations • In the country analysed, the company has over 10 hubs and 74 distribution centres
Current situation with regards to transport
• Long experience in the sector • Difficult to recruit drivers. Most of workforce is approaching retirement age and it is difficult to recruit younger drivers • Most drivers are male
Use case discussed in interview
Long distance self-driving truck
Perceptions
• Self-driving trucks can be a good solution to increase the reliability of the delivery process • But they lack a human element, which is important in the delivery business
Intentions
• Plans for adopting self-driving trucks on an incremental basis. First, incorporating a small truck to transport packages inside the distribution centres • Then, trial a journey from hub to hub or hub to spoke, with a safety driver • Finally, try complete automation
Needs
• The public needs to accept having self-driving trucks using the roads • Self-driving trucks need to be combined with last-mile solutions using smaller vehicles • Even with these solutions, the customer still needs to collect the package from where the vehicle is parked, which could be a problem for individuals with disabilities, and for all customers when it is raining • Requires large data flows between vehicles and control room, with coverage for the whole journey • Requires investment in digital infrastructure – uncertain who will provide it (transport operators, communications companies, or governments)
Impacts
• No anticipated change in the business model • No anticipated expansion in markets served, or change in number of deliveries • Can reduce costs by cutting the human element • Can increase reliability of deliveries as it reduces dependence on drivers (who can, for example arrive late or stop on the way) • The whole delivery process will be more reliable, as the integration between trucks and air transport will be improved. This can also reduce costs • Removing the human element can weaken the bond between the customers and the company (for example, the company's uniforms are a distinctive part of the company's image and are instantly recognised by the public). This can even reduce demand. • Safety will increase but collisions will never be eliminated • Workforce will be reduced, although some staff may be retrained for new positions, such as teleoperations coordinating all the self-driving vehicles on the road • Uncertain if workforce gender quality will improve

Table 177: Organisation E - SWOT analysis

Strengths	Weaknesses
• Large company, part of a multinational group • Long experience in the business	• Difficult to recruit drivers
Opportunities	**Threats**
• Self-driving trucks could mitigate problems recruiting drivers • They can reduce costs by reducing labour costs • They will increase the reliability of the delivery process, reducing costs	• Self-driving trucks can not deliver packages, they require last-mile solutions • Lack of human interaction can deteriorate the company's image and reduce demand • The public may not accept self-driving trucks using the roads • Digital infrastructure may not support reliable data transmission over the whole journey, over long distances

10.3.6 Organisation F – Medical product deliveries

Table 178: Organisation F - information sheet

Organisation characteristics
• Organisation developing and deploying drones • Uses drones to transport medical products • Core funding is private but has received funding from national and European funds • Two business models: selling drones directly to customers (sometimes also involving maintenance series), and providing delivery services, charged either per km or per mission • More than 60 employees, with a good gender balance • Range of jobs: factory workers, drone operation, research and development, business development
Current situation with regards to transport
• Uses drones to transport medical products between labs and hospitals over distances of up to 80km several times a day, above various land uses, including dense cities • The main challenge has not been technological but regulatory
Use case discussed in interview
Delivery drones
Perceptions
• Drone allows for fast and direct delivery of medical products • Faster than road-based deliveries • High degree of reliability; tends to always have same travel time, regardless of weather conditions • Drones reduce delivery time but at a higher cost • Battery life can still be improved. Battery needs to be charged or replaced at destination before drone returns to sender • Wind conditions can limit the distance that can be covered • Landing in rooftops will be possible soon but it will take some time until technology allows for drones to land in balconies in residences • Many safety procedures in place • Regulations are lagging, considering the advance in technology • Complying with regulations is time-consuming and expensive • Cannot fly over some land uses, e.g. schools • Requires extensive testing, which is also expensive • Dealing with liability insurance issues is a complicated process
Intentions
• Wants to scale up operations • Wants to reach new customers within the health sector and beyond
Needs
• Development of drone technology requires large amounts of funding • Needs training of the staff in the healthcare institutions to send and receive the product • Needs systems so that senders and receivers monitor the location and speed of the drone and the state of the medical products transported (e.g. temperature) • Needs systems to ensure that the products transported are not damaged • Needs changes in regulations • Needs suitable locations for taking off and landing (at least a 5x5m space) • Carrying larger loads requires improvements in battery life and relaxing regulations • Requires cooperation with other companies to secure data and prevent hacking, and with research organisations
Impacts
• Reduces delivery time compared with delivery by road, because it flies directly (road-based deliveries usually involve collecting several items along the way) and avoids congestion • More reliable deliveries, not subject to road conditions, and resilient to whether conditions • Deliveries are more expensive

• Reduces road congestion • Electric vehicle, so it can reduce emissions compared with road-based deliveries • It can be used for emergency deliveries that can save lives • Commercially, it works in built up areas, because it has advantages over road-based delivery, but not in rural areas • Can save labour costs, compared with road-based deliveries, staff can supervise several drones at same time • Difficult to expand market, as it is a bespoke service • In the future, if many drones are used, there can be congestion in the air, and priorities need to be established (e.g. for emergency deliveries) • Organisation can attract highly-skilled workers, but it is difficult to retain them in the long-term

Table 179: Organisation F - SWOT analysis

Strengths	Weaknesses
• Company specialising in a new technology, bases on self-driving vehicles that can be useful for a specific sector (health) • Few competitors, given the regulatory barriers	• Sells expensive product and services • Product has short battery life • Cannot transport heavy loads • Compliance with regulations is time-consuming and expensive • Based in Europe, where regulations are tight • Difficult to retain highly-skilled employees
Opportunities	**Threats**
• Potential for expanding market within the health sector (e.g. not only hospitals but also pharmaceutical companies and drug manufacturers).	• Difficult to attract institutional investors • Regulations not adapting to the use of drones

10.3.7 Organisation G – Waste collection

Table 180: Organisation G - information sheet

Organisation characteristics
• Provides waste collection and management, street cleaning, and green area maintenance services in almost 100 municipalities in a European country. • It is also present in other European countries • Part of a larger multinational economic group • Two business models: public contracts through tenders and contracts with large private institutions • Operates mainly in large cities but also in towns and villages • More than 15,000 employees overall in the country, with about 10% working in waste collection
Current situation with regards to transport
• Owns hundreds of vehicles, travelling 24,000km a day • Collects waste from customers and transports to waste treatment sites • More than one trip can be made to collect waste from a customer, in case of large quantities • Trips made from before dawn (4-5am) until early afternoon • Some trips are made by the driver alone, others with more staff • Difficult to recruit drivers. In addition, when there are new positions, women do not usually apply
Use case discussed in interview
Self-driving waste collection vehicle
Perceptions
• Self-driving vehicles will not be deployed in the next 10 years • The industry needs to continue working on ensuring self-driving vehicles are safe • Self-driving vehicles will be expensive • Self-driving vehicles could be rejected by society because of concerns with safety or job losses
Intentions
• Does not envisage a replacement of the whole vehicle fleet of the organisation with self-driving vehicles in the next 25 years • The investment in this type of vehicles is too high to recover in short-term contracts with customers. It is only worth if the vehicle produces large savings and can be used in more than one contract
Needs
• The vehicle design would need to fit the purpose of waste collection (e.g., including a hook that loads a container) • It would also require multiple autonomous functionalities, not only moving but also loading and unloading • It would require testing in controlled environments before deploying • Would require standardization in terms of the location of the containers to collect and the timing of the collection • The organisation would only use self-driving vehicles if reassured that tests have been done and legislation has been applied regarding the safety of the vehicle. The company does not transport passengers, but safety issues are still important with regards to workers using the vehicle and citizens in the surroundings • The use of self-driving vehicles needs to be a priority of the organisation's customers, not the organisation itself. Public sector customers could add this as a selection criterion for awarding tenders. • At the beginning, the public sector would have to pay for these vehicles
Impacts
• Can improve operations, but that will not happen in the next 10 years • Vehicle repair would be more demanding than now • Self-driving vehicles could improve the organisations' competitive position in gaining public tenders but only if the use of these vehicles is a selection criterion (Not because of reduced costs) • Organisation would not expand to new markets

• Self-driving vehicles will probably not change revenue • They could reduce costs as vehicles "can work 14 hours a day, do not take sick leave, and do not have mood swings" • Most drivers could be re-assigned to other tasks such as vehicle maintenance. Re-training is needed • Not all staff would adapt to the change in the same way. That is not related to age but to attitude. • Change to self-driving vehicles could improve the gender balance of the workforce • If self-driving vehicles could reduce waste collection costs, public authorities could reduce taxes that fund this service, benefiting citizens

Table 181: Organisation G - SWOT analysis

Strengths	Weaknesses
• Large company in a specialised sector • Works both for public and private customers	• Difficult to recruit drivers • The waste collection sector has a predominantly male workforce (not only among drivers)
Opportunities	**Threats**
• Possible reduction in costs	• It may not be possible to adapt self-driving vehicles for the purpose of waste collection • Cost reduction may not justify the investment

10.3.8 Organisation H – Local government

Organisation D is a local government. It has participated in the interview mostly by giving the points of view of a large institution using passenger and freight transport. Where applicable, it also gave the point of view of a transport authority

Table 182: Organisation H - information sheet

Organisation characteristics
• Government of a mid-sized city • 450 employees
Current situation with regards to transport
• Does not own vehicles for employee transport • Owns vehicles used for services such as cleaning • No employees whose main occupation is driver, but an employee drives the Mayor for business trips • Most employees commute by car • Employees face problems related to lack of parking space, which sometimes causes them to be late. They also complain about high fuel prices • The organisation currently gives a €200 travel allowance to almost all its employees • The organisation is studying a possibility of a small bus where employees can park outside the city centre and the bus will pick them up • The organisation sends a large amount of internal and external mail, including packages, using the post office. These sometimes arrive late or not at all
Use case discussed in interview
Passenger use case: self-driving bus **Freight use case**: delivery drones
Perceptions
Self-driving bus • Self-driving buses provide an opportunity to transport several people together and may not require parking space • Users may not want to use self-driving buses as they may perceive it as unsafe • Self-driving buses will not be flexible as a driver is. If a passenger is late, the vehicle will not wait **Delivery drone** • Delivery drones address security issues, as it would prevent theft of important documents • However, they cannot carry large quantities or heavy objects • Perceived to be more expensive than existing delivery methods • Perceived to be generally safe
Intentions
• The organisation is receptive to the idea of acquiring a self-driving bus or mini-bus • It would use the self-driving bus to transport employees, a cheaper solution than the travel allowance it currently gives them • The organisation would not buy its own drone but would outsource an external company when it needs to use a one
Needs
• A human driver should be in the self-driving bus, at least in the beginning, so that users gain trust in the system • The road safety code will need to be changed for the safe movement of the self-driving bus • The delivery drone will need to be faster than existing methods, to compensate for the likely higher price

Impacts
Self-driving bus • It will reduce the institution's travel costs, because using the self-driving mini-bus is cheaper than the travel allowance currently given to employees. • It is likely that younger staff will use the bus more than older staff • It would reduce stress reduced effort and time needed to find parking spaces • It would also increase productivity as it would reduce instances of staff arriving late because of time lost finding parking • It would not cut any job, as there are no employees whose sole function is to drive • It would also not create any new jobs, as even the maintenance of the self-driving bus could be done by current staff – but is likely that this would be younger staff only • There would not be any reduction in parking space: the plan is that spaces released by staff no longer needing to park staff would be used by citizens instead • Some facilities could be relocated away from the city centre **Delivery drone** • Drones may reduce road congestion • They may reduce parking problems • They can collide with birds • They will be safe • They will have no impact on the organisation's workforce

Table 183: Organisation H - SWOT analysis

Strengths	Weaknesses
• Public institution • No drivers, i.e., no staff whose role would be threatened by self-driving vehicles	• Staff relying on private car use
Opportunities	**Threats**
• Self-driving bus could save costs by replacing travel allowance currently given to employees • It would reduce car parking problems, reducing stress and late arrival of staff	• Staff not accepting the self-driving vehicle

10.3.9 Organisation I – Educational institution

Table 184: Organisation I - information sheet

Organisation characteristics
• Mid-sized educational institution
Current situation with regards to transport
• Owns a bus but it is not used because of insurance and technical issues • One driver, but their licence has not been renewed because the vehicle is not being used • Outsources deliveries via courier services which go to the organisation and pick up the package • Deliveries are unreliable as they may take long time and be vulnerable to weather conditions. Packages may take long time to arrive even within the region
Use cases discussed in interview
Passenger use case: self-driving bus **Freight use case**: self-driving van
Perceptions
• Self-driving buses can be more reliable than self-driving ones • Self-driving vans can use existing infrastructure, unlike delivery robots and drones
Intentions
• The organisation does not intend to buy a self-driving van but outsource it from a bus company • It would also prefer using a delivery service based on self-driving vans than human-driven ones. It would not buy one, but lease it
Needs
• Prefers outsourcing rather than buying the vehicles to reduce maintenance or extra training needs • The institutional personnel would need to accept the new technology
Impacts
Self-driving bus • The self-driving bus can be used to transport students from/to the campus to the city centre, especially at hours when public buses are not operating • It can also be used for occasional uses, such as site visits or conferences • Up to 20 new job positions may be created, dealing with the information system • The former driver can retain their job, maintaining the vehicle, but this requires retraining • The service can reduce stress of staff and students, due to greater flexibility in their schedules • Staff and students will attend classes on time, improving productivity • Transport plans may be offered for staff and students (e.g. free tickets) • Can improve the image of the institution (better quality of life), which may attract new students • Supply and demand for parking spaces will likely remain the same • Some relocation of buildings inside the campus is possible • It may improve accessibility of people with disabilities, if free bus passes are offered, funded by the public sector **Self-driving van** • No impacts mentioned

Table 185: Organisation I - SWOT analysis

Strengths	Weaknesses
• A diverse community of staff and students	• Belief that in general staff is resistant to change
Opportunities	**Threats**
• Self-driving bus can improve mobility of staff and students • This has potential added benefits in terms of reduced stress, productivity, and the image of the university	• None identified

10.3.10 Organisation J – Vehicle developer

Table 186: Organisation J - information sheet

Organisation characteristics
• Organisation developing a self-driving mini-bus • Secured letters of intent from prospective customers (city governments, transport operators) • Innovation activities have been funded by private and public funding • Other revenue sources are the development of app-based on-demand transport services • 40 employees, and another 20 in an associated company specifically developing the automated system. Variety of roles (technical, business, legal) • Men are 75% of the workforce. The average age is around 30 • Difficult to recruit staff as the market is small for some of the highly-skilled positions required by the company • Partnerships with research institutions
Current situation with regards to transport
• Developed a self-driving mini-bus and has trialled it on public roads • The main challenge has not been technological but regulatory
Use case discussed in interview
Self-driving bus
Perceptions
• Self-driving buses can be used to provide regular bus passenger services over short distances but also longer ones (up to 200km) • Mini-buses can also be used within sites, both public and private (e.g. linking different parts of a company site, business estate, university campus, port, airport, parks, and even cemeteries, or linking them with car parking areas). • They are safe. But collisions will still happen if conventional vehicles or pedestrians do not see the self-driving bus and hit it. • Development of the vehicles is expensive • Trialling them is also expensive and requires navigating complicated regulations and insurance procedures • Vehicle is expensive to produce now and would be expensive to buy, but when it starts to be produced and sold (2028) it is expected it will not be more expensive than a conventional electric mini-bus. • Concern that the potential market for self-driving vehicles has been affected by recent setbacks in the industry, including companies that developed products but failed to commercialise them • Self-driving mini-buses may require having a human operator on board, at least initially, while regulations are still adapting
Intentions
• Wants to keep developing the vehicle so that it is homologated by 2027 • Hopes to start producing the vehicle in 2028 • Hoping to sell to national and international buyers • The organisation could also open up additional revenue sources by offering services to public transport operators such as management or supervision of self-driving bus fleets
Needs
• Requires strategic funding from various sources (private and public, national and European) • Requires more relaxed regulations regarding tests and deployment of the bus on public roads • Requires demonstrating the vehicle to citizens so that they are aware of this solution and how it can change their lives • Requires city authorities to promote these vehicles, so that they are regarded as a better solution than self-driving private cars • Requires producing data to show to potential customers, especially regarding the cost savings that self-driving buses will provide • Infrastructure needs to be changed so that vehicles can communicate with traffic signals

Impacts
• Rising market potential for the organisation, as public transport operators are facing increased labour costs and difficulty to recruit drivers • Believes market will be mostly the public sector (governments on bus services run by municipal companies or contracted by them) • The developed mini-bus can improve people's accessibility, as it can be used for on-demand services or to transport people from areas not currently served by public transport to central locations or public transport hubs • The first localities that deploy self-driving buses can improve their image, due to media coverage • Public transport operators may be able to reduce labour costs • Believes that in the long term city transport systems will be based on shared self-driving vehicles, not private ones • It will be complicated to establish legal liability in case of collisions

Table 187: Organisation J - SWOT analysis

Strengths	Weaknesses
• Early mover in this market • Have developed, tested, and trialled an innovative product • Believes that the country is operating in is pro-technology	• Workforce is predominantly male and younger • Difficult to receive approvals for tests and deployments on public roads • Reliance on public funds: revenues only cover a small percentage of investment and operating costs
Opportunities	**Threats**
• Public transport operators are struggling to find drivers and self-driving buses could be a solution	• Market growing slowly • Not being able to find further funding from public sources • Vehicle not homologated within the expected timeframe (2027) • Regulations not yet in place when company intends to commercialise the vehicles (2028)

10.3.11 Organisation K – Software developer

Table 188: Organisation K - information sheet

Organisation characteristics
• Start-up company working in a European country but with headquarters outside Europe • It is developing systems based on artificial intelligence for self-driving vehicles to react to rare events • The systems are used in trials of self-driving vehicles, not in road traffic • This is based on large datasets including video recordings of real-world traffic, from surveillance cameras and vehicle dashboards, as well as reports from insurance companies, and interviews with taxi and bus drivers • 10 staff in the European office (engineers), only two of them women. Average age around 25. Plan to reach more women and individuals from ethnic minorities in the next recruitment round but without positive discrimination in recruitment procedures • High salary costs, as it requires high-skilled staff and is based in an expensive city • Offers paid internships to university students. Some are recruited by the company afterwards • Main customers are governments • Is trying to diversify revenue sources by offering artificial intelligence solutions in domains other than self-driving vehicles
Current situation with regards to transport
• It is a software developer, not a transport vehicle manufacturer or transport service provider.
Use case discussed in interview
None in particular. General discussion on self-driving vehicles
Perceptions
• Concern that societal, business, and political enthusiasm for self-driving vehicles is decreasing • View that there is still work to do to improve advanced driver-assistance systems, before full automation • View that full automation still requires solutions for the vehicles to detect objects of the road (e.g. wires, litter) and to react to events such as fast-moving emergency vehicles • View that some users are frustrated with current advanced driver-assistance systems and overwhelmed with so many automated functions
Intentions
• The organisation is currently offering solutions for fully automated vehicles • However, it wants to expand business on solutions for advanced driver-assistance systems, as a stepping stone for better solutions for fully automated vehicles
Needs
• Requires strategic funding from a variety of investors, as innovative businesses as this are risky • Requires partnerships with governments, vehicle developers, and research institutions • Requires measures to protect intellectual property, which are costly • Few problems regarding legal liability, as the solution developed is used in trials, not in road traffic • Governments should be involved in trialling the vehicles, rather than relying on transport operators doing it • Requires regulations before solutions are developed, rather than governments reacting to the solutions • Difficult to comply with some regulations without disclosing confidential business information and compromising intellectual property • Requires standardisation (which is also related with regulation) • Users need to accept the technology – starting with advanced driver-assistance systems, before fully automated vehicles. • Requires changes in transport infrastructure • Vehicles should be able to communicate with other vehicles and with the infrastructure (such as traffic signals and electronic signs).

Impacts
• Unsure of the market potential for fully automated vehicles • Market for the software developed by the company is narrow • View that users will not want to spend much time inside the self-driving cars, regardless of the possibilities to use their time. They will rather have shorter travel times

Table 189: Organisation K - SWOT analysis

Strengths	**Weaknesses**
• Company working in a specialised aspect of self-driving vehicle technology (rare events), with few competitors • Highly-skilled workforce • Access to large amounts of data • Partnerships with vehicle manufacturers	• Dependence on public sector customers (governments) • Workforce is predominantly male, younger, and from the ethnic majority
Opportunities	**Threats**
• Funding from research and innovation programmes • Use work on advanced driver-assistance systems as a stepping stone to fully automated vehicles	• Decreasing enthusiasm for self-driving vehicles • Users may not trust the technology • Not enough investors to ensure financial sustainability of the company

10.4 Perceptions, intentions, needs and impacts on organisation

10.4.1 Overview

This section triangulates the information generated by the case studies, to derive insights on perceptions, intentions, needs, and impacts on organisations. The analysis is split by use case.

In the case of self-driving buses and drones, the information is derived from several organisations, including some who are potential users of these vehicles and others who are producing them. We treated self-driving mini-buses as a special case of buses, and so integrated information about them with that about larger buses.

In the case of trucks and waste collection vehicles, the analysis that follows has the caveat that it is derived from a single organisation (which is a potential user).

Self-driving vans were discussed with only one organisation, but the discussion did not generate enough information to allow any analysis. For this reason, results for this use case are not presented.

10.4.2 Perceptions

Table 190 shows the perceptions about the four use cases. The self-driving mini-bus was perceived to have large potential to meet user needs that are not currently met with human-driven buses. However, organisations identified a mix of advantages and disadvantages in using these buses. Self-driving buses are safer and more reliable and may reduce costs, but this requires large investment. There are also problems that need to be fixed, especially those that may cause barriers for users with disabilities. A general view across most organisations was that a human assistant, or even a safety driver, may still be needed, at least in the initial stages of implementation of these buses.

The self-driving truck was perceived as enhancing the reliability of deliveries but it has to be complemented with last-mile solutions and may alienate customers who are used to human interaction when receiving deliveries.

Drones also have wide potential, and share the same advantage identified for buses and drones: reliability. However, it is also perceived as expensive. There are also issues that have not been fully resolved regarding battery range and compliance with regulations.

As the other vehicles, the self-driving waste collection vehicle is also perceived as expensive to buy but it can also lead to a reduction of costs when in use.

Table 190: Perceptions of organisations on self-driving vehicle use cases

Use case	Perceptions
Bus	**Potential** • Large potential to provide new public transport services (i.e. on-demand services, community transport) • Potential to create more bus routes, be flexible with existing ones, and offer night and weekend services • Potential for non-transport companies to use own vehicles to transport staff (e.g. for commuting or business trips) • Mini-buses can be used within sites such as universities or airports • Can cover small or long distances (up to 200km) • The public may not be willing to use a self-driving vehicle. Passengers may be concerned with being recorded **Advantages and disadvantages** • They are safer than human-driven buses, but technology still needs to be developed to avoid failures • More reliable in sticking to schedules • Costly to produce and purchase but can reduce costs, especially labour costs • They may be cheaper to operate (reduced energy and maintenance costs) • Not as flexible as a human driver (e.g., human would wait if a passenger were late) • More difficult to repair or solve problems during travel • Human assistant (safety driver) may be needed • Possible problems for passengers with disabilities
Truck	• Can increase reliability of deliveries and improve integration between different delivery modes (e.g. truck with airplane) • Needs to be complemented with last-mile solutions • They lack a human element that customers value
Drone	**Potential** • Can carry medical products in case of emergencies • Can securely carry confidential documents • Cannot carry numerous or heavy objects **Advantages and disadvantages** • Fast and reliable (in terms of delivery time and resilience to weather conditions) • Generally safe • Issues with battery range, and flying over or landing on certain land uses • Expensive • Costly and time-consuming to comply with regulations and liability insurance • Still requires further testing
Waste collection vehicle	• Will be expensive to buy • It may reduce costs

10.4.3 Intentions

Table 191 shows the conclusions regarding intentions to use self-driving vehicles. The self-driving bus is already a reality in the life of some of the organisations interviewed, who are already using or testing them. There was a generally positive view regarding using these vehicles, both among transport providers and among institutions that use transport services. While most organisation showed interest in self-driving buses, their preference was for smaller ones. Regardless of intentions, self-driving buses they may prove to be necessary as organisations consistently stated that it is increasingly difficult to recruit drivers. At some point in the future, when current drivers (who tend to be older) retire, self-driving buses may be the only viable solution to keep bus services running. The generally positive intentions about these vehicles is somehow balanced with some apprehension among the companies developing the buses and automation software, as they think societal, business, and political enthusiasm over them has waned in the last few years.

Drones are already being used by one of the organisations. Others said they would use but not buy one.

Intentions about the self-driving truck were positive and the ones about the waste collection vehicle were less so, but these conclusions are based on the views of a single organisation each and should not be generalised.

Table 191: Intentions of organisations about self-driving vehicle use cases

Use case	Intentions
Bus	• Some transport providers already using or testing self-driving buses (mainly mini-buses) • Others would want to test these vehicles before acquiring them • Self-driving buses may be necessary at some point in the future due to the growing difficulty in recruiting drivers • Willingness to try self-driving mini-buses for on-demand services • It will take long time to replace the larger buses or to apply self-driving technology on longer routes • Self-driving buses may only complement, rather than completely replace human-driven ones • Non-transport companies may either buy or outsource one to use when needed • Organisations developing self-driving vehicles and software are hopeful they can commercialise their products but concerned that societal, business, and political enthusiasm for them has waned in last few years
Truck	• The organisation interviewed to discuss this use case has an incremental plan to deploy self-driving trucks, first in their own facilities, then on public roads
Drone	• One of the organisations interviewed is already using drones for deliveries • Non-transport organisations would probably not buy their own drone but outsource one when needed
Waste collection vehicle	• The organisation interviewed will not replace their entire vehicle fleet with self-driving vehicles in the next 25 years

10.4.4 Needs

Organisations mentioned several needs and requirements to start using these vehicles (Table 192). Using self-driving buses requires a series of pre-conditions related to the development of the vehicles and adaptation of the infrastructure, regulations, and workforce. The price of the vehicle is also a barrier. Using self-driving buses also requires meeting several operational criteria. Lastly, users need to be convinced that the vehicles are indeed a good solution.

Public acceptance has also been identified as important in the case of the truck. Using a drone has also a series of requirements regarding technical, financial, and regulatory aspects. The case of waste collection vehicles is also complicated, as this is a very specific type of vehicle for which automation needs to meet additional functional criteria.

Table 192: Needs of organisations regarding self-driving vehicle use cases

Use case	Needs
Bus	**Pre-conditions** • Requires funding, research, and collaboration to trial solutions • Need to reduce regulatory barriers to the development of these buses • Need to integrate self-driving buses with other modes • Vehicles need to be cheaper • Need to redesign or improve infrastructure (e.g. bus lanes) and traffic management (e.g. traffic signals communicating with the bus and giving them priority) • Need to expand and improve network of charging facilities • Need to secure technology and data from hackers • Need to adapt road traffic regulations • Need to motivate and reskill employees **Operation** • Requires close monitoring of the whole transport system • Need for suitable interfaces for passengers to communicate with the vehicle (e.g., to get off the bus or be picked up at a stop) • Vehicles need to be adapted for the use of passengers with disabilities • Human assistant (safety driver) will always be needed • Human assistants will also be needed at stations • Speed may have to be low in crowded areas with many pedestrians and cyclists **Users** • Users need to gain awareness and trust • Requires demonstrating the vehicles to citizens to increase acceptance
Truck	• Needs to be combined with last-mile solutions • Requires large amounts of data circulation, and the digital infrastructure to support it, especially in long journeys • The public needs to accept self-driving trucks circulating on the road
Drone	• Requires funding, research, and collaboration to trial solutions • Requires suitable locations for taking off and landing • Requires training both for senders and receivers • Requires extensive safety procedures • Requires changes in regulations • Batteries need to be further improved • Would need to be faster or more secure than existing methods, to compensate for the likely higher price
Waste collection vehicle	• Vehicles need to be fit for the purpose of waste collection • Needs to be autonomous both in movement and in handling waste • Needs comprehensive testing before using • Public authorities need to have a role in promoting these vehicles, both in contract awarding and in funding vehicle purchase

10.4.5 Impacts

This section analyses the impacts that self-driving vehicles may have on different aspects of the organisations. Some new business models may be possible for transport providers offering services using self-driving buses (Table 193). However, viable business models are still uncertain for the organisations developing these buses. In contrast, the organisation who is developing drones is already applying two types of business models. There is no anticipated change in business models for the other two use cases.

Table 193: Impacts of self-driving vehicle use cases on organisations – business models

Use case	Impacts on business models
Bus	• Possibility of running on-demand services based on mini-buses • Possibility of raising revenue through expanding advertising surfaces • Companies developing the vehicles and software need suitable business models, with a diversity of revenue sources.
Truck	• No anticipated change in business models
Drone	• An organisation is already applying two types of business models: selling drones to customers and providing delivery services
Waste collection vehicle	• No anticipated change in business models

Table 194 shows the impacts on financial aspects. The general view for transport providers and institutional users is that self-driving buses are expensive but may increase revenue and decrease costs. However, this may happen only in the long term. Again, for the organisations developing the vehicles, financial aspects are more crucial, as they threaten the viability of the organisation itself. Securing funding and sustainable revenue streams is a challenge for these organisations at the moment.

Trucks and waste collection services are not expected to raise revenue but may reduce costs. The problem with drones is mainly the high cost of the service, which needs to be passed on to the customer.

Table 194: Impacts of self-driving vehicle use cases on organisations – financial aspects

Use case	Impacts on financial aspects
Bus	• Self-driving buses are expensive • Revenue can increase if the efficiency and reliability gains increase demand • Labour and probably energy and maintenance costs will decrease • Large cost reduction and revenue increase only possible when technology is further developed • For non-transport companies, it could reduce costs, if running the bus is cheaper than giving staff a travel allowance • Companies developing the vehicles and software struggle finding enough funding for their activities
Truck	• Not expecting to increase revenue through increased demand • Can reduce labour costs and costs related to delivery problems, as the delivery process will be more reliable
Drone	• The costs of operating a drone delivery service are high, so the prices charged to customers also need to be high, otherwise the service cannot make a profit
Waste collection vehicle	• It will probably not change revenue. No anticipated expansion to new markets or major gains in competitive position • It may reduce costs, as the automated processes may be cheaper than labour

There is a general view among all organisations that all use cases will improve reliability, both for passenger and freight transport (Table 195). This was referred mainly in terms of travel time reliability. Operations may also be more efficient in terms of resource use, for all use cases, although this may happen only in the long term, especially in the case of the waste collection vehicle.

Table 195: Impacts of self-driving vehicle use cases on organisations – operational aspects

Use case	Impacts on operational aspects
Bus	• Vehicles will be more reliable as data can be used to mitigate problems • More efficient use of resources, as bus operation is currently restricted by regulations on number of hours the drivers can work and timing of their breaks
Truck	• More reliable distribution process: problems caused by delays will be reduced, as integration between modes will be easier
Drone	• Reduces delivery time and delays, compared with road-based deliveries
Waste collection vehicle	• Can improve operations although organisation interviewed believes that will not happen in next 10 years • Vehicle repair will be more demanding than now

Employment aspects were discussed at length by all organisations (Table 196). Three themes cut across all use cases: 1) There is a belief that self-driving vehicles will solve existing problems of recruiting drivers. 2) The use of these vehicles will create new positions, and 3) There is also hope that drivers could be retrained to work in these new positions or in existing ones. Organisations discussing the self-driving bus use case gave additional detail, mentioning that is may be possible to diversify their workforce.

Table 196: Impacts of self-driving vehicle use cases on organisations – employment

Use case	Impacts on employment aspects
Bus	• Some organisations think it will reduce problems in recruiting staff, but others think it may still be difficult to recruit staff • New positions needed to manage and monitor the system • Some belief that drivers can still be employed as not all routes would be using self-driving buses • Need to motivate and reskill employees • Can attract staff from groups currently not interested in working for the organisation • Can open entry-level positions
Truck	• Workforce will be reduced • Some staff may be retrained
Drone	• A start-up company has been engaged in drone deliveries. They reported no problems in recruiting staff, but problems in retaining high-qualified staff
Waste collection vehicle	• Organisation interviewed believes that most drivers could be reassigned to other tasks

Regulatory issues came across as a major issue for most organisations, especially for those developing self-driving vehicles and software, but also for transport providers (Table 197). This is especially important in the case of drones.

Table 197: Impacts of self-driving vehicle use cases on organisations – regulatory aspects

Use case	Impacts on regulatory aspects
Bus	• Traffic regulations need to be made compatible with the need to provide services for passengers with disabilities • Regulations applying for long-distance travel need to be re-assessed
Truck	No information provided
Drone	• Requires an extensive set of new regulations regarding where drones can take off, land, and fly over, as well as safety and security aspects
Waste collection vehicle	• Public authorities could require that waste collection is done with self-driving vehicles, when awarding contracts

10.5 Views on wider impacts

This section triangulates the information generated by the case studies to derive insights on the organisations' views on the wider impacts of self-driving vehicles in their regions. The analysis is split between positive and negative impacts.

Mobility is likely to increase, as the new vehicles can be used to extend the supply of public or company-based transport services, while also increasing travel time reliability (Table 198). However, this comes at the expense of higher travel costs. There are also the risks the increases in mobility will be felt in all areas, and that individuals will prefer self-driving cars rather than public transport. The view is that congestion will decrease (Table 199). However, organisations expressed this view thinking that vehicles will be more reliable and can deal better with bottlenecks or unexpected events, reducing delays. They did not relate possible increases in private car ownership and use with increased traffic levels and congestion.

Table 198: Organisations views on wider impacts – mobility

Positive	• New on-demand services may be implemented • More scope for night-time public transport services (which are currently limited by difficulties in recruiting drivers) • Public transport services will be more reliable • Organisations can use self-driving vehicles to transport staff when public transport services are not running
Negative	• New travel options may be expensive • Areas currently not reached by public transport may still be inaccessible if routes remain unprofitable • The public may choose self-driving private cars rather than public transport alternatives

Table 199: Organisations views on wider impacts – transport network

Positive	• Self-driving buses can reduce traffic congestion as vehicles will be more reliable • Drones could reduce road congestion • Disruption may be reduced as data allows vehicles to better handle unexpected situations
Negative	• More complex traffic regulations and control needed

Some organisations expressed an intention to change location of their facilities to less central areas, although this was never expressed very strongly (Table 200). On the negative side, there was consensus among the non-transport institutions that self-driving vehicles will not have an impact either on the supply or demand for parking spaces, so parking problems will remain. The environment was mentioned rarely, with some organisations mentioning that emissions will decrease, with another raising specific concerns about drones colliding with birds (Table 201)

Table 200: Organisations views on wider impacts – land use

Positive	• Some large transport depots could be relocated if automation facilitates parking, refuelling, and cleaning of vehicles • Non-transport organisations may also relocate some facilities to outside the city centre
Negative	• Non-transport institutions mentioned that the use of self-driving buses would not change either the supply or demand for parking spaces

Table 201: Organisations views on wider impacts – environment

Positive	Self-driving vehicles will reduce negative environmental impacts of the transport sector
Negative	Drones could collide with birds

The views on economic impacts (Table 202) revolved mostly about whether jobs will be created or destroyed, with organisations thinking both will happen and that the net effect is uncertain. Other positive impacts are increased productivity and institutional image.

Views were also mixed with regards to equity impacts (Table 203). On the plus side, self-driving vehicles will increase the accessibility of some groups. However, there was strong concern amount almost all organisation about whether self-driving vehicles raise new barriers for the mobility of people with disabilities. There was also no evidence from the interviews that the current gender imbalance in the transport sector will improve. In addition, the emergent industry developing self-driving vehicles and software is creating even more imbalances, as it is dominated by young men from ethnic majorities.

Table 202: Organisations views on wider impacts – economy

Positive	• New types of job will be created • Bus drivers may still be employed (as drivers), as not all routes may be suitable for self-driving vehicles. • It can improve productivity if it allows workers to arrive on time to their workplaces • It can improve the image of non-transport institutions using the vehicle, increasing demand for their services • A new industry developing self-driving vehicles and their software
Negative	• Some jobs will be destroyed • Large investments needed to protect vehicles and data from hackers

Table 203: Organisations views on wider impacts – equity

Positive	• Can improve accessibility of people in rural areas and night-shift workers • Allows for flexible travel, e.g. escort children to school before going to work, a task currently performed by women
Negative	• May be difficult to adapt buses to be accessible for passengers with disabilities (e.g. difficult to install ramps) • Digital exclusion will increase • No evidence from interviews that current gender imbalance in the work force will improve • Older staff may feel excluded • The new industry that is emerging for developing self-driving vehicles and their software is dominated by younger men from ethnic majorities

The reported impacts on public health (Table 204) and safety (Table 205) are all positive. Self-driving buses can improve accessibility to health facilities and drones can make emergency medical deliveries. Having more (and more reliable) public transport can also reduce stress. All organisations believe that vehicles will be safer, but that collisions will not be eliminated. With regards to security (Table 206), there was a strong concern about vehicle and data system hacking.

Table 204: Organisations views on wider impacts – public health

Positive	• On-demand transport services can be used for trips to health facilities • Drone can make emergency deliveries of medical products, saving lives • Public transport services will be more reliable, decreasing stress (e.g. waiting at bus stops, or trip delays) • It can reduce stress of not having flexible or reliable transport or having to find parking space
Negative	No negative impacts mentioned

Table 205: Organisations views on wider impacts – safety

Positive	Vehicles will be safer but will not eliminate collisions. More comprehensive tests are needed
Negative	No negative impacts mentioned

Table 206: Organisations views on wider impacts – security

Positive	• Drones can be used to transport confidential documents
Negative	• Vehicles and data systems can be hacked • Passengers do not want to be recorded while travelling

Organisations usually related some of the impacts addressed above. For example:

- Some economic, equity and public health benefits were related to the increase in mobility
- Some negative equity impacts were related to negative economic ones

10.6 Conclusions

Detailed case studies were conducted with eleven organisations across Europe to understand their views on self-driving vehicles. The objectives were to understand the organisations' perceptions, intentions, needs, and impacts regarding self-driving vehicles, as well as their views on the impacts on their region. The case studies were mostly based on semi-structured interviews. Some parts of the interviews focused on specific use cases of self-driving vehicles, from those co-created in the project and analysed in previous chapters of this report. The following overall conclusions can be derived from the analysis of the information from the case studies:

- **Perceptions**: self-driving buses have a large potential for providing additional bus services, covering unmet demand. Drones can also provide useful services. Both are safe and reliable and can reduce costs but require large investments
- **Intentions**: organisations intend to use self-driving vehicles. In the case of buses, they may even be forced to use them if current problems in recruiting drivers are aggravated. There are also positive intentions regarding the other use cases
- **Needs**: a large number of technical, financial, regulatory, infrastructural, safety, and labour issues need to be addressed before the organisations start using self-driving vehicles in their daily operations
- **Impacts on organisation**: Self-driving vehicles are expensive but may increase revenue and decrease costs, albeit only in the long term. They will also improve operational aspects but will force changes in the workforce.
- **Wider**: Mobility will increase but this will cost. Travel will be more reliable but may fail to meet the needs of people with disabilities. Some large facilities may be moved away from the centre, but parking spaces will not. Jobs will be created and destroyed. Travel will be safer but less secure.

11. Conclusions of Part 2 – Impact on Organisations

Part 2 of this deliverable analysed the impact of self-driving passenger and freight vehicles on organisations. A variety of data types was collected, in activities involving organisations in eight countries in Europe. This included qualitative assessments using group discussions (Chapter 8), a demonstration of self-driving vehicles (Chapter 9), and case studies of 11 organisations (Chapter 10). This final chapter of Part 2 compares the main conclusions from these activities, using the same eight-impact structure assessed in each of the chapters.

Table 207 shows the results. A common conclusion is that self-driving vehicles can enhance **mobility**, especially of groups currently underserved because they live far from city centres or need to travel at night-time when there is little public transport. Trips will be more reliable but also more expensive.

The increase in mobility is likely to increase road traffic levels, especially of private vehicles, although this will not necessarily increase congestion in the **transport network** if vehicles are more reliable in dealing with unexpected events and bottlenecks. Extensive changes to the infrastructure are needed to cope with the new types of vehicles.

Regarding **land use**, parking needs will probably not decrease, especially in city centres. Some free space may be released in city centres, due to relocation of large facilities (e.g. public transport depots).

It is likely that the **environment** will improve, as emissions will decrease. However, organisations expressed concern about issues such as battery disposal and visual pollution (due to increased number of vehicles). Noise may not decrease.

Regarding impacts on the **economy**, organisations were consistent across activities that there will be both job creation and job destruction. There is a high degree of uncertainty on whether the net effect will be positive or negative. Some activities also concluded that productivity could increase both because travel time will be more reliable (so employees can arrive on time to work or business appointments), while also allowing for working while travelling. There was also a concern about customer resistance to new solutions, especially when they fail due to weather or other circumstances. Costs will also probably increase and be passed on to customers. There will also be a new industry developing self-driving vehicles and software. To adjust the economy to the new realities, large investments are needed.

The perceived effects on **equity** are mixed. Self-driving vehicles can improve accessibility of some groups such as rural and suburban residents and night-shift workers. But there are also concerns about whether the new solutions can meet the needs of people with disabilities, and with digital and price exclusion. The self-driving vehicle industry is also dominated by younger males. Across all industries, older workers may feel excluded.

The perceived impacts on **public health** were also mixed. Self-driving vehicles can solve emergency situations. However, the impact on stress is uncertain: it can increase or decrease.

The impacts on **safety** were consistent across activities: travel will be safer, with fewer collisions, but there was a strong concern about emergency situations that self-driving vehicles may not be able to handle.

The strongest concern was **public security**. This was a conclusion about all the activities: travelling in public transport without a human driver or assistant may create fear of crime and harassment. Freight deliveries by self-driving vehicle are also vulnerable to theft. On top of these concerns, vehicles can be hacked, and citizen data can be abused by transport companies or governments, or stolen with malicious intent.

Table 207. Comparison of impacts on self-driving vehicles on organisations

	Qualitative assessment	Demonstration	Case studies
Mobility	• Can enhance citizens mobility	• Can enhance citizens mobility • May be slower and more expensive	• Can increase mobility, especially at night-time or in areas currently underserved by public transport • More reliable trips • Will be more expensive
Transport network	• Reduces congestion only if traffic decreases • Requires extensive changes to transport infrastructure		• Traffic levels can increase, especially of private vehicles • But congestion may decrease because of increased reliability
Land use	• Increases free space in urban areas only if traffic decreases		• Parking needs will not decrease • Some large facilities can be relocated outside the city centre
Environment	• Better air quality only if traffic decreases • Problem of battery disposal • Noise and visual pollution	• Quiet and environmentally-friendly	• Can reduce environmental problems
Economy	• Increased freight delivery reliability • But malfunctions may cause customer resistance • Transport and delivery costs will increase and may be passed onto customers • Fear of job losses • More jobs and industries can be created		• Fear of job losses • More jobs and industries can be created • Use of travel time to work can increase productivity • Creation of a new industry to develop vehicles and software • Large investments needed
Equity	• Concerns about people with disabilities • May create more digital exclusion • Price-related exclusion		• Can improve accessibility of shift-workers and people in rural or outer suburban areas • May improve gender equality • Concerns about people with disabilities • Digital exclusion • Older staff may feel excluded in organisations • Self-driving vehicle industries are dominated by younger males
Public health		• Will increase stress	• Can be used for emergency trips of patients or medical products • Will reduce stress

Safety	• Fewer collisions • Concerns about emergencies • Concerns about weather conditions	• Safe in all situations and for all road users • Concern about emergencies	• Safer but will not eliminate collisions
Security	• Concern about freight security (crime) • Concern about hacking	• Concern with passenger and freight security (crime)	• Concern with hacking and data privacy

PART 3

FURTHER ANALYSIS, SYNTHESIS, AND CONCLUSIONS

Part 3 - FURTHER ANALYSIS, SYNTHESIS, AND CONCLUSIONS

Part 3 reports the results of further analysis on impact, synthesizes all analyses, and concludes the deliverable.

Chapter 12: Further qualitative assessment of impact, through discussions and other activities in groups mixing citizens and organisations

Chapter 13: Syntheses of all analyses in this deliverable, comparing impacts of self-driving vehicles on citizens and organisations in Europe

12. Joint qualitative assessment of impacts - citizens and organisations

12.1 Overview

Following the initial co-creation of use cases, and the qualitative impact assessment activities with citizens and organisations in all regions, a set of co-creation activities was organised in the project's prototypical regions (Helmond, North Aegean Region, Metropolis GZM).

Prior activities with these audiences included:

- Use case co-creation with citizens (reported in D1.2)
- Use case co-creation with organisations (reported in D1.2)
- Impact assessment to create causal loop diagrams with citizens (Chapter 2 of this report)
- Impact assessment to create causal loop diagrams with organisations (Chapter 8 of this report)
- Joint qualitative impact assessment and exploration of areas of uncertainty (this chapter)

Chapters 2 and 8 described the impact assessment in detail, exploring each use case by a range of domains. The activities described in this chapter were designed to validate and expand upon those detailed findings. Bringing together citizens and organisations at the same in-person workshop for the first time, the aim was to further assess the impact of self-driving vehicles in each region, and specifically revisit some previously identified areas of uncertainty: trip frequency and take-up of self-driving vehicles; safety; and jobs. In each of these cases citizens and organisations struggled to reach a consensus on whether introducing new self-driving vehicle services would have positive or negative impacts, and at what scale.

The specific objectives of these activities were:

- **Dialogue between citizens and organisations**: At the very beginning of the engagement, citizens and organisations had different levels of knowledge of self-driving vehicles. However, as citizens had now taken part in several activities, it allowed us to bring citizens and organisations together for a more equitable discussion. While we still expect different perspectives and motivations from these different groups, it is useful to bring them together and explore how this plays out in a dialogue. For example, does exposure to views of organisations influence citizen attitudes, or vice versa? Do they reach new or different conclusions when working together?
- **Consolidated scenario exploration**: Up until this point, self-driving vehicles and services had only been considered on a case-by-case basis. Considering them together and at scale could therefore lead to different perspectives on self-driving vehicles and their impact on the transport system. Moving from a technology-focussed lens to a systems-based one, we conducted the workshops in situ – thus grounding discussions in the physical and social geographies of place, rather than in the abstract technological world.
- **Unpicking uncertainty about future impacts**: The workshops sought to bring different groups together to build a consensus on key areas of uncertainty regarding the impact of self-driving vehicles. These areas (trip frequency, safety, employment) had been identified both in the literature as well as in earlier co-creation activities.
- **Taking a societal perspective on self-driving vehicles**: Understanding the impacts of the introduction of self-driving vehicles relies on understanding how people will behave, which is in turn influenced by how transport systems are implemented. By asking citizens

to step outside of their individual perspectives, we invited them to consider some of the policy challenges which transport planners face. At the same time, we also asked them to reflect on how their own behaviour might be influenced, and how others in society might be impacted.

The chapter is organised as follows:

- Section 12.2 describes the methods used to explore use cases and areas of uncertainty
- Section 12.3 shows the sample characteristics
- Section 12.4 reports the results of the workshops
- Section 12.5 draws conclusions

12.2 Methods

12.2.1 Workshop design

Following the analysis of data from previous co-creation activities, key areas of uncertainty were identified as common across regions and use cases., covering:

- **Dialogue between citizens and organisations**: We invited both citizens and organisations to take part. In each workshop, citizens outnumbered organisations to ensure they felt confident to express their opinions without deferring to "expertise".
- **Consolidated scenario exploration**: We introduced the consolidated use case scenario (i.e. a scenario in which previously discussed use cases are available) as the "baseline conditions" early on in the workshop. These conditions were presented as a hypothetical scenario set in 2050, where manually driven vehicles have been phased out, low emission zones are common, most transport is electrified and using renewable energy, public transport is available and costs are comparable to current prices. The use cases commonly available in this hypothetical future are: self-driving bus service; self-driving e-hailing (shared); mobility bus on demand; and consolidated delivery bot.
- **Unpicking uncertainty about future impacts**: Related to the above use cases, three key areas of uncertainty were explored: trip frequency; safety; and jobs. Within each area of uncertainty, we introduced a potential positive feedback loop and a potential negative feedback loop. Workshop participants discussed ways in which the positive outcome could be encouraged, and the negative outcome prevented, as well as which outcome they felt was more likely.
- **Taking a societal perspective on self-driving vehicles**: Citizens and organisations were asked to imagine that they were in charge of transport planning for their local area/region and had to assess applications for licenses for new self-driving vehicles. They were asked to share their key questions for providers, the wider factors they would take into consideration before approving an application, and how they would decide whether or not to grant a license to a service. Workshops concluded with a map-based activity, where participants marked up where, when, and how they would like services to operate in their city or region.

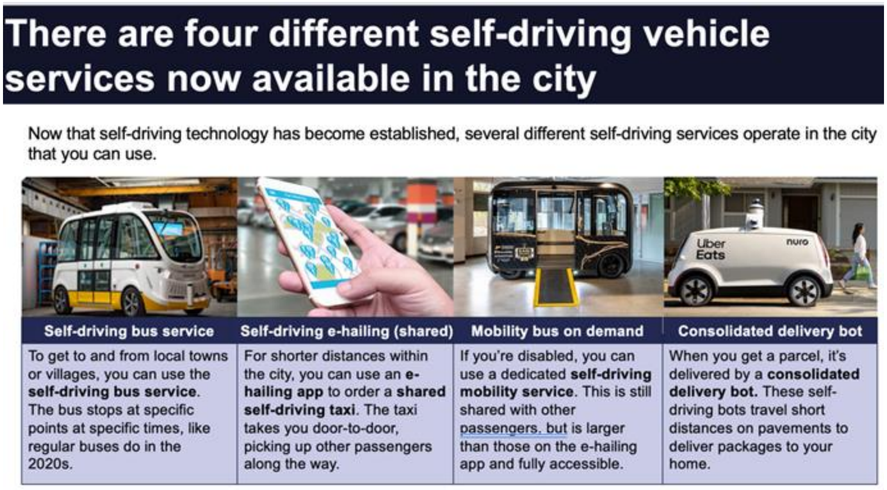


Figure 244: Stimulus outlining the services available in a hypothetical 2050

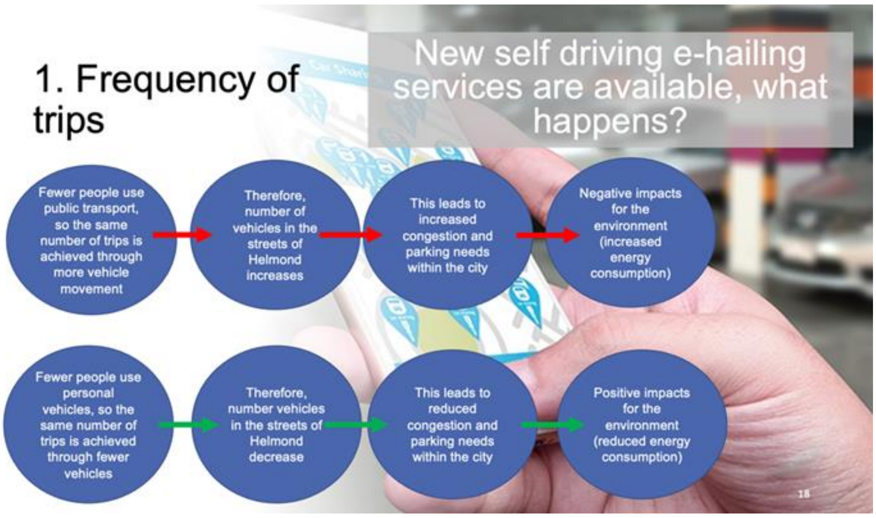


Figure 245: Stimulus showing the potential positive and negative feedback loops in relation to trip frequency for self-driving e-hailing services

12.2.2 Workshop facilitation

In each region, citizens and organisations took part in a 2-hour, face-to-face workshop. All workshops were facilitated by local partners in the local language. Discussions were semi-structured, using translated stimuli and worksheets.

12.3 Sample characteristics

A total of 44 citizens joined the workshops, representing a good mix of demographics and life stages (Table 208). Overall, the sample skewed older, with 17 participants aged 65+. The sample in Greece was the most rural, with more than half of participants living in a village.

A total of 10 organisations joined the workshops. In each workshop, representatives from 3-6 organisations were present, five from research and higher education institutions, three from self-driving vehicle developers/manufacturers, two from non-governmental organisations, and two from authorities and regulatory bodies.

Table 208. Sample characteristics

		All	Nether-lands	Poland	Greece
All		44	13	16	15
Age	18-34	7	0	3	4
	35-64	20	7	6	7
	65+	17	6	7	4
Gender	Man	26	10	8	8
	Woman	18	3	8	7
Employment status*	Works full-time	19	2	10	7
	Works part-time	4	4	0	0
	Student	3	0	2	1
	Seeking work	2	1	0	1
	Homemaker	1	0	0	1
	Retired	13	6	3	3
Household composition*	Single	7	3	3	1
	Shared home	1	1	0	0
	Lives with parents/family	4	0	3	1
	Lives with partner	13	4	6	3
	Lives with partner and children	17	5	4	8
Location*	City centre	12	1	5	6
	City, not in the centre	13	9	4	0
	Small city	2	2	0	0
	Small town	4	0	4	0
	Village	11	1	3	7
Driving attitude*	Enjoys driving	23	9	8	6
	Would prefer to do something else	5	2	1	2
Disability	Has a disability impacting mobility	7	2	5	0

Note: *Some data is missing.

12.4 Results

12.4.1 Encouraging dialogue between citizens and organisations

At the start of each workshop, we conducted a “traffic director for the day” exercise where participants were asked to imagine the kinds of questions they would ask of service providers before approving a service in their city/region. The aim was to prompt participants to consider different viewpoints and needs from the start of the discussion.

Citizens and organisations were relatively aligned in their priorities and concerns regarding the introduction of self-driving vehicles in the local area. Cost, functionality and integration with the wider transport system came out as key themes, as well as concerns about inclusion and accessibility – demonstrating that participants were ready to adopt a systems lens.

Table 209 summarises responses to the “traffic director for the day” exercise:

Table 209: Summary of questions arising during traffic director exercise

Safety	• Safety had been a major concern throughout engagement activities and was still a priority. • However, there was also an assumption that services would not be introduced unless they were safe – through extensive trialling and phased rollouts – which almost made the question of safety a "hygiene factor". ○ This may reflect the influence of organisations in the workshops – representatives from organisations were more likely to argue for the safety of self-driving vehicles compared to manually driven vehicles. • The main remaining concern was about cyber security and the risk of a malicious actor hacking the vehicles.
Functionality, effectiveness and efficiency	• A key question was whether self-driving vehicles would really function more effectively and efficiently than current services, e.g. would the service be more accessible, more timesaving, and – crucially – how would they interact with the services and infrastructure that already exists? • More practically, citizens wanted to know how many people would be able to use a service at a time, how many stops there would be, and how frequently the service would run. • Citizens questioned whether vehicles would be able to navigate more challenging weather conditions, including snow (in Poland), as well as more unusual traffic conditions or random events. • There were questions about the amount of maintenance and servicing required. • In addition, participants wanted self-driving vehicles to be pleasing to the eye, comfortable, and clean.
Cost and funding	• A main concern for all was the potential cost of using self-driving vehicles, including as part of public transport. Citizens suggested free trial periods and subsidised bus passes to increase acceptance and take-up of services initially. At the very least, they would want the service to be of a comparable cost to current public transport. • There were also concerns about the cost to municipalities – of purchasing or hiring vehicles and adapting the local area and infrastructure to their use.
Inclusion and accessibility	• While self-driving vehicles were seen as potential solutions to current exclusion issues for those who cannot or will not drive, participants wanted reassurance that the service would be user-friendly and accessible to elderly and disabled passengers. • However, organisations in Poland raised a concern about services specifically designed to support those with restricted mobility may lead to their further marginalisation by singling them out.
Service provider/ manufacturer	• Participants wanted to know whether manufacturers would be liable for their products and responsible for their upkeep and maintenance. • They would want to know how long a supplier has been in business for and whether they have previously supplied products/services to other cities or regions. • Citizens questioned whether manufacturers would provide custom-made products and services adapted to local contexts, including, for example, the branding of vehicles.

12.4.2 Area of uncertainty: Trip frequency and take-up of self-driving vehicles

Trip frequency and the adoption of shared self-driving transport emerged as a key area of uncertainty in previous engagement activities. This speaks to the wider complexities and uncertainties within transport systems regarding how automation will impact shared mobility, as well as wider modal shifts, and interact with other factors, such as the need for decarbonisation.

In previous workshops, citizens and organisations alike had expressed doubts over whether the public were ready to abandon their private cars to replace them with e-hailing and public transport options. Many felt there was a risk that the introduction of self-driving vehicles would lead to an increase in the overall number of vehicles on the road, rather than the desired reduction.

At these final workshops, we introduced two possible scenarios for the introduction of **self-driving e-hailing services**. Self-driving e-hailing was selected as the most appropriate use case to explore this uncertainty, as it goes beyond simply replacing existing vehicles with self-driving ones, and instead represents a change in the *system*, thus potentially leading to wider and more transformative impacts.

Scenario 1: Fewer people use public transport

Fewer people use public transport, using the self-driving e-hailing service instead. This means the same number of trips is achieved through more vehicle movement. Therefore, the total number of vehicles on the road increases, leading to increased congestion and parking needs, as well as increased energy consumption, which has negative impacts for the environment.

Overall, citizens felt it was unlikely that self-driving e-hailing services would lead to a significant reduction in the use of public transport, as most expected these services to be more expensive, similar to current taxi or e-hailing services (e.g. Uber, Bolt, Lyft). Those familiar with these types of service felt (or assumed) that they had not caused significant modal shifts, affecting mostly traditional taxi services, with no impact on car ownership or use of public transport. However, organisations in Poland cited Uber and Bolt as having led to increased traffic, without increasing the parking space available.

Scenario 2: Fewer people use personal vehicles

Fewer people use personal vehicles, so the same number of trips is achieved with fewer vehicles. Therefore, the number of vehicles on the road decreases, leading to reduced congestion and demand for parking, with positive impacts for the environment through reduced energy consumption.

Participants questioned whether the fact that the service would be *shared* would make it less convenient than even public transport, as it would be more difficult to predict how long a trip might take. Disabled participants also raised the issue of accessibility, which current public transport offers them and which they assumed would not be a given with e-hailing services.

In terms of the service’s impact on privately owned cars, there was a strongly held sentiment that there will always be a group of people who prefer the convenience of their own car to any kind of shared transport – whether that is e-hailing or public transport. Some, mostly female, participants raised safety concerns about sharing an e-hailing service with strangers.

“Freedom for me means that I can go wherever and whenever I want. At any time of the day. Let's say there's an emergency and I need to rush to a hospital in the middle of the night. That's one of the reasons I want to own my own car. Or another option is shared cars. That would work for me too. As long as this car is immediately available in case of an emergency.” Citizen, Helmond

Most felt that, in order to avoid Scenario 1, they key would be to improve public transport, which was seen to have a more significant impact on behaviour and take-up than the presence of e-hailing services. Participants felt that affordable, accessible and reliable public transport (whether self-driving or not) would lead to more positive outcomes than introducing self-driving e-hailing on its own.

Organisations in GZM felt that the most likely outcome would be somewhere between the two scenarios, imagining that some people will change their main travel mode, e.g. because parking their own car is too expensive, but that it is unlikely to affect the overall amount of traffic.

As a result, all felt that self-driving e-hailing would have to have very clear benefits - without a significant added cost - to be adopted at a scale that would affect either public transport or car ownership and use. Indeed, citizens felt that impacts were largely dependent on cost – i.e. if the cost of using the e-hailing service was comparable to public transport, they felt that there was a chance that congestion could *increase*, while a more expensive service, e.g. comparable to current taxi or e-hailing services, was felt to have no impact. Congestion was thought to *potentially* reduce if the cost of the service was low enough to lure people away from their private car, without competing with public transport. In an ideal world, they could see self-driving e-hailing as a way to fill gaps in the current public transport system, and the reduction of friction (e.g. the number of changes) when travelling, thus making public transport the more attractive mode.

Outcomes are seen to be determined most significantly by:

- Cost
- Convenience
- Quality of available public transport

12.4.3 Area of uncertainty: Safety

Throughout the engagement, the personal safety of passengers, other travellers, and pedestrians had been a key concern.

While some felt, having taken part in previous workshops and demonstrations, that self-driving vehicles may be safer than manually operated ones in terms of road accidents, there remained concerns about the risks of unsupervised travel; the risks posed by other travellers, especially to vulnerable passengers; and the threat of cyber attacks.

At the workshops, we introduced two possible scenarios for the introduction of **self-driving bus services** in relation to safety. Self-driving bus services had been selected as particularly appropriate, as there are a number of risk factors – transport is shared with other passengers, buses operate in the same environment as other types of vehicles, and they are currently commonly used by all participants.

Scenario 1: More automated vehicles lead to an increased risk of cyber-attacks

Increasing incidents of cyber-attacks and vehicle hijacking, with vehicles being taken off course and operated with malicious intent leads to increased risks to public health and people do not feel safe using self-driving bus services. This can also lead to increased congestion, due to greater private vehicle use, and reduced mobility for those without access to private transport.

Scenario 2: More automated journeys lead to fewer road accidents caused by human error

Self-driving vehicles are trained to follow rules and regulations, while avoiding collisions and obstacles, so more self-driving journeys results in fewer road accidents caused by human error. This leads to positive impacts for public health and more people feeling safe to travel around the city using self-driving bus services. This also has positive impacts for mobility (reduced congestion) and the environment (reduced energy consumption, pollutants and noise).

Interestingly, Scenario 2 was accepted as very likely, with faith in the vehicles themselves relatively high, reflecting a shift in perceptions over the course of the research. This may indicate that road safety, which had been frequently raised as a key concern, is not as deep-seated as we might have assumed. Citizens seemed fairly easily persuaded that it will be solved before self-driving vehicles are used widely, in part, perhaps, because it feels so essential. According to the baseline conditions which were introduced at the start of the workshop, by 2050, manually driven vehicles will have been slowly phased out and legal issues, such as the question over who is liable in the case of an accident, will have been resolved. This meant that participants' main concerns regarding road safety were about the transition phase, and the ability of self-driving services to integrate with existing ones.

In addition, many believed that self-driving vehicles would be safer than manually operated ones, with human error seen as a main factor in issues with road safety. There was an assumption that news of self-driving vehicles causing fatalities had been blown out of proportion and that, given time, they would be more widely accepted as safe. This may reflect the impact of organisations, who were more likely to be arguing for the safety of self-driving vehicles compared to manually driven ones. An example from an exchange at the workshop in Helmond below:

The combination of self-driving and regular transport clashes with each other. We've seen that in America." Citizen, Helmond

"The Emergency Services Organisation considers self-driving transport to be the safest form of transport at the moment." Organisation, Helmond

Some felt the greater challenge would be for passengers to overcome a "psychological barrier" and get used to being "left alone" on public transport. They imagined an intercom or alarm system through which contact could be made with a human operator.

"For safety, we said, there should be a button in the vehicle, so that if something happens, we can press that button to give a signal to the company that checks all these things, telling them that something has happened, that someone must come and help." Citizen, North Aegean Region

Participants felt that education of citizens on how to behave when using self-driving vehicles would be a key part of building confidence in their safety. Without a driver to intervene in potential social conflict between passengers, participants felt that the public would need to know what to do in certain situations, including what would happen if too many people tried to get onto a bus, if there was an incident between passengers, or with another vehicle.

Scenario 1, however, did raise worries. While the scale of the risk posed by cyber-attacks was unknown to participants, they perceived it as a real threat. However, they also had faith that digital security would increase and that, as self-driving services are introduced and rolled out, security measures would be put in place to reduce any cyber-attacks.

Organisations in particular felt that these risks already existed but were successfully minimised, and that there was no reason to assume that self-driving buses were more at risk of hijacking than existing ones.

"Hacking systems is very topical at the moment. I hope that by 2050 everything will be under control. That there are solutions for this." Citizen, Helmond

"Some fears are artificially blown up - nowadays it is also possible to hijack a bus, but it happens very rarely." Organisation, GZM

In practical terms, citizens imagined that vehicles would have some type of override system, through which a manual (or another remote) controller could take over if needed.

As it stands, cyber security is a much less well understood threat than road safety. Both organisations and citizens find it difficult to predict how big an impact cyber threats will have, while at the same time trusting that security systems will be able to keep up with advancements in malicious types of hacking.

Outcomes are seen to be determined most significantly by:

- Public trust and acceptance
- Technological advancement

12.4.4 Area of uncertainty: Jobs

Discussions of self-driving vehicles triggered discussions of the wider impacts of automation on employment throughout the engagement.

Participants had been undecided on the likely impact of self-driving vehicles on the employment of those currently driving for a living. While there were some expectations that automation would create other jobs, possibly in the maintenance, monitoring or operation of self-driving vehicles, participants found it difficult to judge whether this would make up for the job losses elsewhere and thus still lead to a net reduction in employment.

At the workshops, we introduced two possible scenarios for the introduction of **self-driving consolidated delivery bots** in relation to jobs.

Scenario 1: There are no training opportunities for former delivery drivers

As self-driving consolidated delivery bots are now the norm for last-mile deliveries, delivery drivers are no longer required. Most of these drivers are not presented with any solutions or opportunities to continue working for their companies, which will result in negative impacts for the local economy as unemployment rises.

Scenario 2: There are opportunities for former delivery drivers to retrain

As self-driving consolidated delivery bots are now the norm for last-mile deliveries, delivery drivers are no longer required. Drivers are presented with options for retraining (e.g. remote operation or monitoring of delivery bots) and companies are supported and incentivised to retain and adapt staff to new requirements and demands. This will result in positive impacts for the local economy as people are not only able to keep their jobs but also upskill and meet current transport and delivery needs.

Participants acknowledged and accepted that the transport sector would change, causing a shift in the labour market. Many trusted that workers would be absorbed elsewhere over time, but worried about the impact of sudden automation on low-skilled, manual labour.

Participants wanted reassurance that the transition would be gradual, and that some manual jobs would remain, whether that is in the servicing of the vehicles, or through a system that allowed for humans to be included if needed, e.g. if a passenger requires assistance or a package needs to be delivered to an elderly person.

Participants assumed that these shifts would begin now, with new jobs created in adapting the infrastructure to the new self-driving vehicles, thus smoothing the transition and not leading to a net decrease of jobs in the local economy overall.

"Since the Industrial Revolution, there hasn't been automation that has cost jobs. Knowledge passes on. There will be other jobs, including for the driver. Our children have to grow with this. They are already learning that the job you are studying for is probably not the job you will get later or retire with."
Organisation, Helmond

"First of all, jobs will increase before this is implemented. They will increase for the infrastructure." Citizen, NAR

In Helmond and GZM in particular, there was a sense that automation in transport could be the answer to shortages in bus drivers and other driving professions. Participants spoke of a decline in the popularity of these low-paid jobs, which had already led to issues for public transport.

This means that, while still an area of some uncertainty, there is faith that transport automation will not lead to an increase in net unemployment. Instead, participants expected to see shifts in the labour market, as well as job creation in supporting industries, which would "soften the blow" and – potentially – even lead to more growth and employment.

Outcomes are seen to be determined most significantly by:

- Speed of transition
- Job creation elsewhere

12.4.5 Moving towards a "societal view"

For the final exercise, each workshop used local maps to imagine what a future with self-driving vehicles might look like. The maps were not intended to be geographically accurate, but rather to serve as stimulus for thinking about the needs of different areas and different groups of people. See below an example of a marked up map from the Katowice area (Figure X).

Across locations, participants imagined hubs around the city, for both freight and passenger vehicles. These would be connected with smaller neighbourhood hubs for picking up and distributing parcels. Neighbourhood hubs should be within walking distance of residents' homes (no more than 250 metres). Passenger services would be integrated with inter-regional and national transport, local public transport and cycling hubs, similar to current park and ride arrangements.

In the city centre, there would be self-driving buses for transporting larger numbers of people at the same time, for example, connections to the university, football stadium, and business parks. In Helmond, participants imagined a grid of north-south and east-west connections, where frequent shuttles drive all day, and it is easy to change from one shuttle to another. They imagined a similar system for transporting goods.

For most, self-driving bus services were easiest to imagine, running along similar lines as today, except without a driver. However, this also means they were seen as adding the least value. Shared e-hailing and mobility-on-demand services were therefore seen as most different and therefore offering the most potential change to the overall system, however, there were questions over the pricing structure for these services. Participants imagined that prices would be subsidised for those who needed them (e.g. disabled people), while those who *wanted* them were expected to pay more.

> *"If self-driving e-hailing is as expensive as the regular taxi, then the self-driving e-hailing has no added value. Replacing the existing bus with a self-driving bus service on the same fixed routes as today makes no improvement. I really see the self-driving e-hailing service as an added value." Organisation, Helmond*

Participants in Lesbos (North Aegean Region), where public transport is seen to be sparse and unreliable, thought that self-driving vehicles could be a solution to many of their transport issues, but they had less faith in the feasibility of a roll-out of these types of services. They imagined it would require large-scale public investment which they felt was unlikely to happen. This was also a concern elsewhere, with participants finding it difficult to imagine the public money and investment required to implement even the charging infrastructure for electric vehicles. This prompted discussions over whether the responsibility for these services and their implementation would rely on the private sector and what this would mean for local governments in terms of financing, and users in terms of costs.

Figure 246: Marked-up map of Katowice from workshop

12.5 Conclusions

The following conclusions aim to address the objectives of these co-creation activities stated in the introduction of the chapter.

12.5.1 Citizens and organisations working together

This was the first time in the project in which representatives from organisations and citizens participated in the same co-creation activity and were able to exchange their views. In each session, citizens outnumbered organisations, so as to ensure their voices are heard and they feel empowered not to defer to “expertise”.

The discussions held as part of the workshops were productive, with all participants openly sharing their views about different use cases and their potential impact on their region and society. The two groups shared many opinions and concerns, while also bringing different perspectives to the challenge. Depending on role and function, representatives from organisations were more likely to consider system-wide impacts, thinking, for example, about the overall value added by self-driving vehicles. Citizens, on the other hand, were more likely to consider their impact on “people like them”, but also other groups in society. Organisations were also more likely to argue for the safety of self-driving vehicles, which may have shaped conversations on this topic.

Positively, the two groups complemented each other well, rather than putting forward competing views, participants worked together to assess what the future might look like.

12.5.2 Areas of uncertainty

The areas of uncertainty previously identified were mostly expected to be resolved by 2050:

- **Trip frequency**: Participants found it difficult to judge whether people would be travelling more or less by 2050, however, there was a sense that the same number of trips could be completed with fewer vehicles on the road through a combination of public transport and active travel. In order to avoid adding to congestion, participants felt that public transport would need to be able to “compete” with both private self-driving cars and shared e-hailing services. At the same time, they wanted the convenience of private cars to be preserved, especially for regional and leisure travel, but there was openness to using shared vehicles for this (similar to current car sharing or car clubs).
- **Safety**: Participants believed that security issues would be mostly resolved by 2050, and that public acceptance of the vehicles would automatically increase. While hacking was seen as a potential risk, it felt no greater than the current risk of physical hijacking and was felt to be an issue in other parts of the economy as well. Counter-measures were expected to have to keep up with more sophisticated attacks.
- **Jobs**: As long as the transition was gradual, participants felt that job losses would be absorbed elsewhere, so as not to result in a net loss of jobs overall. They imagined that the transition would create new jobs, while a base level demand for human services would remain.

12.5.3 Moving towards a “societal view”

For most participants, the penetration of self-driving vehicles into their local transport infrastructure was a question of when, not if. As a result, they were very open to the idea of a mostly automated network by the year 2050 and it was understood that the more widespread the roll-out, the safer and more efficient the system would be. Participants worked together to imagine a future that would work for everyone, demonstrating that they had moved from considering their personal circumstances into considering the “societal view”.

For self-driving vehicle services to be successful and gain public trust, participants felt they would need to prove to be:

- Safer than manually driven services
- More punctual than traditional public transport
- Convenient in terms of frequency and routes
- Low cost
- Not causing additional traffic congestion
- Accessible to disabled people
- Comfortable

Importantly, the rollout that participants can realistically envisage depends heavily on interventions from government and transport system operators. It relies on investment and development of security provisions, the public transport system, and job transitions being managed well. Without this investment in a supportive policy environment, participants find it difficult to imagine how benefits might be realised or accrue. Crucially, there are substantial economic and geographic disparities between the prototypical regions, which means that, for example, residents in Greece and, to a slightly lesser degree, Poland, are much more sceptical about the feasibility of securing the necessary investment, compared to those in the Netherlands.

Recommendations for policy makers resulting from this project will therefore consider the wider policy context, as well as the differences between regions and administrations.

13. Synthesis - comparison of impacts on citizens and organisations

This deliverable analysed the impact of self-driving passenger and freight vehicles in Europe, using data from a large variety of activities involving citizens and organisations. This final chapter compares the main conclusions derived from these two types of activities

Table 210 synthesises all results. Opinions of citizens are mostly consistent with those of organisations. Self-driving vehicles can enhance mobility, especially of underserved groups, and improve travel reliability, but this may come at the expense of increased costs. Traffic levels will increase but congestion may not. Parking needs may not decrease. Current environmental problems will be reduced, but new ones will be created, related to the disposal of batteries. There will be both job creation and job destruction and the net effect is uncertain. There is also a concern about the large investments needed to adapt the economy and about customer resistance to freight delivery solutions based on self-driving vehicles. The accessibility of some groups may increase but there is a strong concern about whether self-driving vehicles can meet the needs of people with disabilities, as well as price and digital exclusion. The impact on travel stress is uncertain. Safety will improve but collisions will not be eliminated. The strongest concern, both among citizens and organisations, is the security of both passengers and freight in self-driving vehicles.

Table 210. Comparison of impacts on self-driving vehicles on citizens and organisations

	Citizens	Organisations
Mobility	Can enhance citizens' mobility. Travel may be cheaper or more expensive but will be more comfortable and allow for productive or leisure uses of time. Number of trips may increase, especially by private modes.	Can enhance citizens' mobility, especially of groups currently underserved. Trips will be more reliable but also more expensive
Transport network	Road traffic levels will increase but congestion may not	Road traffic levels will increase but congestion may not
Land use	The effect on parking is uncertain	Parking needs will not decrease. Some large facilities may be relocated away from the centre
Environment	Emissions and noise will decrease, but new problems arise because of increased demand for electricity and need for battery disposal	Emissions will decrease, but new problems arise because of visual pollution and need for battery disposal. Noise may not decrease
Economy	The net effect on jobs is uncertain. Productivity may increase. It may be difficult for new freight solutions to capture market	The net effect on jobs is uncertain. Productivity may increase. It may be difficult for new freight solutions to capture market. Large investments are needed, and cost increases may be passed onto customers

Equity	Can increase accessibility in areas less served by public transport. Concern about people with disabilities and price-related exclusion	Can increase accessibility in areas less served by public transport. Concern about people with disabilities and price and digital-related exclusion. May increase gender and age imbalance in transport industry
Public health	Better air quality. Impact on stress is uncertain	Can solve emergency situations. Impact on stress is uncertain
Safety	Safety will improve but collisions will not be eliminated. Concern about emergency situations	Safety will improve but collisions will not be eliminated. Concern about emergency situations
Security	Strong concern about security of passengers and freight, and with data hacking and privacy violations	Strong concern about security of passengers and freight, and with data hacking and privacy violations

APPENDICES

APPENDICES

The Appendices collect data collection materials (Appendix 1-11) and full results of statistical models (Appendix 12)

Appendix 1 – Questionnaire to collect citizens' demographic data

Q0	Please fill your ID number. This is a number from 1 to 100 given to you by the event organisers	
Q1	How old are you?	1: 18-34; 2: 35-64; 3: 65+; 4: Prefer not to say
Q2	How would you describe your gender?	1: Woman; 2: Man; 3: Other; 4: Prefer not to say
Q3	[NOT IN NETHERLANDS] How would you describe your ethnic background?	1: White 2: Asian 3: Black / African 4: Mixed 5: Other (please specify) 6: Prefer not to say
	[NETHERLANDS ONLY] Do you have a migration background?	1: Yes, one or both of my parents were born abroad 2: No, both of my parents were born in the Netherlands 3: Prefer not to say
Q4	Q4: Which of the following best describes your situation in relation to driving?	1: I have a valid driving license and I am able to drive 2: I don't have a driving license 3: I have a driving license, but I do not have a car in my household that I can use 4: I have a driving license, but I am unable to drive because of health or other reasons 5: Prefer not to say
Q5	Which of the following best describes your current employment situation?	1: I work full time (30+ hours per week) 2: I work part time (8-29 hours per week) 3: I am not working, but seeking work or temporarily unemployed / sick 4: I am not working and not seeking work 5: Student 6: Retired 7: Homemaker/ houseperson/ housewife / househusband etc. 8: Prefer not to say
Q6	What is the highest educational level that you have achieved to date?	1: No formal education 2: Primary school 3: Secondary school 4: Vocational qualification 5: University degree or equivalent professional qualification 6: Higher university degree, doctorate, MBA 7: Still in full time education 8: Don't know 9: Prefer not to say

Q7	[NETHERLANDS ONLY] What is your annual family income? By family income we mean the total income of everyone who contributes financially to your household. If you have a partner or children who also work and contribute to the household finances, this includes their income as well as yours.	1: Under €5000 2: Between €5000-€14,999 3: Between €15,000 and €24,999 4: Between €25,000 and €34,999 5: Between €35,000 and €49,999 6: Between €50,000 and €99,999 7: €100,000+ 8: I'd rather not say 9: I do not know
Q8	Who, if anyone, do you live with?	1: I live alone 2: I live with friends / in a house share 3: I live with my partner / spouse, with no children 4: I live with my partner and my child(ren) who are under 15 5: I live with my partner and my child(ren) who are over 15 6: I live with my parents or other family members 7: Prefer not to say
Q9	Which of the following best describes where you live?	1: City centre (in a city over 10,000 people) 2: City, not in centre (in a city over 10,000 people) 3: Small town (2000-10,000 people) 4: Village (with less than 2000 people) 5: Prefer not to say

Appendix 2 – Pre-events questionnaire - citizens

Q0	Please fill your ID number. This is a number from 1 to 100 given to you by the event organisers	
	Residential Area Characteristics	
Q1	*How far from your home are the following places?*	
	The place where you work or study	1: Less than 1 km 2: 1-2 km 3: 2-5 km 4: More than 5 kms 5: I don't know, or I don't go there
	Shopping areas	
	Health centre	
	Leisure places (e.g. park, sport facilities)	
	Mobility restrictions	
Q2	Do you have a long-term illness, health problem, disability or impairment affecting your daily life? Please remember that your answers are always treated confidentially	1: Yes 2: No [GO TO Q5] 3: Prefer not to say [GO TO Q5]
Q3	[IF Q2=1] Does your long-term illness, health problem, disability or impairment affects your ability to move around?	1: Yes, a lot 2: Yes, a little 3: No 4: Prefer not to say
Q4	[IF Q2=1] Do you use any mobility aids or equipment?	1: Yes, a wheelchair 2: Yes, a mobility scooter 3: Yes, walking stick or crutches 4: Yes, a guide dog 5: Other 6: No 7: Prefer not to say
	Travel behaviour	
Q5	*How often do you travel to the following places?*	
	The place where you work or study	1: Less than once a month (or never) 2: Once a month 3: 2-3 times a month 4: Once a week 5: 2-3 times a week 6: 4 or more times a week
	Shopping areas	
	Health centre	
	Leisure places (e.g., park, sport facilities)	
Q6	*Which transport mode do you use for going to these places? You can choose more than one option*	
	The place where you work or study	[MULTIPLE CHOICE] 1: Bus or tram 2: Train 3: Private car as driver 4: Private car as passenger 5: Taxi (or ride-sharing such as Uber) 6: Walking 7: Cycling
	Shopping areas	
	Health centre	
	Leisure places (e.g., park, sport facilities)	

		8: E-scooter 9: Motorcycle 10: I don't go there
Q7	[ASK IF Q6.1=3 OR Q6.2=3 OR Q6.3=3 OR Q6.4=3] How do you feel about driving?	1: I enjoy driving and I do not mind spending time doing it 2: I would prefer to use the time for doing something else, instead of driving
Q8	[ASK IF Q6.1=3 OR Q6.2=3 OR Q6.3=3 OR Q6.4=3] What else do you do while you are travelling by bus, tram, or train? Choose all that apply	[MULTIPLE CHOICE] 1: Talk to other passengers 2: Talk on the phone 3: Work 4: Listen to music or audiobooks 5: Watch videos 6: Other activities on my phone or laptop (e.g. games, social media, browse internet) 7: Sleeping 8: Look outside window 9: Think 10: Nothing 11: Other (please add)
	Awareness of self-driving vehicles	
Q9	Were you aware that self-driving vehicles are being developed and will be used in the future?	1: I am aware I and have been following developments 2: I am aware, but I do not know much about it 3: I was not aware [END QUESTIONNAIRE]
	Concerns	
Q10	Which are your three main concerns about self-driving vehicles?	1: Traffic safety (collisions) 2: Legal issues (will the vehicle owner be liable if something goes wrong?) 3: Vehicle software can be hacked 4: Vehicle is too expensive to buy 5: Who will have access to data from my trips 6: Vehicle software fails during the trip 7: Jobs lost (e.g. drivers) 8: Others (please add) 9: I do not know
	Adoption of self-driving vehicles	
Q11	Would you use a self-driving vehicle?	1: Yes; 2: No; 3: I am not sure
Q12	Would you pay to use (without buying) a self-driving vehicle?	1: Yes; 2: No; 3: I am not sure
Q13	Would you be likely to buy a self-driving vehicle?	1: Yes; 2: No; 3: I am not sure
	Use of travel time in self-driving vehicles	
Q14	If you used a self-driving vehicle, what would you do during the trip?	[MULTIPLE CHOICE] 1: Talk to other passengers 2: Talk on the phone 3: Work 4: Listen to music or audiobooks 5: Watch videos 6: Other activities on my phone or laptop (e.g. games, social media, browse internet)

		7: Sleeping 8: Look outside window 9: Think 10: Nothing 11: Other (please add)

Appendix 3 – Qualitative assessment of impact - activity guide

Materials used both in workshops with citizens and organisations, both physical and online

Task name and aim	Script	Materials	Time (min.)
Welcome and introduction. Participants understand aim of session and research consent	*Thank you very much for joining us this evening. The aim of today's session is to build on ideas and thoughts from previous sessions, as well as what you have told us last week during the online community, to consider the potential impacts of different scenarios for self-driving vehicles for you and your local area. My name is xx, I'm also joined by my colleagues xx* Lead moderator to briefly outline T&Cs of the research: *As a research organisation, we abide by the Market Research Society Code of Conduct and GDPR legislation. We will never include your name within our research reports.* *Nothing you say here today will be directly attributed to you. The only exception to this is if you tell me something that gives me reason to think that you or someone else is at risk of harm. In the unlikely event that this happens, we do have a duty to report this to the relevant authorities.* Lead moderator to present running slides including information on session's purpose, (including what we are trying to find out and why) and go through agenda for the day. *In order for cities and regions to introduce self driving vehicles in ways that benefit citizens, they need to understand the potential impacts. As you know the Move2CCAM project aims to develop a computer model that will help cities and regions test the impacts of self driving vehicles. One important element of the model is predicting the impacts of different types of vehicles or transport service. That's what we're going to look at today. At the end of the session, we will have worked together to draw a map of the impacts that you think four different vehicles/services could have in your city/region. It will look something like this*	Introduction slides	10

	Lead moderator to show simplified causal feedback diagram *This might seem complex, but we will build it up from simple questions and discussion. There are no right or wrong answers, we just want to hear your opinions.*		
Introducing the first use case. Participants are familiar with the use case and warm up to participating	Participants join a breakout group (max 5 people in online workshop, or 8 in physical workshop). See table for allocation of use cases. Moderator to introduce themselves and go around the table asking participants to share their name and something that stood out to them taking part in previous activities of the project Moderator to refresh participants on the baseline conditions then introduce the first use case.	• Baseline conditions and use case slides • [Physical workshop]: post-it notes and pens	5
Exploring impacts in each domain Participants share their views on the impacts specific to each use case/ domain, online community data is validated by wider group	Moderator to screen share draft impact diagram, printed [in physical workshop] or on Miro [in online workshop]. *Now, imagine that we are 12 years in the future and this service has been operating in your area for a while now. This diagram shows the main impacts you told us you would expect. Let's review them together.* Moderator to spend around 15 minutes reviewing central part of diagram and discussing. Each moderator to start with a different domain and work clockwise around the diagram to ensure all domains are covered. *Which impacts are most important to you?* NB: this will help moderators to focus on the areas about which they are most concerned, given that it is not possible to discuss all possible impacts. *Are there any which you disagree with? Or are uncertain about? What's missing from this diagram so far?* Moderator to prompt participants to think about each domain. For each impact moderator to prompt on whether it would be positive or negative, and why and record.	• [Physical]: printed or hand-drawn impact diagram (use case specific), post-it notes, pens • [Online] Impact diagram on Miro board (use case specific)	15
Exploring causal loops Participants	*Now let's take a step back. Let's look in more detail at each domain. Starting with the impacts you think are most important, I want you to think about what the*	As above	20

contribute their views on the causal feedback loops of impacts	*consequences of these impacts are (for example, if there is less air pollution, does this lead to better health outcomes for local people, does it make the city a more appealing place to live and therefore increase house prices).* • *What are the additional impacts in each domain?* • *Are they positive or negative?* • *Do you think any of these impacts will then affect the number of self-driving vehicles in use? (for example, if people see that air quality is improved by using self driving vehicles are they more likely to use them?)* Moderator to capture these feedback loops in the diagram.		
Timeline and penetration analysis	*Now we'd like to get your views on a different question. When do you think this use case will be deployed in your city/region?* [Physical workshop]: Show questions on screen/read out, and have printed slips on tables for ease, table moderators to distribute and collect. [Online workshop]: Moderator to invite participants into the Miro board to individually complete the timeline chart (moderator will share Miro board link in the zoom chat where they can each place-coloured dots where appropriate on the timeline. OR moderators can do this for them if they/participants prefer. *Thinking about this use case, what proportion of the population in your city/region will choose this service instead of a human-driven service in the following years? 2026, 2035, 2050* Moderators can move on to next use case before the allotted time if everything has been covered.	[Physical]: Timeline worksheet (printed). Enough for 3 for each participant. [Online]: Timeline chart on Miro board	10
[Physical workshop only] Repeat exploring impacts. Causal loops and timeline for second use case	See table for allocation of use cases	Impact diagram (use case specific)	30
Identify differences in impacts and	Moderator to explain that they will now be leaving to go to another group to show them their ideas. They will have a new moderator that will present other groups	Impact diagram and timeline	25

causal loops for third use case (Verifying data by sharing between groups)	ideas for the group to review. New moderator to briefly introduce themselves and then spend a few minutes introducing the third use case. *Now we're going to look at a different passenger/freight use case. What do you think would be different in this use case?* Moderator to encourage participants to identify differences based on the application, vehicle type, journey type, operating model etc. *Let's go back to the impact diagram, are there new impacts that you think are important in this use case? Or impacts that wouldn't happen?* Moderator to share copy of impact diagram and adapt in response to participant discussion. *Let's have a look at the timeline for this use case. Would it differ from the others?* Moderator to share copy of timeline for participants to complete. If there is time left moderator to repeat for the fourth use case.	completed for earlier use case	
Close	Moderator to thank participants and remind about next steps.		5

Appendix 4 – Self-driving vehicle demonstration – post-event questionnaire

Thank you for participating in the self-driving vehicle demonstration! Now we will ask you some questions about your experience

Please fill your ID number below. This is a number from 1 to 100 given to you by the event organisers.

SECTION 1: Previous experience

Q1. Had you had any experience involving fully self-driving vehicles <u>before today</u>?

<u>Click all that apply</u>

Yes, I used a self-driving bus before			
Yes, I used a self-driving mini-bus or shuttle before			
Yes, I used a fully self-driving car before			
Yes, I used another type of self-vehicle before		Which one?	
Yes, I saw a self-driving distribution vehicle before			
No, I had never had any of these experiences before			

SECTION 2: Bus

Today you've experienced using two self-driving vehicles (a bus and a mini-shuttle) and you observed a self-driving distribution vehicle. Think about the <u>bus</u> first

Q2. How did you feel while you were riding on the self-driving? <u>Circle all that apply</u>

Sad	Scared	Happy
Alert	Active	Irritated
Confident	Worried	In control
Motivated	Safe	Bored
Content	Annoyed	Pleased
Melancholic	Amused	Surprised

Q3. What were the top three things you liked about the experience?

Q4. And what were the top three things you disliked?

Q5. How safe did you feel during these parts of the trip?

	Very unsafe	Unsafe	Not safe nor unsafe	Safe	Very safe
Boarding					
Bus starting					
Bus moving forward					
Bus turning					
Pedestrian crossing in front of the bus					
Bus stopping					
Getting off the bus					

Q6. Based on your experience riding in the self-driving bus, think about how self-driving buses will compare with buses with a human driver. Which trips you think will be…

	Human driven bus	Self-driving bus	Both will be similar	I don't know
More interesting				
Faster				
Cheaper				
More stressful				
More comfortable				
More dangerous (in terms of accidents)				
More insecure (in terms of crime				

Q7. If self-driving buses become widely available in your area, would you use one?

Yes	
Maybe	
No	

Q8. Which would be your three main concerns about using a self-driving bus?

Q9. How safe would you feel using other modes in streets used by self-driving buses?

	Very unsafe	Unsafe	Not safe nor unsafe	Safe	Very safe	Don't know/ I normally don't use this mode
Walking						
Cycling						

Answer the next two questions if you have already tried the virtual reality experiment today. If you have not tried it yet, go to Q12

Q10. Was there anything you liked in the real bus that you had previously disliked in the virtual bus?

Q11. Was there anything you disliked in the real bus that you had previously liked in the virtual bus?

SECTION 3: Shuttle mini bus

Now think about the shuttle mini bus

Q12. How did you feel while you were riding on the shuttle mini bus? Circle all that apply

Sad	Scared	Happy
Alert	Active	Irritated
Confident	Worried	In control
Motivated	Safe	Bored
Content	Annoyed	Pleased
Melancholic	Amused	Surprised

Q13. What were the top three things you liked about the experience?

Q14. And what were the top three things you disliked?

Q15. How safe did you feel during these parts of the trip?

	Very unsafe	Unsafe	Not safe nor unsafe	Safe	Very safe
Boarding					
Shuttle starting					
Shuttle moving forward					
Shuttle turning					
Shuttle stopping					
Getting off the shuttle					

Q16. Based on your experience riding in the self-driving shuttle mini bus, think about how self-driving shuttles will compare with human-driven shuttle mini buses. Which trips you think will be…

	Human driven shuttle	Self-driving shuttle	Both will be similar	I don't know
More interesting				
Faster				
Cheaper				
More stressful				
More comfortable				
More dangerous (in terms of accidents)				
More insecure (in terms of crime				

Q17. If self-driving shuttle mini buses become widely available in your area, would you use one?

Yes	
Maybe	
No	

Q18. Which would be your three main concerns about using a self-driving shuttle mini bus?

Q19. How safe would you feel using other modes in streets used by self-driving shuttle mini buses?

	Very unsafe	Unsafe	Not safe nor unsafe	Safe	Very safe	Don't know/ I normally don't use this mode
Walking						
Cycling						

SECTION 4: Delivery vehicle

Now think about the delivery vehicle

Q20. What were the top three things you liked about these vehicles?

Q21. And what were the top three things you disliked?

Q22. Based on your experience observing this vehicle, think about how deliveries made by this type of vehicles will compare with deliveries made by vehicles driven by humans (e.g. vans). Which trips you think will be…

	Human driven vehicles	Self-driving vehicles	Both will be similar	I don't know
Faster				
Cheaper				
More dangerous (in terms of accidents)				
More insecure (in terms of stolen deliveries)				

Q23. If self-driving delivery vehicles become widely available in your area, would you order deliveries using one?

Yes	
Maybe	
No	

Q24. Which would be your three main concerns about ordering goods delivered by these vehicles?

Q25. How safe would you feel using other modes in streets used by self-driving delivery vehicles?

	Very unsafe	Unsafe	Not safe nor unsafe	Safe	Very safe	Don't know/ I normally don't use this mode
Walking						
Cycling						

SECTION 5: Final question (self-driving cars)

Q26. If self-driving passenger cars were to become widely available in the future, would you buy one?

Yes	
Maybe	
No	

Appendix 5 – Virtual reality experiments – post-event questionnaire

Thank you for participating the virtual reality experiment! Now we will ask you some questions about your experience

Please fill your ID number below. This is a number from 1 to 100 given to you by the event organisers

SECTION 1: Your choices

Q1. <u>When the experiment started</u>, which vehicle did you choose?

Car	
Bus	

Q2. Why did you choose that vehicle?

Q3. Did you switch to the other vehicle during the trip (from car to bus or from bus to car)?

Yes		Go to Q4
No		Go to end of this page

Q4: Why did you switch to the other vehicle?

Q5: Did you regret switching to the other vehicle?

Yes		Go to Q6
No		Go to end of this page

Q6: Why do you regret switching to the other vehicle?

If you switch modes during the trip, fill all sections (2, 3, 4)

If you tried only the bus, without switching to car, fill sections 2 and 4 only

If you tried only the car, without switching to bus, fill sections 3 and 4 only

SECTION 2: Bus

Answer only if you travelled in the virtual bus (in the beginning or after switching from car)

If you did not travel in the bus at all, go to Section 3

Q7. How did you feel during the virtual bus trip? Circle all that apply

Sad	Scared	Happy
Alert	Active	Irritated
Confident	Worried	In control
Motivated	Safe	Bored
Content	Annoyed	Pleased
Melancholic	Amused	Surprised

Q8. What are the three things you remember the most from the bus trip?

Q9. Which changes have you noticed in the things you saw during the bus trip? Choose all that apply.

Type of buildings outside			
Time of day			
Speed of the bus			
Speed of cars in the other lanes			
Number of other passengers in the bus			
Behaviour of other passengers			
Presence or absence of a human assistant			
Other		What?	
I did not notice any change			

Q10. Overall, how realistic was the bus scenario?

Very realistic	
Realistic	
Neither realistic nor unrealistic	
Unrealistic	
Very unrealistic	
I don't know	

Q11: What was not realistic in the scenario?

Q12. Based on what you experienced in virtual reality, think about how trips on self-driving buses will compare with trips on buses with a human driver. Which trips will be…

	Human driven bus	Self-driving bus	Both will be similar	I don't know
More interesting				
Faster				
Cheaper				
More stressful				
More comfortable				
More dangerous (in terms of accidents)				
More insecure (in terms of crime				

Q13. Answer this questions only if you have already tried the real self-driving bus today

Was there anything you liked in the virtual bus that you had previously disliked in the real bus?

Q14. Answer this questions only if you have already tried the real self-driving bus today

Was there anything you disliked in the virtual bus that you had previously liked in the real bus?

SECTION 3: Car

Answer only if you travelled in the virtual car (in the beginning or after switching from bus)
If you did not travel in the car at all, go to Section 4

Q15. How did you feel during the virtual bus trip? Circle all that apply

Sad	Scared	Happy
Alert	Active	Irritated
Confident	Worried	In control
Motivated	Safe	Bored
Content	Annoyed	Pleased
Melancholic	Amused	Surprised

Q16. What are the three things you remember the most from the car trip?

Q17. Which changes have you noticed in the things you saw during the car trip? Choose all that apply.

Type of buildings outside			
Time of day			
Speed of the car			
Speed of buses in the other lanes			
Other		What?	
I did not notice any change			

Q18. Overall, how realistic was the car scenario?

Very realistic	Very unrealistic	
Realistic	Unrealistic	
Neither realistic nor unrealistic	Neither realistic nor unrealistic	
Unrealistic	Realistic	
Very unrealistic	Very realistic	
I don’t know	I don’t know	

Q19: What was not realistic in the scenario?

Q20. Based on what you experienced in virtual reality, think about how trips on self-driving cars will compare with trips on cars with a human driver. Which trips do you think will be…

	Human driven car	Self-driving car	Both will be similar	I don't know
More interesting				
Faster				
Cheaper				
More stressful				
More comfortable				
More dangerous (in terms of accidents)				
More insecure (in terms of crime				

SECTION 4: Your future travel

Q21. If self-driving buses become widely available in your area, would you use one?

Yes	
Maybe	
No	

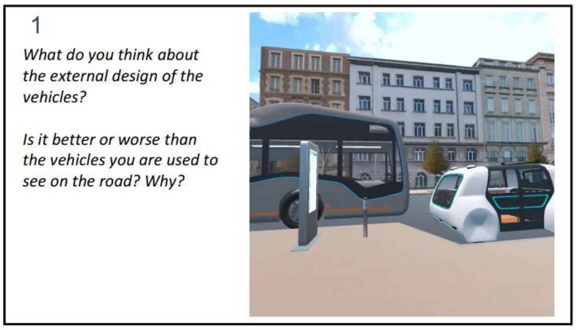
Q22. If self-driving cars become widely available in your area, would you use one?

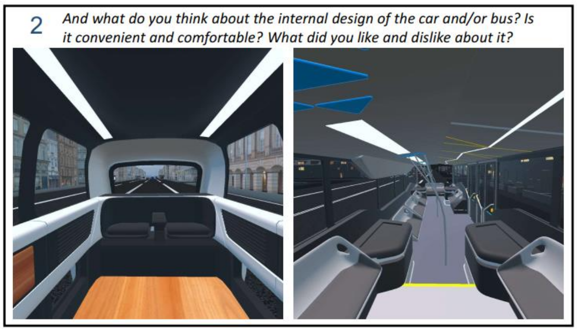
Yes	
Maybe	
No	

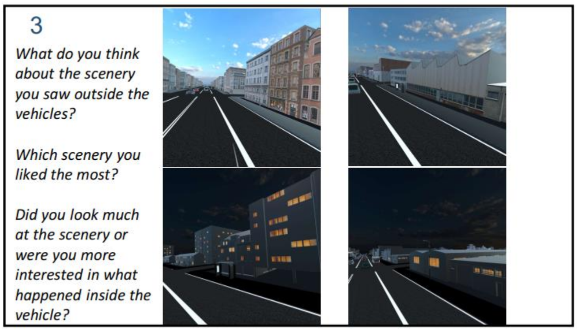
Q23. How do you think your travel would change if you could use self-driving vehicles?

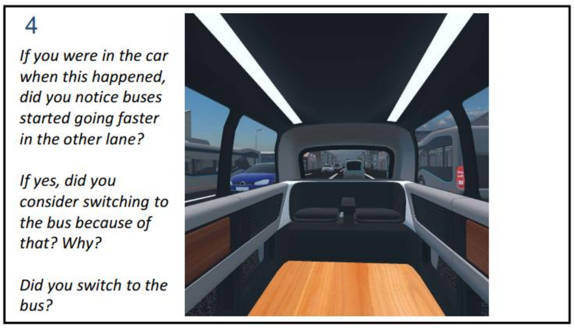
I would do something productive while travelling, which I cannot do now	
I would do something enjoyable or relaxing while travelling, which I cannot do now	
I would worry less about parking	
I would travel by car more often	
I would travel by bus more often	
Regardless of vehicle, I would make more trips than I do now	

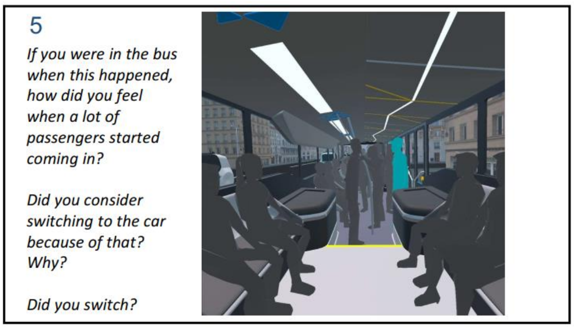
Appendix 6 – Virtual reality experiment – group discussion guide

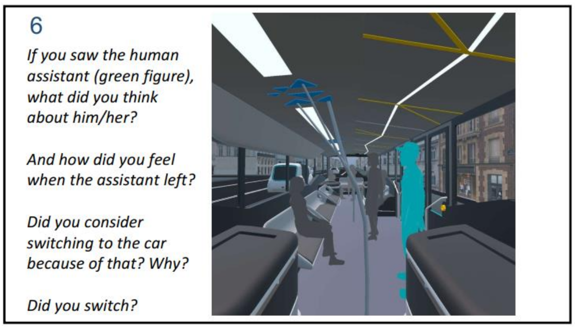


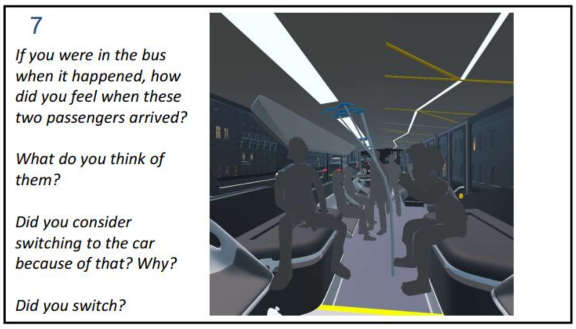












8

If you were in the bus when it happened, how did you feel when all passengers left?

Is there anything else you would like to share with us about the virtual reality experiment?

Appendix 7 – Pan-European survey on impact on citizens - Questionnaire

1	**Participant Characteristics**	
Q01	In which country do you live?	
Q02	In which region do you live?	
	Now we will ask you some questions about yourself. Please remember that your answers to this and all other questions are always treated confidentially. You can choose not to answer if you don't feel comfortable answering this question.	
Q1	How old are you?	
Q2	How would you describe your gender?	1: Woman; 2: Man; 3: Other; 4: Prefer not to say
Q3	What is the highest educational level that you have achieved to date?	1 No formal education 2 Primary school 3 Secondary school or vocational education 4 University degree or equivalent professional qualification 5 Higher university degree (e.g. Master's, MBA, doctorate) 6 Still in full time education 7 Prefer not to say
Q4	Which of the following best describes where you live?	1 City or town centre 2 City or town, not in centre 3 Suburbs (far from city or town centre) 4 Village
Q5	How would you describe yourself in terms of adopting technologies and innovations? I consider myself	1 Innovator 2 Early adopter 3 Early majority 4 Late majority 5 Laggard
Q6	How would you describe yourself in terms of using technologies and innovations in your daily life? I consider myself	1 Very confident in using technology in my daily life 2 Somewhat confident in using technology in my daily life 3 Neutral 4 Somewhat not confident in using technology in daily life 5 Not confident in using technology in my daily life

2	**Travel Behaviour Characteristics**	
	Let's start with some questions about how you travel.	
Q7	Do you have a valid driving licence?	1: Yes; 2: No; 3: I'd rather not say
Q8	How many private cars does your household own?	
Q9	What is the most frequent trip you make?	1 To go to the place I work/study 2 To go shopping 3 To meet friends and family 4 For leisure activities (e.g. go to park) 5 For personal businesses (e.g. go to health centre, go to bank). 6 To pick-up /drop-off family members 7 Other

Q10	What is the duration (in minutes) of your most frequent trip?	
Q11	*How many trips do you conduct with each of the below transport modes within a week? Home-work-home are two trips.*	
	Private car as driver (driving alone)	
	Private car as a driver (driving with other passengers on board)	
	Private car as passenger	
	Bus or tram	
	Train or underground	
	Taxi or ride-sharing (such as Uber)	
	Walking	
	Cycling or e-scooter	
	Motorcycle	
Q12	How much do you spend each month in Euros on the following transport modes?	
	Car (take into account parking, fuel, maintenance, tickets - all related costs)	
	Taxi / Uber	
	Public transport (e.g., bus, train, tram, underground, metro)	
Q13	Rank the three most important factors that affect your transport mode choice for your main trips.	Travel time Travel cost Convenience and comfort Parking availability Reliability (mode to be on time) No need to combine/change tr. modes Waiting time Safety Other
Q14	How often do you receive deliveries for things you order online or by phone?	1 Never 2 Few times per year (1-5 times per year) 3 Few times per month (2-3 times per month) 4 Few times per week (2-3 times per week) 5 Almost every day (1 or more times a day)
Q15	What are these deliveries about? Please, select all that apply.	1 Food delivery 2 Super market delivery 3 Clothes delivery 4 Other
Q16	Including yourself, how many people live in your household?	
Q17	How many children (<18) live with you?	
Q18	How often do you escort them to school or after-school activities in a week?	1 Never 2 Once per week 3 Few times per week 4 Once per day 5 Several times per day
Q19	How do you describe your employment situation?	1 Currently not working 2 Working part-time 3 Working full-time 4 Student 5 Retired

		6 Homemaker 7 Prefer not to say
Q20	Do you have any health issue that hinders your mobility?	1: Yes; 2: No; 3: I'd rather not say
Q21	Does any of your family members have any health issue hinders their mobility	1: Yes; 2: No; 3: I'd rather not say

3	**Self-driving vehicles and services for your personal mobility**	
	This section is about self-driving vehicles. A self-driving vehicle is a vehicle that is capable of traveling without human input. Self-driving cars are responsible for perceiving the environment, monitoring important systems, and control, including navigation. In other words, a self-driving vehicle does not need a driver any more.	
Q22	How well aware are you about self-driving vehicles?	1 I am not aware of self-driving vehicles 2 I have only listened about self-driving vehicles, but I do not know much 3 I am aware of self-driving vehicles 4 I am well aware of self-driving vehicles
	Imagine that now almost half of the current vehicles in the area where you live are self-driving. By having this in mind, please see below scenarios of self-driving vehicles and services and answer the questions that follow each scenario. The questions are related to the impact each specific scenario may have in your daily travel behaviour.	

Self-driving taxi

The self-driving taxi allows you to order a self-driving vehicle whenever you want to go somewhere. The self-driving taxi can be used only by you or you can share it with others (strangers) if you want to.

Characteristics of the service:

- Order the self-driving vehicle whenever you need to make a trip
- There is a waiting time for the vehicle to arrive
- There is no need for searching for parking
- Just you or you can share it with up to 3 strangers

Q23	*Self-driving taxis are now available in the area where you live. Given that the cost and travel time are the same as of using a conventional taxi today, how likely is that you will be using a self driving taxi:*	
	for your commute trips?	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
	for your non-commute trips?	
	for your kids to go to their activities?	

Q24	How do you expect your current travel time of your most frequent trip (that currently is [Q10] to change (in minutes)?	-120 to +120
Q25	*Assuming that the cost and travel time of self-driving taxis are the same as of today's taxis, how do you expect the below to be affected?*	
	total number of your current weekly trips (you can insert negative or positive numbers).	-20 to 20
	your current parking needs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	your current residential location	-2 = Relocate to a rural area, -1 =Relocate to city's suburbs, 0=No change, 1=Relocate closer to the city centre, 2= Relocate to the city centre
Q26	*How many of your current weekly trips would you substitute with self-driving taxi*	
	Private car as driver (driving alone)	1 = None of them (0%), 2 = Few of them (up to 33%), 3=About half of them (33%-66%), 4=Most of them (66%-99%), 5= All of them (100%)
	Private car as a driver (driving with other passengers on board)	
	Private car as passenger	
	Bus or tram	
	Train or underground	
	Taxi or ride-sharing (such as Uber)	
	Walking	
	Cycling or e-scooter	
	Motorcycle	
Q27	For which trip purpose(s) would you use a self-driving taxi?	1 To go to the place I work/study 2 To go shopping 3 To meet friends and family 4 For leisure activities (e.g. go to park) 5 For personal businesses (e.g. go to health centre, go to bank) 6 To pick-up /drop-off family members 7 Other (specify)
Q28	How much would you be willing to pay for an up to 3km (around 15min) ride with a self-driving taxi?	
Q29	Would you be willing to share the ride with one or more strangers?	1 Yes 2 No, I would like to be alone or with people I know 3 I am not planning to use one

Self-driving private car

The self-driving private car operates similarly to a privately owned vehicle, but this time nobody needs to drive. You can access your self-driving car whenever you need to go somewhere, but it may be needed to spend time to find a parking place.

Characteristics of the service:

- You access your car immediately whenever you need it.
- It may be needed to spend time to find a parking place.
- It may be needed to pay for the parking.
- Just you or members from your household travel with you.

Q30	How likely is it to buy/lease a private self-driving car? There is no need to have a driving license to purchase one.	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
Q31	How much would you be willing to pay for a self-driving sedan (5-seat) car? Take as a basis that the average current value of an electric sedan is around 30,000 Euro.	
Q32	What type of car would you like your self-driving vehicle to be?	1: city car; 2: sedan; 3: SUV; 4: sports car / roadster; 5: pickup truck; 6: pod; 7: I do not want to buy a self-driving private car
Q33	*Given that the cost and travel time are the same as of using a conventional electric car, how likely is that you will be using a self driving private car:*	
	for your commuting trips	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
	for your non-commuting trips	
	for your kids to go to their activities	
Q34	How do you expect your current travel time of your most frequent trip (that currently is [Q10] to change (in minutes)?	-120 to +120
Q35	*Assuming that the cost and travel time of self-driving private car are the same as of today's cars, how do you expect the below to be affected?*	
	the total number of your current weekly trips (you can insert negative or positive numbers).	-20 to 20
	your current parking needs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	your current residential location	-2 = Relocate to a rural area, -1 =Relocate to city's suburbs, 0=No change, 1=Relocate closer to the city centre, 2= Relocate to the city centre
Q36	*How many of your current weekly trips would you substitute with self driving private car?*	
	Private car as driver (driving alone)	1 = None of them (0%), 2 = Few of them (up to 33%), 3=About half of them (33%-66%), 4=Most of them (66%-99%), 5= All of them (100%)
	Private car as a driver (driving with other passengers on board)	
	Private car as passenger	
	Bus or tram	

	Train or underground	
	Taxi or ride-sharing (such as Uber)	
	Walking	
	Cycling or e-scooter	
	Motorcycle	
Q37	For which trip purpose(s) would you use a self-driving private car?	1 To go to the place I work/study 2 To go shopping 3 To meet friends and family 4 For leisure activities (e.g. go to park) 5 For personal businesses (e.g. go to health centre, go to bank) 6 To pick-up /drop-off family members
Q38	You pay [Q12a] Euros monthly for operating and maintaining your private car(s). How much would you be willing to pay per month to use and maintain a self-driving private car?	

Self-driving public bus

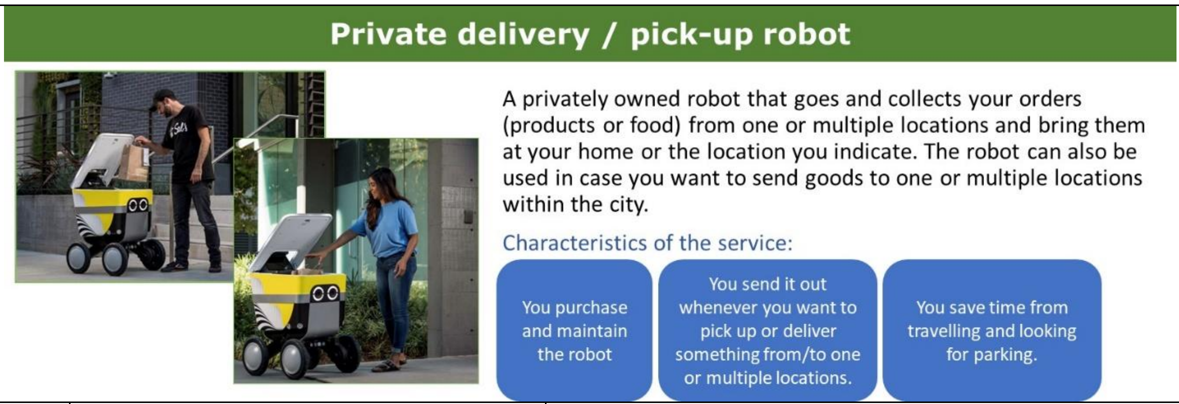
The self-driving bus operates similarly to the current public buses, but this time there is no driver. You should go to a bus stop; wait for the bus that goes to the direction you would like to go; get off to the bus stop and walk/cycle to your destination.

Characteristics of the service:

- You walk to the bus stop
- You wait for the right bus to arrive
- You get off the bus and walk to your destination
- Other passengers are on the bus

Q39	*Self-driving public buses are now available in the area where you live. Given that the cost and travel time are the same as of using a today's conventional public bus, how likely is that you will be using a self driving public bus*	
	for your commuting trips	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
	for your non-commuting trips	
	for your kids to go to their activities?	
Q40	How do you expect your current travel time of your most frequent trip (that currently is [Q10] to change in minutes?	-120 to +120
Q41	Assuming that the cost and travel time of self-driving public buses are the same as of today's public buses, how do you expect the below to be affected?	
	total number of your current weekly trips (you can insert negative or positive numbers).	-20 to 20
	your current parking needs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)

	your current residential location	-2 = Relocated to a more rural area, -1 =Relocated to city's suburbs, 0=No change, 1=Relocated closer to the city centre, 2= Relocated to the city centre
Q42	*How many of your current weekly trips would you substitute with self-driving bus?*	
	Private car as driver (driving alone)	1 = None of them (0%), 2 = Few of them (up to 33%), 3=About half of them (33%-66%), 4=Most of them (66%-99%), 5= All of them (100%)
	Private car as a driver (driving with other passengers on board)	
	Private car as passenger	
	Bus or tram	
	Train or underground	
	Taxi or ride-sharing (such as Uber)	
	Walking	
	Cycling or e-scooter	
	Motorcycle	
Q43	For which trip purpose(s) would you use a self-driving bus?	1 To go to the place I work/study 2 To go shopping 3 To meet friends and family 4 For leisure activities (e.g. go to park) 5 For personal businesses (e.g. go to health centre, go to bank) 6 To pick-up /drop-off family members



Q44	How much would you be willing to pay for a one-way ticket with the self-driving bus?	
Q45	How likely is that you will be using a private delivery/pick-up robot?	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
Q46	*Assuming that the cost/time of private delivery/pick-up robots are the same as today's conventional delivery service, how you expect the below to be affected?*	
	current number of monthly online orders (you can insert negative or positive numbers).	-20 to 20
	total number of your current weekly trips (you can insert negative or positive numbers).	-20 to 20
	your current parking needs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)

	your current residential location	-2 = Relocated to a more rural area, -1 =Relocated to city's suburbs, 0=No change, 1=Relocated closer to the city centre, 2= Relocated to the city centre
	your current delivery costs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
Q47	How many of your deliveries would you substitute with private delivery/pick-up robots in a month?	1 = None of them (0%), 2 = Few of them (up to 33%), 3=About half of them (33%-66%), 4=Most of them (66%-99%), 5= All of them (100%)
Q48	How useful would you think the private delivery/pick-up robot would be for your work (the organisation you work for)?	1: Not useful at all; 2: Somewhat not useful; 3: Neutral; 4: Somewhat useful; 5: Very useful

Delivery drone

A delivery drone owned by a delivery service that picks-up and drops-off your order at your home or the location you indicate. The drone can also be used for small-backpack size products, goods or food items within the city.

Characteristics of the service:

- The delivery service purchases and maintains the drone
- The delivery service sends it out to pick up your order and to drop it off at your specified location.
- You save time from travelling and looking for parking.

Q49	How likely is that you will be using a delivery drone?	1: Highly unlikely; 2: Somewhat unlikely; 3: Neutral; 4: Somewhat likely; 5: Highly likely
Q50	*Assuming that the cost/time of delivery drones are the same as of today's conventional delivery service, how do you expect the below to be affected?*	
	your current number of monthly online orders (you can insert negative or positive numbers).	-20 to 20
	the total number of your current weekly trips (you can insert negative or positive numbers).	-20 to 20
	your current parking needs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	your current residential location	-2 = Relocated to a more rural area, -1 =Relocated to city's suburbs, 0=No change, 1=Relocated closer to the city centre, 2= Relocated to the city centre
	your current delivery costs	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
Q51	How many of your deliveries would you substitute with delivery drone within a month?	1 = None of them (0%), 2 = Few of them (up to 33%), 3=About half of them (33%-66%), 4=Most of them (66%-99%), 5= All of them (100%)
Q52	How useful would you think that the drone delivery would be for your work (the organisation you work for)?	1: Not useful at all; 2: Somewhat not useful; 3: Neutral; 4: Somewhat useful; 5: Very useful

4	**Needs and Requirements**	
	Now that you have seen different scenarios of self-driving vehicles, we would like to ask you about further requirements that you may have from these vehicles or services.	
Q53	When considering self driving vehicles and services, which three of the below options would you use the most for your trips? Rank from 1=the most preferred, to 3=preferred	1 Self driving taxi 2 Self driving private car 3 Self driving pod (small 2-seater vehicle for short trips) 4 Self driving public bus 5 Self driving on-demand shuttle bus 6 None
Q54	Which one of the below options would you use the most for your <u>commute trips</u>?	1 Self driving taxi 2 Self driving private car 3 Self driving pod (small 2-seater vehicle for short trips) 4 Self driving public bus 5 Self driving on-demand shuttle bus 6 None of the above
Q55	*By when do you think that the below self-driving services/vehicles will start being implemented in the area where you live?*	
	Self-driving taxi	1= 2030, 2=2035, 3=2040, 4=2045, 5=2050, 6= Never
	Self-driving private cars	
	Self driving pods	
	Self driving public bus	
	Self driving on-demand shuttle bus	
Q56	What activities would you make while travelling with a self-driving vehicle?	Work / Study Talk on the phone Surf the web Sleep Watch movies Have a meal Focus on the road Other

5	**Attitudes regarding the impact self-driving vehicles will have in general**	
	This section presents potential impacts that self-driving vehicles may have in different sectors. Indicate what the impact you think it would be.	
Q57	**Impact on Mobility**	
	Citizens' number of trips	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Citizens travel time	
	Travel costs for citizens' trips	
	Ownership of conventional priv. vehicles	
	Ownership of self-driving vehicles	
	Usage of self-driving shared services (public transport, car clubs)	
	Citizens' number of trips for shopping	
	Delivery costs	
Q58	**Impact on Network**	
	Number of vehicles on the network	-2 = Reduced significantly (50% reduction or more), -

	Traffic congestion	1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
Q59	**Impact on Land use**	
	Number of people who live in rural areas	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Number of people who live in the city centres	
	Demand for parking spaces in the city centres	
	Demand for redesign transport infrastructure	
Q60	**Impact on the Environment**	
	Transport sector's emissions	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Demand for electricity to charge self-driving vehicles	
	Noise pollution	
Q61	**Impact on Economy**	
	Economic growth	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Investments	
	Job losses	
	New skills requirements	
Q62	**Equity**	
	Accessibility of general population	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Accessibility of people with special mobility needs	
	Accessibility of older people	
	Accessibility of families with kids	
	Employment opportunities	
Q63	**Public health**	
	Stress related to travelling	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Access to healthcare	
	Emergency response	
Q64	**Safety**	
	Number of traffic accidents	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
	Number of traffic fatalities	
	Number of traffic violations and tickets	
	Number of harassment events while travelling	
Q65	**Security**	
	Number of cyber-attacks related to transport sector	-2 = Reduced significantly (50% reduction or more), -1 =Reduced (up to 50% reduction), 0=No change, 1=Increase (up to 50% increase), 2= Increase significantly (50% increase or more)
Q66	**Other impacts**	
	Feel free to write any other impacts that self-driving vehicles will have.	

Appendix 8 – Impact of self-driving freight vehicles – questionnaire

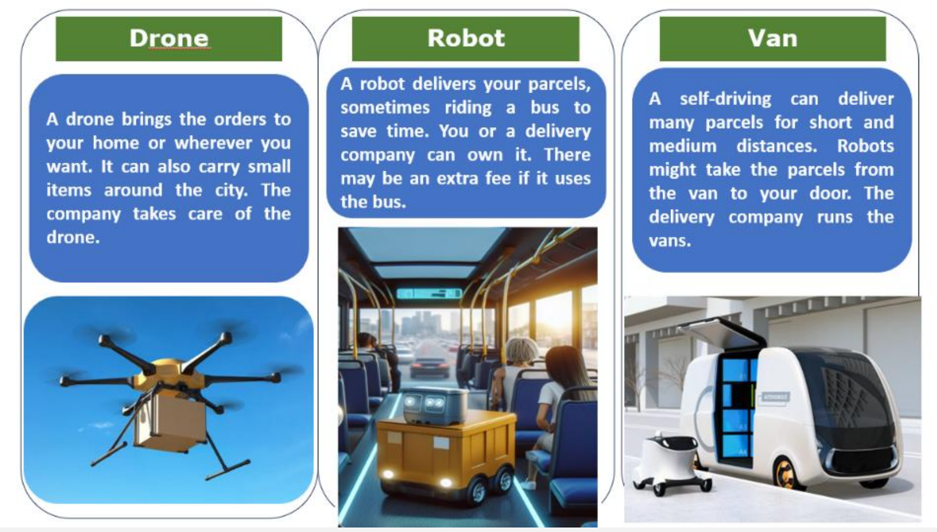
1	**Background questions**	
Q1	In which region do you live?	1 North East England 2 North Wast England 3 Yorkshire and the Humber 4 East Midlands 5 West Midlands 6 East of England 7 London 8 South East 9 South West 10 Wales 11 Scotland 12 Northern Ireland 13 Not in UK (THANK YOU CLOSE)
	Now we will ask you some questions about yourself.	
Q2	How old are you?	
Q3	How would you describe your gender?	1: Woman; 2: Man; 3: Other; 4: Prefer not to say
Q4	What is the highest educational level that you have achieved to date?	1 No formal education 2 Primary school 3 Secondary school or vocational education 4 University degree or equivalent professional qualification 5 Higher university degree (e.g. Master's, MBA, doctorate) 6 Still in full time education 7 Prefer not to say
Q5	Please provide the first three digits of your postal code to indicate your general location where you live. (e.g. If you live at SW1A 1AA, then put SW1)	
Q6	How do you describe your employment situation?	1 Currently not working 2 Working part-time 3 Working full-time 4 Student 5 Retired 6 Homemaker 7 Prefer not to say
Q7	*How many trips do you make with these modes in a usual week?* *Note: home to work and back is two trips*	
	Private car as driver	
	Private car as passenger	
	Bus	
	Train/tube	
	Walking	
	Cycling	
Q8	Does your home have a garden or terrace?	1: Yes 2: No

Q9	How would you describe yourself in terms of adopting technologies and innovations? I consider myself	1 I like to try new technologies and innovations as soon as they are available. 2 I embrace new technologies and innovations relatively early in their lifecycle. 3 I prefer to adopt technologies and innovations once they have become well-established. 4 I adopt technologies and innovations only after they have become widely accepted by others. 5 I am cautious about adopting new technologies and innovations and prefer to stick with traditional methods.
Q10	You consider yourself	1 Very confident in using technology in my daily life 2 Somewhat confident in using technology in my daily life 3 Neutral 4 Somewhat not confident in using technology in daily life 5 Not confident in using technology in my daily life
Q11	How well aware are you about self-driving delivery vehicles such as delivery robots, self-driving vans, and delivery drones?	1 I am not aware of self-driving delivery vehicles 2 I have only listened about self-driving delivery vehicles, but I do not know much 3 I am aware of self-driving delivery vehicles 4 I am well aware of self-driving delivery vehicles

2	**Delivery Behaviour and Experience**	
Q12	Please rank factors that affect your choice of delivery options from 1 to 8, with 1 being the most important and 8 being the least important to you	Time from order to delivery Cost Chance of delivery problems Flexible delivery slots Flexible delivery address Delivery time window Human interaction Delivery location
	The following questions are about your delivery preference as a receiver. Notice: For this survey, "online orders" include household items, supermarket deliveries, and any packages you receive. This includes both home delivery and click-and-collect services.	
Q13	*In a usual month, how many online orders did you receive before and after COVID? (Please provide numerical values in the box)*	
	Household and other personal items	
	Supermarket orders	
	Clothes orders	
	Others (Please specify)	

Q14	*How often do you use these delivery methods now, compared with before COVID?*	
	Orders received at home	1 I've never used this method 2 Less often now than before COVID 3 No change 4 More often now than before COVID
	Pick up from pickup points (e.g. local corner shops)	
	Pick up orders from a locker	
	Pick up from the store/shop	
	Go to the shop and buy	
	The following questions are about returning delivered orders you previously bought.	
Q15	How often do you return things you ordered online now compared to before the COVID-19 pandemic?	1 I return orders less frequently now than before Covid 2 About the same 3 I return orders more frequently now than before Covid
Q16	*Please indicate the degree of change for each category of return online orders since the COVID-19 pandemic.*	
	Household and other personal items	1 Never return 2 Less often 3 No change 4 More often
	Supermarket orders	
	Clothes orders	
	Others (Please specify)	
Q17	*How often do you return items using the following methods, compared with before COVID?*	
	Pick up from your door	1 I've never used this method 2 Less often now than before COVID 3 No change 4 More often now than before COVID
	Drop off at the delivery point	
	Drop off at a locker	
	Drop off at the store/shop	
	Let's look at some questions about your experiences with delivery when something goes wrong.	
Q18	How many times have your deliveries arrived late in the last 6 months?	1 Never 2 1-2 times 3 3-4 times 4 More than 5 times 5 I did not order anything in last 6 months
Q19	How many times have your deliveries been stolen during the last 6 months?	1 Never 2 1-2 times 3 3-4 times 4 More than 5 times 5 I did not order anything in last 6 months
Q20	How many times have the goods you ordered been damaged during the last 6 months?	1 Never 2 1-2 times 3 3-4 times 4 More than 5 times 5 I did not order anything in last 6 months

3	**Views on automation in freight transport**
	This section is about your views on the use of self-driving delivery vehicles such as delivery robots, self-driving vans, and delivery drones to deliver packages that you order online. Please read the following introduction of these vehicles.



Imagine you want to order some household items online and need them as soon as possible. There are different options for delivery, using conventional vans (driven by humans), self-driving vans, self-driving robots, and self-driving drones.

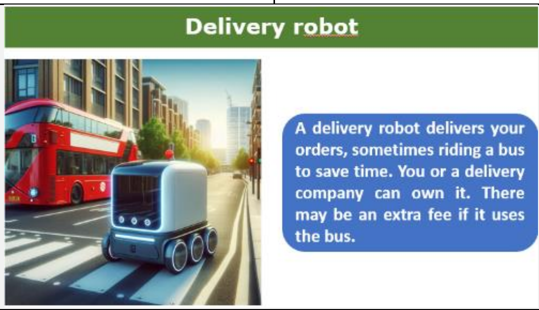
We will now show you 6 questions. Each question has 4 options for delivering your package. In each question, we will ask you to choose the option you prefer.

When choosing, please consider:

- *Delivery location - Where the orders are dropped off - e.g. front door, walk to vehicle (up to 3 minutes), garden/terrace*
- *Human interaction - The amount of contact you have with another person during the delivery process – e.g. no interaction OR contact delivery company via telephone OR contact driver*
- *Time from order to delivery - How long it takes for the package to arrive - e.g. 1 day,2 days, 3 days*
- *Delivery window - The time interval to deliver your package - e.g. 0.5 hour, 1 hour or 2 hours. For example, "delivery between 2pm and 4pm" is a 2-hour delivery window*
- *Delivery problems - How likely the delivery will go wrong such as being late, delivered to a wrong address, lost, or not received - e.g. 5%, 10%, 15%*
- *Cost - How much does it cost - e.g. £2, £4, £6*

Look at the following four options

	Conventional van	**Self-driving van**	**Delivery robot**	**Delivery drone**
Delivery location	Front door	Walk to vehicle (up to 3 minutes)	Front door	Front door
Human interaction	Driver	Delivery company via telephone	No	No
Time from order to delivery (days)	3 days	1 day	1 day	2 days
Delivery time window (hours)	2 hours	2 hours	1 hour	2 hours
Delivery problems (%)	10%	5%	10%	5%
Cost (£)	4	2	2	4

Q21	Which vehicle do you prefer?	1 Self-driving van 2 Delivery robot 3 Delivery drone 4 Conventional van
Q21a	Why did you choose that option?	
Q22-Q26	[as Q21, different options shown]	
Q27	How easy it was to compare the options and make choices?	1 Very easy 2 Easy 3 Neutral 4 Difficult 5 Very Difficult
Q28	[IFQ27 =4] Why it is "Very Difficult"?	
Q29	[IFQ27=5] Why it is "Difficult"?	
		
Q30	*Please choose how much you agree or disagree with each statement about delivery robots.*	
	I will be using a robot when available for deliveries	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree
	I will be using the service of a robot to return items	
	Using robot delivery will be convenient	
	The robot will make deliveries faster	
	The conventional delivery with a driver will be more on-time than robot	
	The order carried by the robot might be stolen	
	The robot and/or its contents might be damaged by someone	
	The delivery may take too long	
	The robot might damage the package	
	The robot might injure someone	
	The robot might deliver to a different address	
	The robot might fail to deliver in bad weather	
		

Q31	*Please choose how much you agree or disagree with each statement about self-driving vans.*	
	I will be using a self-driving van when available for deliveries	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree
	I will be using the service of a self-driving van to return items	
	Using self-driving van delivery will be convenient	
	The self-driving van will make deliveries faster	
	The conventional delivery with a driver will be more on-time than self-driving van	
	The order carried by the self-driving van might be stolen	
	The self-driving van and/or its contents might be damaged by someone	
	The delivery may take too long	
	The self-driving van might damage the package	
	The self-driving van might injure someone	
	The self-driving van might deliver to a different address	
	The self-driving van might fail to deliver in bad weather	
		
Q32	*Please choose how much you agree or disagree with each statement about delivery drones.*	
	I will be using a drone when available for deliveries	1 Strongly disagree 2 Disagree 3 Neutral 4 Agree 5 Strongly agree
	I will be using the service of a drone to return items	
	Using drone delivery will be convenient	
	The drone will make deliveries faster	
	The conventional delivery with a driver will be more on-time than drone	
	The order carried by drone might be stolen	
	The drone and/or its contents might be damaged by someone	
	The parcel delivery may take too long	
	The drone might damage the package	
	The drone might injure someone	
	The drone might deliver to a different address	
	The drone might fail to deliver in bad weather	

Q33	Would you worry about these issues if your orders are delivered to your home by self-driving delivery vehicles?	
	The vehicle technology might fail	1 Not at all 2 Slightly 3 Moderately 4 A bit 5 Very much
	Hacking might cause vehicle accidents	
	Someone might track your location	
	The vehicle might record you on audio or video	

4	**Road user attitudes**	
	Imagine a scenario in the future when half of the vehicles on the road are self-driving. How comfortable would you feel with these situations?	
Q34	You are on a conventional bus and a delivery robot gets on the bus. How would you feel?	1 Uncomfortable 2 Somewhat uncomfortable 3 Neutral 4 Somewhat comfortable 5 Comfortable
	You are on a self-driving bus and a delivery robot gets on the bus. How would you feel?	
	You are walking on the street and the delivery robots and self-driving vans drive past. How would you feel?	
	Delivery robot	
	Self-driving van	
	You are cycling on the street and delivery robots and self-driving vans drive past, how would you feel?	
	Delivery robot	
	Self-driving van	
	You are driving a conventional car on the street and delivery robots and self-driving vans drive past. How would you feel?	
	Delivery robot	
	Self-driving van	
	You are sitting on a private self-driving car and delivery robots and self-driving vans drive past. How would you feel?	
	Delivery robot	
	Self-driving van	
	How would you feel about a drone flying above you with a small parcel?	
Q35	*How concerned are you about these possible situations?*	
	Self-driving delivery vehicles might cause traffic jams and travel delays	1 Very concerned 2 Moderately concerned 3 Somewhat concerned 4 Slightly concerned 5 Not concerned
	Robots and/or its content on the bus might cause harm to passengers	
	Self-driving delivery vehicles on the street might crash other vehicles or people	
	Cameras or sensors on these vehicles capturing information about people on the street	

5	**Impacts on daily life**	
Q36	*Imagine a future where self-driving vehicles are widely used to make deliveries. Think about how your life would change. Do you agree or disagree with these statements?*	
	I would work more from home.	1 Strongly disagree 2 Somewhat disagree 3 Neither agree nor disagree 4 Somewhat agree 5 Strongly agree
	I would meet people in person more.	
	My life would be more stressful.	
	I would have more time to do things I want.	
	I would go out for shopping more often.	
	I would take more public transport.	

Appendix 9 – Pre-events questionnaire - organisations

Q0	Please fill your ID number. This is a number from 1 to 100 given to you by the event organisers	
	Type of organisation	
Q1	Which type of organisation do you represent?	1: Freight and logistic operators 2: Passenger transport operator 3: Transport infrastructure operators 4: Vehicle manufacturer/developer 5: Fuel provider 6: Health expert 7: Telecommunications/ cybersecurity 8: Authority or regulatory body 9: Autonomous vehicle demonstration areas 10: Research organisation 11: NGO 12: Other (please specify)
Q2	What is the geographical coverage of the organisation you represent?	1: International 2: Europe 3: Country (which one?) 4: Region (which one?) 5: City (which one?)
Q3	Were you aware that self-driving vehicles are being developed and will be used in the future?	1: I am aware I and have been following developments 2: I am aware, but I do not know much about it 3: I was not aware [END QUESTIONNAIRE]
Q4	[ASK ONLY IF Q3=1 OR Q3=2] Do you have a positive or negative view of self-driving cars?	1: Positive; 2: Negative; 3: Uncertain
Q5	[ASK ONLY IF Q3=1 OR Q3=2] Which are your three main concerns about self-driving vehicles?	[MULTIPLE CHOICE] 1: Traffic safety (collisions) 2: Legal issues (will the vehicle owner be liable if something goes wrong?) 3: Vehicle software can be hacked 4: Vehicle is too expensive to buy 5: Who will have access to data from my trips 6: Vehicle software fails during the trip 7: Jobs lost (e.g. drivers) 8: Others (please add) 9: I do not know
Q6	[ASK ONLY IF Q3=1 OR Q3=2] *How likely it is that the following groups will benefit from self-driving vehicles?*	
	Individuals who cannot drive because of age or disability	1: Extremely likely 2: Likely 3: Neither likely nor unlikely 4: Unlikely 5: Extremely unlikely
	Individuals who do not want to drive or do not have a driving licence	
	Tourists	

	Individuals with high income Individuals with low income Companies delivering goods Consumers receiving goods	
Q7	[ASK ONLY IF Q3=1 OR Q3=2] Q7: What will be the three most influential actors in the deployment of self-driving vehicles?	[MULTIPLE CHOICE] 1: Freight and logistic operators 2: Passenger transport operator 3: Transport infrastructure operators 4: Vehicle manufacturer/developer 5: Fuel provider 6: Health expert 7: Telecommunications & cybersecurity expert/ organisation 8: Authority or regulatory body 9: Autonomous vehicle demonstration areas 10: Research organisation 11: NGO 12: Other (please specify)

Appendix 10 – Organisation case studies – Topic guides

INTERVIEW TOPIC GUIDE

Passenger transport

Organisation A

1. Organisation characteristics	
Let's start with a few questions about *[organisation name]*	
General characteristics	• What is your role in *[organisation name]*? • What type of passenger transport services does *[organisation name]* offer? • What is the business model? (e.g. sources of revenue, subsidies from the government, other sources of funding)
Workforce	• How many employees *[organisation name]* has? • What types of jobs they perform?
Current activity	• How many vehicles does *[organisation name]* own to transport passengers? • What are the main challenges you face in the transport of passengers?

2. Impact of self-driving buses	
Last year we talked with citizens and organisations in *[country]*. They believe that self-driving vehicles will be deployed in *[country]* between 2035 and 2050. Today, we want to hear from you about one type of self-driving vehicles: <u>self-driving buses</u>. *[Show SHOWCARD]* We want to know how the deployment of self-driving buses will affect the activities of *[organisation name]*	
General	• In general, what do you think of self-driving buses?
Perceptions	• Which aspects of self-driving buses are attractive to *[organisation name]*? • Which aspects are not attractive?
Intentions	• Would *[organisation name]* consider replacing some of its vehicle fleet with self-driving buses? • If yes: when would that happen? As soon as self-driving become available or later (when?) • If no: Why? Which incentives would *[organisation name]* need before replacing the vehicle fleet with self-driving buses?
Impact – open questions	• Which aspects of *[organisation name]*'s operations would be affected? • What new opportunities will there be for *[organisation name]*? • What difficulties do you foresee?
Business model	• Would your business model change? How? • Would you consider offering new transport services? Or would you consider stopping offering some transport services you offer now? • Would you consider expanding the area you operate in? Or would you consider narrowing it?
Operational aspects	• Would you consider changing the days or times you transport passengers? • Would it solve any problems you may face now regarding picking up or dropping off passengers? • What other operational aspects could improve?

Mobility	• Would transport be faster or slower? • Would it be more or less reliable?
Safety	• Would transport be safer or more dangerous when it comes to accidents?
Employment	• Could drivers still be employed by *[organisation name]*? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by *[organisation name]*?
Economic aspects	• Could *[organisation name]* grow, in terms of revenue, as a result of using self-driving buses? Why? • Would costs be higher or lower than now, as a proportion of your revenue?
Land use	• Would you consider changing the location of some of *[organisation name]* sites (e.g. depots)? To where? Why?
Equity	• Would it be easier to have a gender-balanced workforce in *[organisation name]*? • Could you offer more entry-level job positions? Which ones? • Would it be easier or more difficult for your older employees to remain productive and motivated? How about younger ones?
Societal impact	• From a society's point of view, do you think self-driving buses would have a positive or negative impact in *[country name]*?

3. Further comments	
Open question	• Is there anything about self-driving buses that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Passenger transport

Organisation B

1. Organisation characteristics	
Let's start with a few questions about *[organisation name]*	
General characteristics	• What is your role in *[organisation name]*? • What type of passenger transport services does *[organisation name]* offer? • What is the business model? (e.g. sources of revenue, subsidies from the government, other sources of funding)
Workforce	• How many employees *[organisation name]* has? • What types of jobs they perform?
Current activity	• How many vehicles does *[organisation name]* own to transport passengers? • What are the main challenges you face in the transport of passengers?

2. Impact of self-driving buses	
Last year we talked with citizens and organisations in *[country name]*. They believe that within the next 10 years, self-driving vehicles will start to be used in *[country name]*, and that in 25 years time, most of the vehicle fleet will be self-driving. Today, we want to hear from you about one type of self-driving vehicles: self-driving buses. *[Show SHOWCARD]* We want to know how the deployment of self-driving buses will affect the activities of *[organisation name]*	
General	• In general, what do you think of self-driving buses?
Perceptions	• Which aspects of self-driving buses are attractive to *[organisation name]*? • Which aspects are not attractive?
Intentions	• Would *[organisation name]* consider replacing some of its vehicle fleet with self-driving buses? • If yes: when would that happen? As soon as self-driving become available (which can be as early as in 5 years time) or later (when?) • If no: Why? Which incentives would *[organisation name]* need before replacing the vehicle fleet with self-driving buses?
Impact – open questions	• Which aspects of *[organisation name]*'s operations would be affected? • What new opportunities will there be for *[organisation name]*? • What difficulties do you foresee?
Business model	• Would your business model change? How? • Would you consider offering new transport services? • Would you consider stopping offering some transport services you offer now? • Would you consider expanding the area you operate in? Or would you consider narrowing it?
Operational aspects	• Would you consider changing the days or times you transport passengers? • Would it solve any problems you may face now regarding picking up or dropping off passengers? • What other operational aspects could improve?
Mobility	• Would transport be faster or slower? • Would it be more or less reliable?
Safety	• Would transport be safer or more dangerous when it comes to accidents?

Employment	• Could drivers still be employed by *[organisation name]*? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by *[organisation name]*?
Economic aspects	• Could *[organisation name]* grow, in terms of revenue, as a result of using self-driving buses? Why? • Would costs be higher or lower than now, as a proportion of your revenue?
Land use	• Would you consider changing the location of some of *[organisation name]* sites (e.g. depots)? To where? Why?
Equity	• Would it be easier to have a gender-balanced workforce in *[organisation name]*? • Could you offer more entry-level job positions? Which ones? • Would it be easier or more difficult for your older employees to remain productive and motivated? How about younger ones?
Societal impact	• From a society's point of view, do you think self-driving buses would have a positive or negative impact in *[country name]*?

3. Further comments	
Open question	• Is there anything about self-driving buses that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Passenger transport

Organisation C

1. Organisation characteristics	
Let's start with a few questions about *[organisation name]*	
General characteristics	• What is your role in *[organisation name]*? • What type of passenger transport services does *[organisation name]* offer? • What is the business model? (e.g. sources of revenue, subsidies from the government, other sources of funding)
Workforce	• How many employees *[organisation name]* has? • What types of jobs they perform?
Current activity	• How many vehicles does *[organisation name]* own to transport passengers? • What are the main challenges you face in the transport of passengers?

2. Impact of self-driving buses	
Last year we talked with citizens and organisations in *[country name]*. They believe that within the next 5 years, self-driving vehicles will start to be used in *[country name]*, and that in 25 years time, most of the vehicle fleet will be self-driving. Today, we want to hear from you about one type of self-driving vehicles: self-driving buses. *[Show SHOWCARD]* We want to know how the deployment of self-driving buses will affect the activities of *[organisation name]*	
General	• In general, what do you think of self-driving buses?
Perceptions	• Which aspects of self-driving buses are attractive to *[organisation name]*? • Which aspects are not attractive?
Intentions	• Would *[organisation name]* consider replacing some of its vehicle fleet with self-driving buses? • If yes: when would that happen? As soon as self-driving become available (which can be as early as in 5 years time) or later (when?) • If no: Why? Which incentives would *[organisation name]* need before replacing the vehicle fleet with self-driving buses?
Impact – open questions	• Which aspects of *[organisation name]*'s operations would be affected? • What new opportunities will there be for *[organisation name]*? • What difficulties do you foresee?
Business model	• Would your business model change? How? • Would you consider offering new transport services? • Would you consider stopping offering some transport services you offer now? • Would you consider expanding the area you operate in? Or would you consider narrowing it?
Operational aspects	• Would you consider changing the days or times you transport passengers? • Would it solve any problems you may face now regarding picking up or dropping off passengers? • What other operational aspects could improve?
Mobility	• Would transport be faster or slower? • Would it be more or less reliable?
Safety	• Would transport be safer or more dangerous when it comes to accidents?

Employment	• Could drivers still be employed by *[organisation name]*? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by *[organisation name]*?
Economic aspects	• Could *[organisation name]* grow, in terms of revenue, as a result of using self-driving buses? Why? • Would costs be higher or lower than now, as a proportion of your revenue?
Land use	• Would you consider changing the location of some of *[organisation name]* sites (e.g. depots)? To where? Why?
Equity	• Would it be easier to have a gender-balanced workforce in *[organisation name]*? • Could you offer more entry-level job positions? Which ones? • Would it be easier or more difficult for your older employees to remain productive and motivated? How about younger ones?
Societal impact	• From a society's point of view, do you think self-driving buses would have a positive or negative impact in *[country name]*?

3. Further comments	
Open question	• Is there anything about self-driving buses that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Passenger transport

Organisation D

- Thank you for your availability to participate in this interview. Before we start, can you tell me what is your role in *[organisation name]*?

1. Organisation characteristics	
General characteristics	• What type of passenger transport services are provided in *[organisation name]* provide? • What is the business model? (e.g. sources of revenue, subsidies)
Workforce	• How many employees are involved in the provision of passenger transport? • What types of jobs they perform?
Current activity	• How many vehicles do transport operators own to transport passengers? • What are the main challenges they face in the transport of passengers?

2. Impact of self-driving buses on the provision of transport	
As part of the Move2CCAM project, last year we talked with citizens and organisations in *[country name]*. They believe that within the next 5 years self-driving vehicles will start to be used in *[country name]*, and that in 25 years time, all the vehicle fleet will be self-driving. Today, we want to hear from you about one type of self-driving vehicles: <u>self-driving buses.</u> We want to know how the deployment of these buses will affect the provision of passenger transport services by *[organisation name]*.	
General	• In general, what do you think of self-driving buses?
Perceptions	• Which aspects of self-driving buses are attractive and unattractive to your organisation, as transport authority, and to transport operators?

Intentions	• Would your organisation encourage operators to replace some of their vehicle fleet with self-driving buses?
	    ○ If yes: when would that happen? As soon as self-driving become available (which can be as early as in 5 years time) or later (when?)
	    ○ If no: Why? Which incentives would operators need before replacing the vehicle fleet with self-driving buses?

Impact (open questions)	• Which aspects of your job as local transport authority would be affected? • Which aspect of the job of the transport operators would be affected? • What new opportunities will there be for the province's transport authority and operators? • What difficulties do you foresee?
Business model	• Would the province's transport authority and operators' business models change? How would revenues and costs be affected? • Would operators consider offering new transport services? Or would they consider stopping offering some transport services they offer now? • Would they consider expanding the area they operate in? Or would they consider narrowing it?
Operational aspects	• Would there be a change in the transport services offered by operators (days and times of operation, service frequency)? • Would it solve any problems operators face now regarding picking up or dropping off passengers? • What other operational aspects could improve?

Mobility	• Would transport be faster or slower? • Would it be more or less reliable? • Do you think more or less people will use bus services in the future (using self-driving buses), compared to now (using conventional buses)? What would be the effect in terms of km driven by buses • Are self-driving buses attractive as a means of transport in a future with easily available self-driving private cars? What would be the main motivation for citizens to use self-driving buses rather than cars?
Safety	• Would transport be safer or more dangerous with the introduction of automated vehicles (in general), when it comes to accidents?
Employment	• Could the staff that are currently drivers still be employed by the transport operators? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by the transport operators, as a result of deploying self-driving buses?
Land use	• Would the transport authority or the transport operators consider changing the location of some of their sites (e.g. bus depots)? To where?
Equity	• Would it be easier to have a gender-balanced workforce in the provision of passenger transport services in *[organisation name]*? • Could the transport authority and operators offer more entry-level job positions? Which ones? • Would it be easier or more difficult for the older employees of the transport authority and operators to remain productive and motivated? How about younger ones?

3. Wider impacts on the organisation's activities	
Let's think more broadly now about self-driving vehicles (not only buses, but also cars and vehicles for freight distribution)	

Regulations	• What impact would the deployment of these vehicles have on regulations that *[organisation name]* applies regarding traffic management and control, road design, and vehicle parking? What new regulations are needed, and which would be obsolete?
	• What would be the impact on monitoring and enforcement of these regulations?
	  ○ Would it require new types of technology?
	  ○ What would be the impact on the workforce currently responsible for monitoring and enforcement?
	• What would be the impact on the regional planning strategies and policies implemented by *[organisation name]* ?

4. Further comments	
Open question	• Is there anything about self-driving vehicles that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Freight transport

Organisation E

1. Organisation characteristics	
Let's start with a few questions about *[organisation name]*	
General characteristics	• What is your role in *[organisation name]*? • What type of freight transport services does *[organisation name]* offer? • What is the business model? (e.g. revenue streams, other sources of funding)
Workforce	• How many employees *[organisation name]* has? • What types of jobs they perform?
Current activity	• Does *[organisation name]* transport goods to companies or to final customers? • Which type of vehicles do you use? • How many vehicles does *[organisation name]* own for the transport of goods? • Tell me about a typical delivery using these vehicles. How far is the trip? How frequently is it made? • What are the main challenges you face in the transport of goods?

2. Impact of self-driving vehicles	
Last year we talked with citizens and organisations in *[country name]*. They believe that self-driving vehicles will be deployed in *[country name]* between 2035 and 2050. In this showcard *[Show SHOWCARD]* you can see three different types of self-driving vehicles: 1) self-driving vans or trucks, 2) delivery robots, and 3) delivery drones Which of these three vehicles would be more useful to *[organisation name]*? (or would any other type of self-driving vehicle be more useful, apart from these three?) [*Record answer as: USE CASE*]. So, let's talk about *[USE CASE]* and how *[USE CASE]* could affect the activities of *[organisation name]* in the future.	
General	• In general, what do you think of *[USE CASE]* ?
Perceptions	• Which aspects of *[USE CASE]* are attractive to *[organisation name]*? • Which aspects are not attractive?
Intentions	• Would you consider replacing some of your vehicle fleet with [USE CASE]? • If yes: when would that happen? As soon as self-driving become available or later (when?) • If yes: Why? What would you use the vehicles for? • If yes: Would you consider sharing the ownership of the vehicles with other organisations? • If not considering using [USE CASE]: Why? Which incentives would *[organisation name]* need before replacing the vehicle fleet with [USE CASE]?
Impact – open	• Which aspects of *[organisation name]*'s operations would be affected? • What new opportunities and threats will there be for *[organisation name]*?
Business model	• Would your business model change? How? • Would you consider offering new transport services? • Would you consider expanding the area you operate in? • Would you be in a better position, comparing with your competitors, if you could use [USE CASE]?

Operational aspects	• Would you increase or decrease the number of trips to deliver goods? • Would it solve any problems regarding loading and unloading goods? • What other operational aspects could improve?
Mobility	• Would the delivery of goods be faster or slower? • Would it be more or less reliable?
Safety	• Would transport be safer or more dangerous, when it comes to accidents, stolen goods, or damage during travelling?
Employment impacts	• Could drivers still be employed by *[organisation name]*? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by *[organisation name]*?
Economic aspects	• Could *[organisation name]* grow, in terms of revenue, as a result of using [USE CASE]? • Would costs be higher or lower than now, as a proportion of your revenue?
Land use	• Would you consider changing the location of some of *[organisation name]* sites (offices, warehouses)? To where? Why?
Equity	• Would it be easier to have a gender-balanced workforce in *[organisation name]*? • Would it be easier or more difficult for your older employees to remain productive and motivated? How about the younger ones?
Societal impact	• From a society's point of view, do you think that [USE CASE] would have a positive or negative impact in *[country name]*?

3. Further comments	
Open question	• Is there anything about self-driving vehicles that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Freight transport (emergency deliveries)

Organisation F

Thank you for your availability to participate in this interview. Before we start, can you please tell me what is your role in *[organisation name]*?

As part of the Move2CCAM project, last year we talked with citizens and organisations in *[country name]*. They believe that between 2030-2040 autonomous vehicles will start to be widely used for deliveries.

Today we want to talk to you about deliveries made by unmanned aerial vehicles (drones) and the opportunities and challenges that your organisation faces in the development and implementation of these vehicles.

Delivery services	• Drones produced by *[organisation name]* have been used to transport medical products in *[country name]*. Can you tell me about these deliveries: what were the origin and destinations, how far was the trip, how frequently was it made? • Besides medical deliveries, what other deliveries could be feasible using these vehicles? Have you had interest from other organisations?
Business and financial	• What is your business model? Which revenue streams do you have? • How to ensure the sustainability of those revenues? • What sources of funding you have? Is it easy to attract private sources of funding, given the risk associated with developing such an innovative technology?
Market	• Which regions/countries you operate in? Would you consider expanding to other regions/countries? • What is the potential for scaling up sales and revenues? Is the market for drone deliveries big enough now and do you expect the market to grow in the future? • Can drones can get a competitive advantage in the market for deliveries, considering competition from deliveries using land-based conventional and autonomous vehicles? • Some users may be concerned with the cost of drone deliveries. What measures have you developed to reduce these costs? • Would sending/receiving drone deliveries be feasible only for small organisations, considering the cost?
Regulatory issues	• What type of regulatory barriers have you faced in the development of drones? • What regulatory barriers have you face in the use of drones for deliveries? • How did you overcome these regulatory barriers?
Operational aspects	• How to ensure the reliability of the delivery in case of weather events such as rain or strong wind? • How to deal with possible "congestion" along the aerial routes used by these vehicles? • What types of facilities and/or equipment are required by the senders and receivers of the deliveries? Would it be feasible to use these vehicles by organisations based in city centre office buildings in crowded areas?
Safety	• Which measures have been put in place to reduce the risk of accident (e.g. falls, collisions)? • And which measures reduce the risk of malicious hacking into the system? • Who would be legally responsible in case there is an accident or cyber attack involving an unmanned aerial vehicle?

Risks	• What are the main risks you faced when developing and implementing a technology as innovative as this? (e.g. technological, commercial, financial risks)
Employment	• How many employees *[organisation name]* has and what types of jobs they perform? • How do you assess the gender and age balance of *[organisation name]*? Is it easy to attract both male and female employees, as well as those from different age groups? • Overall, is it easy to attract employees with the skills you require?
Partnerships	• What type of partnerships have you established with other organisations, to develop and commercialise the vehicles (e.g. suppliers, customers, universities)
Open question	• Is there anything about drone deliveries that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Other transport (waste collection and management)

Organisation G

1. Organisation characteristics	
Thank you for your availability to participate in this interview. What is your role in *[organisation name]*? *[organisation name]* is a large organisation offering several products and services in several countries. Today we would like to talk to you about one of those services: waste collection and management in a particular country: *[country name]*.	
General characteristics	• What type of waste collection/management services does *[organisation name]* offer in *[country name]*? • What is the business model? (e.g. revenue streams, other sources of funding)
Workforce	• How many employees *[organisation name]* has in *[country name]* and what proportion of them are drivers?
Current activity	• Which type of vehicles do you use for waste collection/management? • How many vehicles does *[organisation name]* own for waste management in *[country name]*? • Tell me about a typical trip using these vehicles. How far is the trip? How frequently is it made? How many staff are involved • What are the main challenges you face in waste management in *[country name]*?

• 2. Impact of self-driving vehicles	
Last year we talked with citizens and organisations in *[country name]*. They believe that within the next 10 years, self-driving vehicles will start to be used in *[country name]*, and that in 25 years time, most of the vehicle fleet will be self-driving. Today, we want to talk to you about how self-driving vehicles could affect waste management services provided by *[organisation name]* in *[country name]*.	
General	• In general, what do you think of self-driving vehicles ?
Perceptions	• Which aspects of self-driving vehicles are attractive to the provision of waste management services by *[organisation name]*? • Which aspects are not attractive?

Intentions	• Would the company consider replacing some of the vehicle fleet with self-driving vehicles?
	  ○ If yes: when would that happen? As soon as self-driving vehicles become available or later (when?)
	  ○ If yes: What type of vehicles and what would you use the vehicles for?
	• If not considering using self-driving vehicles: Why? Which incentives would *[organisation name]* need before replacing the vehicle fleet with self-driving vehicles?

General impact	• Which aspects of *[organisation name]*'s operations would be affected if you could use self-driving vehicles? • What new opportunities and threats will there be for *[organisation name]*?
Business model	• Would your business model change? How? • Would you consider offering new services? • Would you consider expanding the geographic areas you operate in? • Would you be in a better position, comparing with your competitors, if you could use self-driving vehicles?
Mobility	• Do you think waste management be faster, more reliable, and/or safer?

Employment impacts	• Could drivers still be employed by *[organisation name]*? What would be their new role and what training or reskilling would it be needed? • What new jobs could be offered by *[organisation name]*?
Economic aspects	• Could *[organisation name]* grow, in terms of revenue, as a result of using self-driving vehicles? • Would costs be higher or lower than now, as a proportion of your revenue?
Land use	• Would you consider changing the location of some of *[organisation name]* sites (offices, depots)? To where?
Equity	• Would it be easier to have a gender-balanced workforce in *[organisation name]*? • Would it be easier or more difficult for your older employees to remain productive and motivated? How about the younger ones?
Societal impact	• From a society's point of view, do you think that self-driving vehicles would have a positive or negative impact in *[country name]*?

3. Further comments	
Open question	• Is there anything about self-driving vehicles that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Transport users (local authority)

Organisation H

Thank you for your availability to participate in this interview. What is your role in *[organisation name]*?

1. Organisation characteristics	
Transport	• Does your organisation own vehicles for the transport of employees? If yes, • Which type of vehicles and what are they used for? • Are there employees whose many role in the organisation is driving? • What are the main challenges you face regarding the transport of employees?
Deliveries	• Does the organisation send or receive deliveries? If yes: • What type of deliveries? • Do you use your own vehicles, or you hire the services of delivery companies? • What are the main challenges you face regarding sending/receiving deliveries?

Last year we talked with citizens and organisations in *[country name]*. They believe that in the next 5 years, self-driving vehicles will start to be used in *[country name]*, and that in 25 years most vehicles will be self-driving.

2. Impact of self-driving passenger transport vehicles	
In this slide *[Show SLIDE1]* you can see two types of self-driving vehicles for passenger transport: 1) self-driving bus or mini-bus; 2) self-driving car; Which of these would be more useful to *[organisation name]*? [*Record answer as: VEH1*]. So, let's talk about *[VEH1]* and how it could affect the activities of *[organisation name]*.	
Perceptions	• Which aspects of [VEH1] are attractive to *[organisation name]*? • Which aspects are not attractive?

Intentions	• Would the organisation consider acquiring their own [VEH1]?
	  ○ If not: Why not?
	  ○ If yes: What would *[organisation name]* use [VEH1] for?

Operations	• Do you think [VEH1] could reduce your transport costs? • Would you consider offering travel plans to your employees (e.g. incentives for vehicle sharing for commuting)?
Employment	• If your workforce currently includes drivers, could they still be employed? What would be their new role and what training would be needed? • Would self-driving vehicles threaten the job or change the role of other employees apart from drivers? • What new jobs could be offered, as a result of having [VEH1]? • Would it be easier to have a more gender and age-balanced workforce? • Would it reduce stress and improve productivity if your employees could use [VEH1] to commute to work? • Would it be easier for employ people with disabilities or those living in isolated areas) if they could commute by [VEH1]? Would you provide travel incentives?
Land use	• Would your sites need as much parking space as today? If not, what could the space be used for? • Would you consider changing the location of some of your sites, as a result of having [VEH1]? To where?

3. Impact of self-driving freight transport vehicles	
Let's talk about freight transport now. In this slide *[Show SLIDE2]* you can see three different types of self-driving vehicles that can be used for deliveries: 1) self-driving vans; 2) delivery bots; 3) delivery drones. Which of these three vehicles would be more useful to *[organisation name]*? [*Record answer as: VEH2*]. So, let's talk about how *[VEH2]* could affect the activities of *[organisation name]*.	
Perceptions	• Which aspects of [VEH2] are attractive to the organisation? • Which aspects are not attractive?

Intentions	• Would you consider sending/receiving deliveries using [VEH2] services provided by private companies, instead of sending them using conventional vehicles?
	• Would you consider acquiring your own [VEH2]?
	  ○ If not: Why not?
	  ○ If yes: What would you use [VEH2] for?

Operations	• Do you think the use of [VEH2] could benefit the organisation, in terms of reduced delivery costs and times, or increased reliability? • Would it solve any problems you face now regarding parking vehicles or loading/unloading goods? • Are you concerned with any safety issues regarding the use of [VEH2]?
Wider impacts	• Would [VEH2] have any impacts on your workforce or on your sites (e.g. use of space, location)?

4. Wider impacts on the organisation's activities	
Let's think more broadly now about self-driving vehicles	
Regulations	• What new regulations *[organisation name]* would need to implement regarding traffic management and control, road design, and vehicle parking? • Would monitoring and enforcement of these regulations require new technology, or workforce with new skills? • Would you need to revise your current urban planning strategies and interventions (e.g. zoning)?
Other activities	• Would you consider using self-driving vehicles for activities other than transport or deliveries, for example street cleaning or waste collection? Why?

5. Further comments	
Open question	• Is there anything about passenger or freight self-driving vehicles that we have not talked yet and you would like to mention?

INTERVIEW TOPIC GUIDE

Transport users (university)

Organisation I

Thank you for your availability to participate in this interview. What is your role in the university?

1. Organisation characteristics	
Transport	Does the university own vehicles for the transport of staff and/or students? If yes: • Which type of vehicles and what are they used for? • Are there employees whose many role in the university is driving? • What are the main challenges you face regarding transport?
Deliveries	• Does the university send or receive deliveries? If yes: • What type of deliveries? • Do you use your own vehicles, or you hire the services of delivery companies? • What are the main challenges you face regarding sending/receiving deliveries?

Last year we talked with citizens and organisations in *[country name]* They believe that in the next 5 years, self-driving vehicles will start to be used in *[country name]*, and that in 20 years all vehicles will be self-driving.

2. Impact of self-driving passenger transport vehicles	
In this slide *[Show SLIDE1]* you can see two types of self-driving vehicles for passenger transport: 1) self-driving bus or mini-bus; 2) self-driving car; Which of these would be more useful to the university? [*Record answer as: VEH1*]. So, let’s talk about [VEH1] and how it could affect the activities of the university	
Perceptions	• Which aspects of [VEH1] are attractive to the university and which ones are not?

Intentions	• Would the university consider acquiring their own [VEH1]?
	  ○ If not: Why not?
	  ○ If yes: What would they be used for? How would it benefit the university?

Employment	• If your workforce currently includes drivers, could they still be employed? What would be their new role and what re-training would be needed? • Would self-driving vehicles change the role of other staff apart from drivers? • What new jobs could be offered, as a result of having [VEH1]? • Would it be easier to have a more gender and age-balanced staff? • Would it reduce stress and improve productivity if your staff could use [VEH1] to commute to work? • Would you consider offering travel plans to your staff (e.g. incentives for vehicle sharing for commuting)?
Students	• What benefits would [VEH1] provide to students? Would that contribute to attract more students for the university?
Land use	• Would your campuses need as much parking space as today? If not, what could the released space be used for? • Would the university consider changing the location of some of its buildings, as a result of having [VEH1]? To where?
Equity	• Would it be easier for people with disabilities, or living in isolated areas, to study or work in the university if they could commute by [VEH1]? Would you provide travel incentives?

3. Impact of self-driving freight transport vehicles	
Let's talk about freight transport now. In this slide *[Show SLIDE2]* you can see three different types of self-driving vehicles for deliveries: 1) self-driving vans; 2) delivery bots; 3) delivery drones. Which of these three vehicles would be more useful to the university? [*Record answer as: VEH2*]. So, let's talk about how *[VEH2]* could affect the activities of the university.	
Perceptions	• Which aspects of [VEH2] are attractive to the university and which ones are not?
Intentions	• Would you consider sending/receiving deliveries using [VEH2] services provided by private companies, instead of sending them using conventional vehicles? • Would the university consider acquiring its own [VEH2]? o If not: Why not? o If yes: What would you use [VEH2] for? How would that benefit the university?
Wider impacts	• Would [VEH2] have any impacts on the university staff, campuses, or buildings (e.g. use of space, parking needs, location).

4. Other impacts	
Teaching	• What new degrees or training courses would the university provide to meet increased demand for skills related to self-driving vehicles? • What changes would be needed to the curricula of existing degrees/courses? • Would teaching staff need to acquire new skills to teach these new and/or revised curricula?
Research	• Which new research partnerships the university would need to make in order to produce impactful research on transport and mobility?
Operational activities	• Would the university consider using self-driving vehicles for activities other than transport or deliveries, for example cleaning or waste collection?

5. Further comments	
Open question	• Is there anything about passenger or freight self-driving vehicles that we have not talked yet and you would like to mention?

INTERVIEW TOPIC GUIDE

Self-driving vehicle industry (vehicle developer)

Organisation J

Thank you for your availability to participate in this interview. Before we start, can you please tell me what is your role in *[organisation name]*?

As part of the Move2CCAM project, last year we talked with citizens and organisations in *[country name]*. They believe that between 2030-2040 autonomous vehicles will start to be widely used in *[country name]*.

Today we want to talk to you about <u>autonomous buses</u> and the opportunities and challenges that your organisation faces in the development and implementation of these vehicles. We are aware that you have also developed on-demand transport solutions, but today we are mostly interested in your other product: autonomous buses.

Products	• Tell me about the autonomous minibus that you have developed: For which type of trips are they suitable? • Where has the vehicle been tested? Are any transport providers using the vehicle or planning to use it for regular transport services?
Business and financial	• What is your business model? Which revenue streams do you have from the development and commercialisation of the autonomous bus? • How to ensure the sustainability of those revenues? • What sources of funding you have? Is it easy to attract private sources of funding, given the risk associated with developing such an innovative technology?
Market	• Who are the customers or potential customers of the autonomous bus? Where are they located (regions/countries)? Would you consider expanding to other regions/countries? • What is the potential for scaling up sales and revenues? Is the market for autonomous buses big enough now and do you expect the market to grow in the future? When? • Some potential customers may be concerned with the cost of buying and operating these buses. What measures have you developed to reduce these costs? • Do you think autonomous buses can be attractive as a means of transport in a future with easily available autonomous private cars? What would be the main selling point of your product?
Regulatory issues	• What type of regulatory barriers have you faced in the development of autonomous buses? • How did you overcome these regulatory barriers?
Operational aspects	• What types of facilities, equipment, software, and employee skills are required by the transport provider to operate these buses on a day-to-day basis?
Safety	• Which measures have been put in place to reduce the risk of traffic collisions? • And which measures reduce the risk of malicious hacking into the system? • Who would be legally responsible in case there is an accident or cyber attack involving an autonomous bus?
Risks	• What are the main risks you faced when developing and implementing a technology as innovative as this? (e.g. technological, commercial, financial risks)

Employment	• How many employees *[organisation name]* has and what types of jobs they perform? • How do you assess the gender and age balance of *[organisation name]*? Is it easy to attract both male and female employees, as well as those from different age groups? • Overall, is it easy to attract employees with the skills you require?
Partnerships	• What type of partnerships have you established with other organisations, to develop and commercialise the vehicles (e.g. suppliers, customers, universities)
Open question	• Is there anything about autonomous buses that we have not talked yet and you would like to talk?

INTERVIEW TOPIC GUIDE

Self-driving vehicle industry (software developer)

Organisation K

Thank you for your availability to participate in this interview.

As part of the Move2CCAM project, last year we talked with citizens and organisations in *[country name]*. They believe that in 15 years time, autonomous vehicles will start to be widely used in *[country name]* and that in 25 years time, all vehicles will be autonomous.

Today we want to talk to you about the opportunities and challenges that your organisation faces in the development of solutions for the development of autonomous vehicles. Please keep in mind that your answers will be anonymised. The name of the company will not be identified in any reports or other research outputs we will produce with the results of this interview.

Products	• Can you briefly explain how your data analysis and artificial intelligence solutions contribute to the development of autonomous vehicles? • Which autonomous vehicle developers have used your solutions? Can you give me an example
Business and financial	• What is your business model? Which revenue streams do you have and how do you assess the sustainability of those revenues in the future? • What sources of funding do you have? Is it easy to attract private sources of funding, given the risks of developing such an innovative product?
Market	• Who are the potential customers of your products? Where are they based? • What is the potential for scaling up sales and revenues? Is the market for training autonomous vehicles big enough now and do you expect the market to grow much in the future? • What would you say is the unique selling point of your product, compared with your competitors? • How to be competitive in providing solutions to train autonomous vehicles, considering that vehicle developers can develop their own solutions in-house?
Risks	• What are the main risks you face when developing and implementing a technology as innovative as this? (e.g. technological, commercial, financial risks) and how do you mitigate against these risks? • What if the public rejects autonomous vehicles and the market never grows as expected?
Regulatory issues	• What type of regulatory barriers have you faced, if any, in the development and application of your products? • How did you overcome these regulatory barriers?
Intellectual property	• How do you protect the intellectual property of the products that you have developed?
Safety	• Which measures have you put in place to reduce any safety issues that may arise from the development of autonomous vehicles trained using your products? • Would you be legally responsible in case there is an accident or cyber attack involving an autonomous vehicle trained using your products?

Employment	• How many employees *[organisation name]* has and what types of jobs they have?
	• The industry you operate in tends to have problems in terms of gender and age balance of the workforce.
	  ○ How do you assess the gender and age balance of *[organisation name]* staff?
	  ○ Is it easy to attract both male and female employees, as well as those from different age groups?
	  ○ What measures do you have in place, or plan to have, to maintain/improve the diversity of your workforce?
	  ○ Do you have any plans to provide internships/traineeships, or entry level positions for recent graduates?
	• Which problems do you face in attracting employees with the skills you require?

Partnerships	• What type of partnerships have you established with other organisations, to develop and commercialise your products (e.g. suppliers, customers, universities)?
Open question	• Is there anything about autonomous vehicles, and associated systems, that we have not talked yet and you would like to talk?

Appendix 11 – Further qualitative assessment of impact – activity guide

Aim	Script	Min.
Welcome and introduction *Participants understand aim of session and research consent*	Thank you very much for joining us today. My name is xx, I'm also joined by my colleagues xx. The aim of this session is to build on ideas and thoughts from previous sessions and imagine a future where different self-driving vehicles and services are working together in your local area/city. Today, we will focus on some of the areas of uncertainty and challenges identified in previous sessions. *Lead moderator to briefly outline T&Cs of the research:* As a research organisation, we abide by the Market Research Society Code of Conduct and GDPR legislation. We will never include your name within our research reports. Nothing you say here today will be directly attributed to you. The only exception to this is if you tell me something that gives me reason to think that you or someone else is at risk of harm. In the unlikely event that this happens, we do have a duty to report this to the relevant authorities. There are no right or wrong answers, we just want to hear your opinions. Please make sure your phones are switched off/silent and speak one at a time. *Lead moderator to present running slides, introducing agenda and ground rules (slides 3-4)* *Next, share information on project's purpose, including what we are trying to find out and why (slides 5-7) and go through the information below:* **Slide 5**: As part of this ongoing research programme, we have been running a series of workshop sessions with citizens and organisations like yourselves, exploring the potential impacts of self driving vehicles and services on a local level. **Slide 6**: Your input has been extremely valuable in informing the development of the impact assessment model that we have been building and helping us understand which self driving vehicles and services feel more relevant to each region. **Slide 7**: This tool is designed to predict the potential impacts (i.e. what would happen) in different cities/regions if these services where operating. You will receive a demonstration of the tool in future sessions, but for now all you need to know is that the tool is intended to be used by a number of organisations including for example public authorities, research organisations, transport operators, self-driving vehicle developers. It will give them access to the data and evidence they require to support their plans and propositions, demonstrating that their thinking is grounded in	10

	people's expectations of self-driving vehicles and services. For example, if you were in charge of transport in your city, and you are thinking about introducing a delivery bot, the tool would tell you what the likely impact would be. Alongside our ongoing conversations, we are running a pan-European survey gathering feedback on the potential impacts of self driving vehicles and services from approximately 1,000 citizens in each participating region. All of these inputs will collectively feed into the development of the model, ensuring the criteria that it takes into account to assess potential impacts in each region are based on feedback and ideas we have gathered from engaging with citizens and organisations on a local level. As part of our continued conversations in future sessions, we will conduct some demonstrations of how the model will operate to gather your thoughts and feedback. **Slide 8**: In today's session we want you to envisage these impacts from the perspective of people / organisations in your local area/city. We want you to imagine what the future will look like for your city/local area as a whole. We will now split into groups.	
Warm up activity *1. Move citizens and organisations away from an individual perspective* *2. Gather feedback on the model and it's use from informed citizens and stakeholders* *3. Inform citizens and organisations about the impact of their contributions*	*Participants join a breakout room (between 6-10 people).* *Group moderator to introduce themselves and go around the table asking participants to share:* • Your name and a bit about yourselves • Something that stood out to you from the previous session • What you look forward to in this session *Moderator to then introduce warm up exercise.* I'd like you to imagine you are the transport director for your city/region and that different company representatives have come to you with proposals to obtain licenses for self-driving vehicle services (e.g. a license for an e-hailing service, a license for an accessible bus service etc.). • What are your questions? What do you need to know at this stage about these proposals? • Are these questions the same for each service? • What do you take into consideration? *Explore spontaneous responses first, only use prompts if needed: environment, accessibility, safety, equity, etc.* • How do you decide whether or not to go ahead with each of these proposals?	20
Introducing the baseline conditions	*Lead moderator to talk through baseline conditions and consolidated scenario of use cases operating together in the city/local area (slides 10-14).*	10

	Slide 10: I now want you to imagine that the year is 2050. Things are a little different nowadays. **Slide 11**: Much of our lives is happening online, reducing the need to commute to work or travel to appointments. For many people, technological advances mean they can work less and have more leisure time. This has changed how often and at what times people travel, with high streets and green spaces busier during the week, as people have more flexible working hours. Finally, we the population in 2050 is older on average and despite advancements in medical treatments, this means that many people have additional accessibility and mobility needs. It also means more people are retired, further increasing the demand for off-peak travel. **Slide 12**: In 2050, manually driven vehicles have been phased out and, to mitigate the impacts of the climate crisis, low-emissions travel is a necessity: • Low emissions zones → more walking, cycling, and shared transport • Electric bikes and scooters are available, local infrastructure has improved to support those with mobility needs • Most transport is now electrified, and renewable energy sources produce most of the energy needed to power our cities • There is higher demand for public transport and higher demand for good quality • Transport costs are comparable to prices now **Slide 13**: *Talk through development from 2035-2050*. **Slide 14**: Some of the use cases we have discussed in previous sessions are now available in the city. As a reminder, there are four: *Moderator to present from slide.* For the next few exercises, I want you to keep in mind this future.	
Exploring key areas of uncertainty *Participants share thoughts regarding areas of uncertainty, including consideration factors and expectations for what others in their city/region would like*	**Slide 15**: When we discussed the self-driving vehicles and services last time and looked at them individually, we discussed the various impacts they might have on your region. While citizens and organisations agreed on many of these impacts, we discovered that there are some areas of uncertainty where it is hard to determine whether these services will have positive or negative impacts. We'd now like to discuss these areas of uncertainty in a bit more detail, and how they might change in the future. **Slide 16**: There were 3 key areas of uncertainty: • Frequency of trips and the adoption of shared transport over private vehicles • Safety • Jobs For each of these areas we are going to think about: • How likely is it that the impact will be negative? Why? • How likely is it that the impact will be positive? Why?	30

	Spend 10 minutes on each Frequency of trips *Present slide 17, before asking:* • How likely do you think it is it that the number of individual trips will *increase*? Why? • How likely do you think it is that the number of individual trips will *decrease*? Why? • What do you think would cause this increase or decrease? *Moderator to prompt on private car ownership, people sharing rides vs. using them individually, consolidated deliveries, quality of public transport.* *Present slide 18:* I now want you to imagine that new self-driving e-hailing services are available. There are two potential ways this could affect frequency of trips: Fewer people use public transport, instead using the e-hailing service. This means that the same number of individual trips is being completed, but there are more vehicles on the roads. *Moderator to talk through negative feedback loop, before asking:* • How likely does this feel? • What are the factors influencing this/why is this happening? • How, if at all, could this be prevented? Fewer people use personal vehicles, instead using the e-hailing service, so the same number of trips is completed with fewer vehicles. *Moderator to talk through positive feedback loop before asking:* • How likely does this feel? • What are the factors influencing this/why is this happening? • How, if at all, could this be encouraged? *Discuss both scenarios:* • Now thinking about these two potential outcomes, which scenario feels more likely? Why? • How do you think people in your city will behave? • Are there any other factors that might influence this? Safety *Present slide 19, before asking:* • How likely do you think it is it that self-driving vehicles will *increase* security? Why? • How likely do you think it is that self-driving vehicles will *decrease* security? Why? • What do you think would cause this increase or decrease? *Moderator to prompt on network connectivity/signal failure, remote monitoring and assistance, cyber security.* *Present slide 20:* I now want you to imagine that new self-driving bus services are available. There are two potential ways this could affect security: There are increased risks of cyber attacks and vehicle hijacking, leading	

to increased chances of vehicles being taken off course or operated with malicious intent. *Moderator to talk through negative feedback loop, before asking:*

- How likely does this feel?
- What are the factors influencing this/why is this happening?
- How, if at all, could this be prevented?

Self-driving vehicles are trained to follow rules and regulations, while avoiding collisions and obstacles, resulting in fewer road accidents due to human error. *Moderator to talk through positive feedback loop before asking:*

- How likely does this feel?
- What are the factors influencing this/why is this happening?
- How, if at all, could this be encouraged?

Discuss both scenarios:

- Now thinking about these two potential outcomes, which scenario feels more likely? Why?
- How do you think people in your city will behave?
- Are there any other factors that might influence this?

Jobs

Present slide 21 before asking:

- How likely do you think it is it that self-driving vehicles will create *more* jobs? Why?
- How likely do you think it is that self-driving vehicles will lead to *job losses*? Why?
- What do you think would cause this increase or decrease?

Moderator to prompt on training schemes, job opportunities in monitoring and maintenance, phased transition process.

Present slide 22: I now want you to imagine that new self-driving delivery bot services are available.

There are two potential ways this could affect jobs:
As consolidated delivery bots are now the norm for last-mile deliveries, delivery drivers are no longer required. *Moderator to talk through negative feedback loop, before asking:*

- How likely does this feel?
- What could be done to mitigate the impact of this?

As consolidated delivery bots are now the norm for last-mile deliveries, delivery drivers are no longer required. *Moderator to talk through positive feedback loop before asking:*

- How likely does this feel?
- What are the factors influencing this/why is this happening?
- How, if at all, could this be encouraged?

Discuss both scenarios:

- Now thinking about these two potential outcomes, which scenario feels more likely? Why?
- How do you think people in your city will behave?
- Are there any other factors that might influence this?

<table>
<tr><td>Ideal scenario in their city/region
Participants come up with a plan of how these services should be operating in their city/region</td><td>I'd now like us to start working towards a plan for how these services should be operating in your city/region, thinking about this from the perspective of what citizens in your city/region would want (and not your own individual/organisation views).

Please imagine that all four services are available and could work together.

Let's start from populating on this map of your city/local area how we would like these services to operate. Each participant to receive A4 map for visualisation

• WHERE are these services located on the map, and where do they go to and from?
• WHEN do they operate?
• WHO are they for and how many people/packages do they transport/deliver?
• HOW do people use them?

Moderator to consolidate on large map.
Now thinking back to our earlier discussions about factors that we to take into account when considering proposals for self-driving vehicles and services [Moderator to recap from first warm-up exercise], as well as the areas of uncertainty we discussed, which aspects of how the self-driving services operate do we want to prioritise or consider carefully? Why? If needed, prompt with jobs, safety, environment, frequency/number of trips. Please keep in mind the needs of different people/organisations in your region/city (e.g. transport companies, older people, those with mobility issues, young students, people who live in remote locations etc.)

• What, if any, potential conflicts of interest can you see? E.g. between different types of people in your city/local area, between businesses and citizens or between different aspects of experiences with self-driving vehicles and services such as safety and convenience?
• What, if any, compromises do we need to make to resolve these conflicts and ensure these services and vehicles are working well for the city/local area as a whole?

• What do we need to have in place/ensure to make more people in the city/local area use these self-driving services and vehicles?
• What rules and regulations do we need?
• What reassurances do citizens need to feel confident in the services and vehicles?

Moderator to capture group thoughts on flipchart and ask for a volunteer to present them in the next part of the session (ideally a citizen).</td><td>30</td></tr>
<tr><td>Wrap up
Participants from each room present their thoughts on areas of uncertainty and</td><td>All participants are brought back together. One participant from each room to present views on areas of uncertainty and plan for self-driving services their group has come with. After each presentation:
• What are your thoughts on this?
• Do you have any questions/concerns?
• Which elements of each plan do you need to prioritise to ensure the best outcomes for your city/region?</td><td>15</td></tr>
</table>

plan for self-driving vehicle services in their city/region	• How, if at all, would the city/local area change if we implemented these services in this way?	
Thank and close	• Does anyone have any further thoughts / anything they would like to add at this point? *Moderator to thank participants and remind them of next steps.*	5

Appendix 12 – Statistical models of impacts

Table 211. Models of likelihood of using self-driving vehicles for non-commuting trips (Full models)

	Car		Taxi		Bus	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**
Impact on travel time	0.002	<0.01	0.002	0.01	0.001	0.14
Impact on trips	0.05	<0.01	0.03	<0.01	0.05	<0.01
Impact on parking needs: positive	0.48	<0.01	0.62	<0.01	0.46	<0.01
Impact on parking needs: negative	0.65	<0.01	0.65	<0.01	0.71	<0.01
Relocate to rural	-0.60	0.01	-0.11	0.66	-0.86	<0.01
Age: 18-34	0.12	0.05	0.17	0.01	0.15	0.02
Age: 65+	-0.71	<0.01	-0.53	<0.01	-0.11	0.14
No children	-0.24	<0.01	-0.10	0.08	-0.16	<0.01
Education: higher university degree	0.03	0.86	0.04	0.83	0.30	0.07
Health issue	0.07	0.38	0.11	0.15	0.17	0.03
Health issue (family)	-0.07	0.33	-0.14	0.07	-0.03	0.66
Number of trips: car	0.01	0.07	0.18	<0.01	0.06	<0.01
No car	-0.16	0.13	-0.02	0.84	0.36	<0.01
Duration of most frequent trip	0.002	0.10	-0.0001	0.89	0.002	0.08
Most important factor: travel cost	0.19	<0.01	0.20	<0.01	0.25	<0.01
Most important factor: parking availability	0.28	0.04	0.24	0.08	0.16	0.22
Technology: “innovator”	0.33	<0.01	0.40	<0.01	0.10	0.24
Technology: “early adopter”	0.15	0.04	0.12	0.08	0.06	0.36
Technology: “late majority”	-0.47	<0.01	-0.40	<0.01	-0.30	<0.01
Technology: “laggard”	-0.67	<0.01	-0.89	<0.01	-0.51	<0.01
Not aware of self-driving vehicles	-0.41	<0.01	-0.43	<0.01	-0.46	<0.01
Aware of self-driving vehicles	0.21	<0.01	0.20	<0.01	0.17	0.01
Well aware of self-driving vehicles	0.65	<0.01	0.50	<0.01	0.13	0.27
City centre	0.16	0.01	0.24	<0.01	0.20	<0.01
Village	-0.03	0.67	-0.04	0.55	-0.25	<0.01
Region: population density (log)	0.04	0.21	0.08	0.01	0.09	<0.01
Region: Income per capita (log)	-0.22	0.01	-0.41	<0.01	-0.35	<0.01
cut1	-1.93		-2.29		-1.83	
cut2	-1.24		-1.40		-1.12	
cut3	-0.12		-0.28		0.10	
cut4	1.58		1.56		1.87	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 5043 (car), 5020 (taxi), 5075 (bus). **Prob>chi2**<0.01 (all models). **Omitted categories**: No impact on parking needs; No relocation to rural areas; age 35-64; Children in household; Education: university degree or lower; No health issue; Car in household; Other important factors (see Appendix 7, Q13); Technology: “early majority”; Awareness: only listened to; Residence: City (not centre) or suburbs.

Table 212. Models of willingness to pay to use self-driving passenger vehicles (Full models)

	Car (buy)		Car (use)		Taxi		Bus	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**	**b**	**P>z**
Woman	-0.05	0.02	-0.03	0.40	0.17	<0.01	-0.03	0.25
Age: 18-34	-0.04	0.10	0.01	0.70	0.11	<0.01	0.20	<0.01
Age: 65+	0.01	0.66	-0.24	<0.01	0.02	0.56	0.09	0.05
No children	-0.02	0.41	-0.12	<0.01	-0.10	<0.01	-0.15	<0.01
Education: below university degree	-0.04	0.11	-0.07	0.04	0.03	0.24	0.15	<0.01
Health issue	0.04	0.15	0.12	0.01	-0.03	0.34	-0.18	<0.01
Number of trips: car	0.003	0.09	0.02	<0.01	0.09	<0.01	0.005	0.39
No driving licence	-0.08	0.04	-0.04	0.51	0.04	0.32	0.08	0.13
No car	-0.12	0.01	-0.32	<0.01	-0.01	0.77	0.05	0.39
Duration of most frequent trip	0.0003	0.47	0.003	<0.01	0.0001	0.83	0.003	<0.01
Most important factor: travel time	0.28	0.01	0.26	0.12	0.10	0.40	-0.01	0.98
Most important factor: travel cost	0.24	0.03	0.12	0.46	0.03	0.80	-0.03	0.86
Most important factor: convenience/comfort	0.30	0.01	0.22	0.18	0.08	0.49	-0.05	0.73
Most important factor: parking availability	0.26	0.03	-0.01	0.96	0.28	0.04	-0.01	0.95
Most important factor: reliability	0.32	0.01	0.26	0.14	0.10	0.43	-0.13	0.41
Most important factor: waiting time	0.26	0.06	0.11	0.59	0.18	0.21	0.05	0.79
Most important factor: safety	0.21	0.07	0.23	0.19	0.27	0.04	0.00	0.98
Technology: “innovator”	-0.03	0.44	0.03	0.48	0.02	0.60	-0.01	0.85
Technology: “early adopter”	0.07	0.01	0.05	0.29	0.003	0.92	0.10	0.01
Technology: “late majority”	-0.03	0.30	-0.08	0.08	-0.13	<0.01	-0.06	0.17
Technology: “laggard”	-0.15	<0.01	-0.09	0.18	-0.08	0.11	-0.11	0.07
Not aware of self-driving vehicles	-0.23	<0.01	-0.14	<0.01	-0.06	0.07	0.06	0.12
Aware of self-driving vehicles	0.06	0.03	0.10	0.02	0.08	<0.01	0.01	0.79
Well aware of self-driving vehicles	0.01	0.77	0.07	0.30	0.07	0.17	0.20	<0.01
City centre	0.002	0.94	-0.02	0.55	0.03	0.25	-0.08	0.02
Village	-0.02	0.49	0.08	0.07	0.01	0.77	0.21	<0.01
Region: population density (log)	-0.001	0.93	0.01	0.54	-0.04	<0.01	0.03	0.10
Region: Income per capita (log)	0.12	<0.01	0.22	<0.01	0.57	<0.01	0.09	0.04
Constant	9.37	<0.01	2.99	<0.01	-0.34	0.07	1.22	<0.01

Specification: log-linear. **Number of observations**: 3288 (car - buy), 3863 (car – use), 4220 (taxi), 4134 (bus). **R^2**: 0.07 (car - buy), 0.11 (car – use), 0.14 (taxi), 0.17 (bus). **Omitted categories**: Man; age 35-64; Children in household; Education: university degree or above; No health issue; Driving licence; Car in household; Other important factors (see Appendix 7, Q13); Technology: “early majority”; Awareness: only listened to; Residence: City (not centre) or suburbs.

Table 213. Models of impact of self-driving passenger vehicles on travel time (Full models)

	Car		Taxi		Bus	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**
Age: 18-34	0.38	<0.01	0.22	<0.01	0.27	<0.01
Age: 65+	-0.20	0.03	-0.19	0.02	-0.21	0.02
No children	-0.22	<0.01	-0.13	0.05	-0.14	0.05
Health issue	-0.03	0.70	-0.15	0.09	0.06	0.50
Health issue (family)	-0.19	0.03	-0.03	0.70	-0.22	0.01
Number of trips: car	-0.01	0.13	0.18	<0.01	-0.02	0.12
No car	0.21	0.05	0.04	0.71	-0.28	0.01
Duration of most frequent trip	0.01	<0.01	0.01	<0.01	0.01	<0.01
Most important factor: travel cost	0.25	<0.01	0.17	0.02	0.12	0.12
Most important factor: parking availability	0.45	<0.01	0.02	0.88	0.33	0.04
Technology: “innovator”	0.34	<0.01	0.36	<0.01	0.43	<0.01
Technology: “early adopter”	0.15	0.09	0.13	0.11	0.09	0.31
Technology: “late majority”	-0.13	0.13	-0.03	0.73	-0.25	<0.01
Technology: “laggard”	-0.28	0.03	-0.22	0.06	-0.17	0.18
Not aware of self-driving vehicles	0.04	0.59	0.16	0.04	0.10	0.20
Well aware of self-driving vehicles	0.31	0.02	0.18	0.14	0.28	0.03
City centre	0.17	0.01	0.00	0.98	0.19	0.01
Region: Income per capita (log)	0.14	0.04	0.14	0.03	0.07	0.28
Constant	1.70	<0.01	1.61	<0.01	2.04	<0.01

Specification: log-linear. **Number of observations**: 2664 (car), 2856 (taxi), 2686 (bus). **R^2**: 0.10 (car), 0.09 (taxi), 0.07 (bus). **Omitted categories**: Age 35-64; Children in household; No health issue; Car in household; Other important factors (see Appendix 7, Q13); Technology: “early majority”; Awareness: only listened to, or “aware”; Residence: Not city centre.

Table 214. Models of impact of self-driving passenger vehicles on number of trips (Full models)

	Car		Taxi		Bus	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**
Woman	0.11	0.05	0.09	0.11	0.12	0.03
Age: 18-34	0.21	<0.01	0.15	0.02	0.15	0.01
Age: 65+	-0.25	<0.01	-0.23	<0.01	-0.15	0.07
No children	-0.11	0.08	-0.19	<0.01	-0.18	<0.01
Number of trips: car	0.004	0.24	0.12	<0.01	0.02	0.01
Duration of most frequent trip	0.003	<0.01	0.001	0.15	0.004	<0.01
Most important factor: travel cost	0.09	0.30	0.11	0.18	0.14	0.09
Most important factor: parking availability	0.11	0.45	0.11	0.43	0.27	0.05
Technology: “innovator”	0.48	<0.01	0.43	<0.01	0.41	<0.01
Technology: “early adopter”	0.13	0.07	0.11	0.13	0.15	0.04
Technology: “late majority”	-0.15	0.06	-0.11	0.15	-0.19	0.02
Technology: “laggard”	0.10	0.38	-0.10	0.41	-0.29	0.02
Not aware of self-driving vehicles	0.05	0.46	0.15	0.04	0.21	<0.01
Well aware of self-driving vehicles	0.03	0.79	0.01	0.94	0.19	0.11
City centre	0.13	0.04	0.18	<0.01	0.18	<0.01
Village	-0.12	0.11	0.16	0.04	-0.05	0.49
Region: Income per capita (log)	-0.21	<0.01	-0.16	0.01	-0.22	<0.01
Constant	1.41	<0.01	1.31	<0.01	1.40	<0.01

Specification: log-linear. **Number of observations**: 2618 (car), 2511 (taxi), 2420 (bus). $\mathbf{R^2}$: 0.07 (car), 0.08 (taxi), 0.09 (bus). **Omitted categories**: Man; Age 35-64; Children in household; Other important factors (see Appendix 7, Q13); Technology: “early majority”; Awareness: only listened to, or “aware”; Residence: City (not in centre) or suburbs).

Table 215. Models of impact of self-driving passenger vehicles on parking needs (Full models)

	Car		Taxi		Bus	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**
Age: 18-34	0.22	<0.01	0.22	<0.01	0.17	0.01
Age: 65+	-0.14	0.08	-0.03	0.73	-0.05	0.51
No children	-0.14	0.03	-0.20	<0.01	-0.15	0.02
Education: below university degree	0.004	0.95	0.16	0.01	0.06	0.33
Health issue	-0.31	<0.01	-0.10	0.24	-0.04	0.61
Health issue (family)	-0.13	0.12	-0.12	0.13	-0.28	<0.01
Number of trips: car	-0.001	0.73	0.19	<0.01	0.02	0.06
Most important factor: travel cost	0.15	0.05	0.05	0.47	0.04	0.53
Technology: “innovator”	0.14	0.15	-0.11	0.26	-0.06	0.52
Technology: “early adopter”	0.27	<0.01	0.01	0.86	0.24	<0.01
Technology: “late majority”	0.16	0.03	0.02	0.79	0.03	0.69
Technology: “laggard”	-0.01	0.93	0.05	0.68	0.06	0.57
Not aware of self-driving vehicles	-0.09	0.24	-0.03	0.64	-0.02	0.82
Aware of self-driving vehicles	0.06	0.43	-0.004	0.95	0.02	0.78
Well aware of self-driving vehicles	0.40	<0.01	0.48	<0.01	-0.01	0.94
Region: population density (log)	0.06	0.09	0.10	<0.01	-0.001	0.97
Region: Income per capita (log)	0.12	0.15	0.02	0.78	0.17	0.04
cut1	-3.20		-2.62		-1.97	
cut2	-1.96		-1.46		-1.08	
cut3	1.09		1.27		1.80	
cut4	3.10		3.23		3.45	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 5043 (car), 5020 (taxi), 5075 (bus). **Prob>chi2**<0.01 (all models). **Omitted categories**: Age 35-64; Children in household; Education: university degree or above; No health issue; Other important factors (see Appendix 7, Q13); Technology: “early majority”; Awareness: only listened to.

Table 216. Models of impact of self-driving passenger vehicles on intention to move to more urbanised areas (Full models)

	Car		Taxi		Bus	
	b	P>z	b	P>z	b	P>z
Age: 18-34	0.46	<0.01	0.43	<0.01	0.46	<0.01
Age: 65+	-0.10	0.27	-0.10	0.28	-0.19	0.04
No children	-0.27	<0.01	-0.16	0.04	-0.29	<0.01
Health issue	-0.17	0.09	-0.11	0.27	-0.17	0.08
Health issue (family)	-0.16	0.10	-0.20	0.05	-0.12	0.18
Number of trips (car, taxi, or bus)	-0.01	0.30	0.31	<0.01	0.03	0.01
Duration of most frequent trip	0.002	0.10	0.004	0.01	0.001	0.31
Most important factor: safety	-0.13	0.55	-0.29	0.23	-0.51	0.03
Technology: “innovator”	0.32	<0.01	0.31	0.01	0.08	0.47
Technology: “early adopter”	0.17	0.07	0.04	0.67	0.08	0.36
Technology: “late majority”	0.03	0.72	0.04	0.66	0.02	0.84
Technology: “laggard”	-0.16	0.23	-0.32	0.02	-0.09	0.47
Not aware of self-driving vehicles	-0.14	0.13	-0.10	0.26	-0.16	0.07
Aware of self-driving vehicles	0.02	0.78	-0.12	0.17	0.07	0.40
Well aware of self-driving vehicles	0.28	0.05	0.37	0.01	0.04	0.81
City centre	0.28	<0.01	0.23	<0.01	0.20	0.01
Village	0.07	0.41	-0.06	0.55	-0.23	0.01
Region: Income per capita (log)	0.10	0.30	0.30	<0.01	-0.09	0.35
cut1	-3.27		-2.84		-4.21	
cut2	-2.30		-1.79		-3.30	
cut3	1.88		2.61		0.79	
cut4	3.63		4.49		2.49	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 5043 (car), 5020 (taxi), 5075 (bus). **Prob>chi2**<0.01 (all models). **Omitted categories**: Age 35-64; Children in household; Education: university degree or above; No health issue; Most important factor: not safety; Technology: “early majority”; Awareness: only listened to; Residence: City (not centre) or suburbs.

Table 217. Models of likelihood of using self-driving freight vehicles (Full models)

	Robot		Drone	
	b	**P>z**	**b**	**P>z**
Impact on number of delivery orders	0.07	<0.01	0.08	<0.01
Impact on delivery costs: negative	0.37	<0.01	0.48	<0.01
Impact on delivery costs: positive	0.53	<0.01	0.44	<0.01
Impact on number of trips	0.01	0.01	0.01	0.02
Impact on parking needs: negative	0.62	<0.01	0.68	<0.01
Impact on parking needs: positive	0.55	<0.01	0.56	<0.01
Relocate to rural	-0.78	<0.01	-0.79	<0.01
Relocate to suburban	-0.19	0.41	-0.40	0.10
Relocate to city centre	-0.36	0.08	-0.09	0.67
Woman	0.05	0.47	-0.11	0.07
Age: 18-34	0.16	0.03	0.16	0.03
Age: 65+	-0.84	<0.01	-0.43	<0.01
No children	-0.19	0.01	-0.16	0.02
Education: higher university degree	0.09	0.19	0.25	<0.01
Number of trips (all modes)	0.01	0.01	0.01	0.01
No driving licence	0.17	0.13	-0.21	0.06
Most frequent trip: shopping	0.07	0.38	0.17	0.03
Technology: “innovator”	0.41	<0.01	0.003	0.97
Technology: “early adopter”	0.10	0.24	0.09	0.27
Technology: “late majority”	-0.44	<0.01	-0.47	<0.01
Technology: “laggard”	-0.71	<0.01	-0.64	<0.01
Not aware of self-driving vehicles	-0.26	<0.01	-0.33	<0.01
Aware of self-driving vehicles	0.05	0.52	0.46	<0.01
Well aware of self-driving vehicles	0.48	<0.01	0.80	<0.01
City centre	0.12	0.08	0.08	0.27
Village	-0.26	<0.01	-0.002	0.98
Region: Income per capita (log)	-0.18	0.04	-0.07	0.47
cut1	-1.49		-1.03	
cut2	-0.72		-0.30	
cut3	0.56		0.90	
cut4	2.24		2.68	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 3790 (robot), 3779 (drone). **Prob>chi2**<0.01. **Omitted categories**: No impact on delivery costs, No impact on parking needs; No relocation; man; age 35-64; Children in household; Education: university degree or above; Driving licence; Most frequent trip: not for shopping; Technology: “early majority”; Awareness: only listened to; Residence: City (not centre) or suburbs.

Table 218. Models of impact of self-driving freight vehicles on delivery orders (Full models)

	Robot		Drone	
	b	**P>z**	**b**	**P>z**
Woman	0.21	<0.01	0.06	0.29
Age: 18-34	0.15	0.02	0.17	0.01
Age: 65+	-0.31	<0.01	-0.23	0.01
No children	-0.13	0.04	-0.23	<0.01
Number of trips (all modes)	0.01	<0.01	0.003	0.20
No car	0.01	0.93	-0.26	0.01
Technology: “innovator”	0.41	<0.01	0.41	<0.01
Technology: “early adopter”	0.29	<0.01	0.21	0.01
Technology: “late majority”	-0.16	0.06	-0.27	<0.01
Technology: “laggard”	-0.16	0.23	-0.03	0.80
Aware of self-driving vehicles	0.02	0.81	0.12	0.10
Well aware of self-driving vehicles	0.06	0.62	0.16	0.20
City centre	0.20	<0.01	0.17	0.01
Region: Income per capita (log)	-0.20	0.02	-0.31	<0.01
Constant	1.36	<0.01	2.03	<0.01

Specification: log-linear. **Number of observations**: 1835 (robot), 1905 (drone). $\mathbf{R^2}$: 0.10 (robot), 0.10 (drone). **Omitted categories**: Man; Age 35-64; Children in household; Car in household; Technology: “early majority”; Awareness: only listened to, or “aware”; Residence: Not in city centre.

Table 219. Models of impact of self-driving freight vehicles on delivery costs (Full models)

	Robot		Drone	
	b	**P>z**	**b**	**P>z**
Woman	-0.18	0.01	-0.09	0.16
Age: 18-34	0.45	<0.01	0.26	<0.01
No children	-0.12	0.12	-0.18	0.02
Number of trips (all modes)	-0.002	0.44	-0.01	0.02
Technology: “innovator”	-0.18	0.11	0.22	0.04
Technology: “early adopter”	-0.22	0.02	0.04	0.66
Well aware of self-driving vehicles	0.31	0.04	0.38	0.01
City centre	0.22	<0.01	0.10	0.21
Region: Income per capita (log)	0.00	0.97	0.22	0.02
cut1	-2.57		-2.09	
cut2	-1.31		-0.75	
cut3	1.68		2.23	
cut4	3.65		4.04	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 3790 (robot), 3779 (drone). **Prob>chi2**<0.01. **Omitted categories**: Man; age35+; Children in household; Technology: “early majority”, “late majority”, or “laggard”; Awareness: less than well aware; Residence: City (not centre) or suburbs.

Table 220. Models of impact of self-driving freight vehicles on number of trips (Full models)

	Robot		Drone	
	b	P>z	b	P>z
Woman	0.13	0.05	0.08	0.21
Age: 18-34	0.19	0.01	0.27	<0.01
Age: 65+	-0.22	0.03	0.02	0.82
No children	-0.05	0.51	-0.28	<0.01
Number of trips (all modes)	0.01	<0.01	0.004	0.19
Most frequent trip: shopping	-0.15	0.07	-0.06	0.51
Technology: “innovator”	0.36	<0.01	0.40	<0.01
Technology: “early adopter”	0.26	<0.01	0.15	0.07
Technology: “late majority”	-0.19	0.03	-0.29	<0.01
Technology: “laggard”	-0.21	0.15	-0.03	0.83
Not aware of self-driving vehicles	0.10	0.21	0.17	0.04
City centre	0.20	<0.01	0.16	0.02
Region: Income per capita (log)	-0.15	0.03	-0.35	<0.01
Constant	1.22	<0.01	2.14	<0.01

Specification: log-linear. **Number of observations**: 1741 (robot), 1723 (drone). R^2: 0.08 (robot), 0.09 (drone). **Omitted categories**: Man; Age 35-64; Children in household; Most frequent trip: not for shopping; Technology: “early majority”; Awareness: only listened to, “aware”, or “well aware”; Residence: Not in city centre.

Table 221. Models of impact of self-driving freight vehicles on parking needs (Full models)

	Robot		Drone	
	b	P>z	b	P>z
Woman	-0.12	0.07	-0.14	0.05
Age: 18-34	0.32	<0.01	0.37	<0.01
No children	-0.07	0.34	-0.25	<0.01
Education: below university degree	0.41	0.05	0.38	0.10
Education: higher university degree	0.34	0.10	0.22	0.32
Number of trips (all modes)	-0.01	0.01	-0.001	0.70
Technology: “innovator”	-0.08	0.45	0.08	0.48
Technology: “early adopter”	0.15	0.10	0.07	0.45
Technology: “late majority”	0.02	0.82	0.02	0.87
Technology: “laggard”	0.01	0.93	0.05	0.68
Well aware of self-driving vehicles	0.23	0.13	0.32	0.03
City centre	0.19	0.01	0.15	0.04
cut1	-1.87		-1.97	
cut2	-0.91		-1.04	
cut3	2.12		2.07	
cut4	3.97		3.82	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 3790 (robot), 3779 (drone). **Prob>chi2**<0.01. **Omitted categories**: Man; age 35-64; Children in household; Education: university degree; Car in household; Technology: “early majority”; Awareness: not aware or only listened to; Residence: Not city centre.

Table 222. Models of impact of self-driving freight vehicles on intention to move to more urbanised areas (Full models)

	Robot		Drone	
	b	**P>z**	**b**	**P>z**
Woman	-0.13	0.09	-0.02	0.79
Age: 18-34	0.50	<0.01	0.38	<0.01
No children	-0.08	0.37	-0.17	0.04
Technology: “innovator”	0.33	0.01	0.48	<0.01
Technology: “early adopter”	0.11	0.29	0.13	0.20
Technology: “late majority”	0.03	0.76	-0.17	0.11
Technology: “laggard”	-0.13	0.39	-0.35	0.02
Not aware of self-driving vehicles	-0.20	0.04	-0.03	0.76
Well aware of self-driving vehicles	0.30	0.07	0.07	0.66
City centre	0.32	<0.01	0.23	0.01
cut1	-3.04		-3.05	
cut2	-2.20		-2.18	
cut3	1.97		1.98	
cut4	3.70		3.66	

Specification: ordinal model. Dependent variable rescaled to 1-5. “Cut”: values of the rescaled dependent variable where it is expected a change in the probability of moving from one category to another in the original ordinal variable. **Number of observations**: 3790 (robot), 3779 (drone). **Prob>chi2**<0.01. **Omitted categories**: Man; age 35+; Children in household; Technology: “early majority”; Awareness: only listened to, or “aware”; Residence: Not city centre.

Table 223. Models of wider impact of self-driving vehicles (Full models)

	F1		F2		F3	
	b	**P>z**	**b**	**P>z**	**b**	**P>z**
Woman	0.05	0.09	0.07	0.02	0.02	0.55
Age: 18-34	0.04	0.23	0.13	<0.01	-0.19	<0.01
Age: 65+	-0.04	0.25	-0.02	0.70	-0.14	<0.01
No driving licence	0.06	0.23	0.11	0.06	0.05	0.33
No car	0.02	0.73	-0.12	0.06	0.12	0.03
Technology: “innovator”	-0.12	<0.01	0.01	0.76	-0.02	0.67
Technology: “late majority”	0.05	0.15	0.04	0.32	-0.14	<0.01
Technology: “laggard”	-0.03	0.54	0.25	<0.01	-0.25	<0.01
Not aware of self-driving vehicles	-0.15	<0.01	0.07	0.14	-0.03	0.47
Aware of self-driving vehicles	0.07	0.05	-0.02	0.58	0.08	0.02
Well aware of self-driving vehicles	0.14	0.03	0.03	0.65	0.15	0.02
Village	-0.08	0.02	0.01	0.83	-0.04	0.28
Region: Income per capita (log)	0.00	0.90	0.10	0.04	0.04	0.41
Impact on travel time: negative	-0.04	0.17	-0.09	0.02	0.09	0.01
Impact on travel time: positive	0.04	0.24	0.04	0.33	0.02	0.64
Impact on number of trips: negative	-0.02	0.45	0.00	0.97	-0.03	0.37
Impact on number of trips: positive	0.16	<0.01	-0.02	0.69	0.21	<0.01
Impact on parking needs: negative	-0.18	<0.01	-0.30	<0.01	0.06	0.05
Impact on parking needs: positive	0.22	<0.01	0.22	<0.01	0.16	<0.01
Relocate to rural	-0.26	<0.01	-0.01	0.90	-0.04	0.49
Relocate to suburban	-0.03	0.56	-0.07	0.26	-0.03	0.61
Relocate to city centre	0.26	<0.01	0.07	0.48	0.19	0.01
Impact on number of delivery orders: negative	-0.20	<0.01	0.24	<0.01	-0.19	<0.01
Impact on number of delivery orders: positive	-0.05	0.19	-0.01	0.88	0.07	0.11
Impact on number of delivery costs: negative	-0.23	<0.01	-0.17	<0.01	0.05	0.25
Impact on number of delivery costs: positive	0.28	<0.01	0.27	<0.01	0.15	<0.01
Constant	0.38	0.01	-0.82	<0.01	0.18	0.28

Specification: Linear. **Number of observations**: 3425 (F1 and F2), 3461 (drone). **R^2**: 0.16 (robot), 0.11 (drone). **Omitted categories**: Man; Age 35-64; Driving licence; Car in household. Technology: “early majority”; Awareness: only listened to; Residence: Not village; No impact on travel time; No impact on number of trips; No impact on parking needs; No relocation: No impact om delivery orders; No impact on delivery costs