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**[D3.1] – [User-centered recommendations]**

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List of acronyms

| Acronym | Meaning |
| --- | --- |
| EBU | European Blind Union |
| CAV | Connected and autonomous vehicles |
| PC | Personal Consequences |
| GC | General Consequences |

**Notice**

This document complies with the European Blind Union’s guidelines (<http://www.euroblind.org/publications-and-resources/making-information-accessible-all>) in order to be accessible to anyone, including blind and partially sighted people, and at the same time and at no additional cost.

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# Executive summary

Focussing on the consequences of large-scale CAV adoption, D3.1 combines results from Tasks 3.1, 3.2 and 3.3 and presents the outcomes of the first survey conducted in WP3, embedded in the context of existing literature. The aim is to provide user-centered recommendations based on survey results and literature on CAV adoption consequences.

Results of the survey replicate and extend previous findings, both by employing a stratified sample across multiple countries (Germany, France, Italy and UK) and providing results from the subpopulations (car-sharing users, professional drivers, people with visual impairments, and road co-users).

We investigated which anticipated consequences are the most importantly rated by participants, and which tend to be seen favourably or unfavourably by respondents. Our results provide instructive information on how to design CAV systems.

While positive consequences were expected in the context of road safety, stress reduction, enjoyment and life quality, negative consequences were expected in the areas of privacy and driving fun. Environmental issues could be somewhat ambiguous, mostly due to the necessary distinction between CAV usage as private cars vs in public transport context of busses. Participation in social life turned out to rank at a relatively high importance for respondents across the board, though expectations for improvement due to CAV adoption were neutral.

While country differences were less pronounced, some differing expectations were uncovered in the subpopulations: An increase in cost was particularly worrisome for respondents with visual impairments, while the potential for social life and economic participation ranked particularly high in importance for them. Car-sharing users were sensitive to privacy consequences and the potential positive impact of CAVs on safety. Comfort improvements were more prominently featured in responses from professional drivers. Especially with regards to busses, respondents expected improvements for scenery and traffic congestion.

These aspects are discussed in the context of existing literature and policy recommendations.

This version of the report was created for accessibility purposes. In addition, it only focuses on data and information of direct interest to blind and partially sighted persons. The full original version of the report is available on the PAsCAL project’s website ([www.pascal-project.eu](http://www.pascal-project.eu)).

# Introduction

## Purpose and organization of the document

The following document, D3.1, aims to provide an overview over user-centered research, both existing and employed within the PAsCAL project, and to discuss the recommendations that can be gained from this research. It will allow insights into potential impacts of interventions as well as help data collection related to connected and autonomous vehicles (CAVs).

In line with Tasks 3.1, 3.2 and 3.3, the document outlines the survey conducted in WP3 and presents descriptive results related to important issues in the context of existing literature on CAV acceptance.

Following the Introduction (section 1), the document is divided into four main sections:

In section 2, we will describe the literature for CAV acceptance across a variety of user groups and from various perspectives. The focus here will be particularly on motivators and barriers for CAV usage, heading towards garnering first recommendations for CAV integration into the road ecosystem.

In section 3 we will briefly summarise the first survey conducted in the context of WP3, including presentation of the items used, in particular those related to consequences of CAV introduction.

In section 4, we cover the most important consequences of CAV adoption, as judged by a variety of subpopulations such as a representative sample, car-sharing users, professional drivers, road co-users and visually impaired populations. We also describe those consequences in depth that survey participants felt would have the most positive or negative impacts on their lives and society.

Finally, in section 5, we combine literature and findings from our survey into a conclusion regarding recommendations and what policy makers should take into consideration when designing the political landscape around CAV integration.

An appendix with all items and their values, and literature are provided in sections 6 and 7.

## Intended audience of this document

The audience for this document are (1) the consortium members of the PAsCAL project, specifically partners responsible for the different CAV trials, simulations, pilots, CAV training skills development and development of business cases, (2) policymakers, specifically those with an interest in creating a more participatory CAV introduction that suits the needs of a variety of subpopulations, and (3) researchers with an interest in CAV acceptance measures as well as motivators and barriers to CAV integration.

The wider research community is invited to use the overview to extend their research into appropriate CAV solutions based on the recommendations, in particular when approaching varying target groups.

The idea is to give an introduction to what various participants of our survey think about the consequences of CAV solution implementations, how this fits into the current literature on CAV acceptance, and some recommendations based on these judgements, through which they can achieve their set goals.

A main objective of the PAsCAL project is to move the focus towards a more user-centric design of CAV research, so an analysis of general expectations of end-users, and their motivators and barriers is paramount.

# Literature overview user-centered research in CAVs

The adoption of autonomous and connected vehicles (CAVs) has the potential to reduce air pollution (Bansal et al., 2016; Anderson et al., 2014;), traffic accidents due to driver error (NHTSA, 2008), and to increase human mobility and safety (Anderson et al., 2014; Harper et al, 2016). Cost of human lives aside, summing up most of these estimated impacts on society suggests economic benefits (in savings) reaching 97.5 billion per annum, assuming half of the population starts using CAVs on a regular basis (Fagnant & Kockelman, 2015). Nevertheless, mass CAV adoption may also pose challenges related to driver safety due to equipment failure (Bansal et al., 2016), infringement on personal data privacy (Collingwood, 2017), and issues with legislative liability (Xu et al., 2018; NHTSA, 2016).

Hence, previous research is partially focused on whether the benefits of CAV adoption outweigh its potential risks (Liu, Ma, & Zuo, 2019; Liu, Yang, & Xu, 2019, Liu et al, 2019). Findings generally indicate that on the technological level, the current state of CAV technology cannot meet people’s expectations regarding their personal safety (Liu et al., 2019) or the safety of others on the road (Hulse, Xie, & Galea, 2018). On the positive side, research reports a positive impact of CAV adoption on the environment in terms of less land use for parking spaces (Dia & Javanshour, 2017; Fournier et al., 2017) and dramatic reduction in greenhouse gas emissions (Greenblat & Saxena, 2015; Arbib & Seba, 2017).

However, as noted by Liu, Ma & Zuo (2019), the majority of studies on adoption forecasting are based on expert knowledge, and information presented in specialized journals. Therefore, researchers also focused on the *perceived* consequences of CAV adoption in order to predict CAV acceptance (Hegner, Beldad, & Brunswick, 2019). These can be broadly divided in two major categories: social consequences and personal consequences. The first category includes (among others) peoples’ perceptions on the impact of CAV adoption on the environment in terms of pollution (Schoettle & Sivak 2014; Ipsos MORI, 2014), the job market (Taiebat et al., 2018), and land use (Soteropoulos, Berger, & Ciari, 2018; Dia & Javanshour, 2017).

Overall, evidence on people’s opinion on the environmental and social impact of CAV technology is positive, and the majority of the population recognizes the potential of CAVs to reduce environmental pollution (Haboucha et al., 2017; Ipsos MORI, 2014), and to increase the availability of parking spaces (Dia & Javanshour, 2017). However, some express concerns that the usage of CAVs might increase travel distance, therefore negating a potential positive effect on emissions (La Mondia et al., 2016). A game-theoretical approach to CAV parking behaviour predicts a congestion problem as a result of reduced need of parking spaces (Mullard-Ball, 2019).

The second category contains personal concerns about travel safety (Bansal & Kockelman, 2018), personal comfort while driving (Kyriakidis, Happee, & de Winter, 2015), vehicle hacking (Kennedy, 2016; Tennant et al., 2017) and data privacy (Collingwood, 2017; Howard & Dai, 2014). While the public generally agrees that CAVs are safer than conventional modes of transportation (Liu, Yang, & Xu, 2019; Becker & Axhausen, 2017) they also worry about possible equipment failures (Seapine Software, 2014; Bansal et al., 2016) and lack of control over the vehicle (Fraedrich & Lenz, 2016). Other major concerns are the fear of hacking (Kyriakidis, Happee, & de Winter, 2015; Bansal et al., 2016), and issues about personal privacy (Glancy, D., 2012).

To sum up, the plethora of evidence on peoples’ perceptions about the consequences from mass CAV adoption and personal use shows that opinions are mixed. Despite the fact, that the public’s general opinion on CAVs is positive (Schoettle and Sivak, 2014; Kyriakidis et al., 2015), a variety of safety and privacy concerns remain.

We therefore decided to carry out a survey asking specifically about a variety of potential consequences, with the aim to analyse people’s most important concerns, and gauge their opinions on whether CAVs might improve or worsen the current status of these issues. The survey is presented in the following section.

# Survey summary

## Survey description

In the following section, we will briefly describe the within WP3 conducted survey upon which the results and recommendations in sections 4 and 5 are based.

Participants were invited via either a panel service, which we employed to gather a stratified sample (by age, gender and for four countries), or via email and/or social media for the subpopulations, i. e. individuals with visual impairments, professional drivers and shared vehicle users.

Before starting the survey, respondents gave informed consent for voluntary participation, data use, and data storage in accordance with ethics requirements by the German psychology association (DGPS) and DGPR guidelines.

After that, the respondents were randomly assigned to one of three experimental conditions, varying the target solution:

In the first condition, the respondents read a short description of what autonomous and connected cars are (Figure 1), whereas in the second, the same text was accompanied by a description the anticipated effects from CAVs adoption for the environment, the road infrastructure, and for the general flexibility in transportation (Figure 2). You can see the entire intervention in the following two figures.

Figure 1. Information presented to respondents in condition 1.

**Autonomous and connected vehicles**

In the following we will ask you some questions about autonomous and connected vehicles (Connected Autonomous Vehicle, CAV for short). The distinctive feature of a CAV is that it is not controlled by a human driver. Instead, it is completely controlled by a computer system. The vehicle takes over all tasks and automatically controls all actions, including steering, acceleration and braking.

Here we are interested in autonomous and connected cars.

Figure 2. Additional information presented to respondents in condition  2.

**Autonomous and connected vehicles and their consequences**

Bringing autonomous and connected cars (CAVS) onto the streets will have different effects. On the one hand, people using CAVS will be able to spend their time more flexibly than drivers of manually controlled cars.

In addition, CAVS will require significant extensions to the current mobile communication networks to function reliably1.

The proliferation of CAVS will probably lead to an increase in the number of kilometres driven, so that in the long term more congestion2 can be expected. It is unclear whether CAVS will help reduce CO2 emissions from traffic3.

CAVS will also help shift jobs from low-skilled to high-skilled occupations4.

1z.B. Datta, S. K., Da Costa, R. P. F., Härri, J., & Bonnet, C. (2016). Integrating connected vehicles in Internet of Things ecosystems: Challenges and solutions. 2016 EEE 17th International Symposium on A World of Wireless, Mobile and Multimedia Networks (WOWMOM), 1-6.

2 z.B. Milakis, D., Van Arem, B., and Van Wee, B., Policy and society related implications of automated driving: A review of literature and directions for future research, Journal of Intelligent Transportation Systems (2017) 1-25.

3 z.B. Pakusch, C., Stevens, G., & Bossauer, P. (n.d.). Shared Autonomous Vehicles: Potentials for a Sustainable Mobility and Risks of Unintended Effects. 258-245.

4 z.B. Pettigrew, S., Fritschi, L., & Norman, R. (2018). The Potential Implications of Autonomous Vehicles in and around the Workplace. International Journal of Environmental Research and Public Health, 15(9), 1876..

In a third condition, the participants received the same information as in the first, this time related to autonomous and connected buses. You can see the intervention presented in Figure 3.

Figure 3. Information presented to respondents in condition 3.

**Autonomous and connected vehicles**

In the following we will ask you some questions about autonomous and connected vehicles (Connected Autonomous Vehicle, CAV for short).

The distinctive feature of a CAV is that it is not controlled by a human driver, Instead, it is completely controlled by a computer system. The vehicle takes over all tasks and automatically controls all actions, including steering, acceleration and braking.

Here we are interested in autonomous and connected buses. Such a bus would be part of the public transport system and would accommodate between 10 and 50 passengers.

In terms of content, participants first indicated their general assessment of autonomous cars/buses on 4 items (7-point Likert scales): They answered:

* Whether they find CAVs good/bad in general
* whether they find the thought of CAVs generally disconcerting or promising
* whether they would prefer CAVs or conventional vehicles as a means of transportation
* whether their spontaneous attitude towards CAVs was positive or negative.

After that, the respondents were prompted to list (free text) at least one reason for and against the introduction of CAVs in general.

The participants were then asked to imagine they used CAVs regularly, and to express their agreement with a list of 28 statements (7-point Likert). The statements were designed to assess the personal consequences, which the regular use of CAVs might have for the respondents. Each statement was paired with an item, which measured the degree to which the participants considered the respective consequence important. The following Figure 4. shows an example of a few sample pairs.

Figure 4. Sample statement and importance measure, condition 3.

Now imagine that You would regularly use autonomous busses. What effect would that have on you?

If I used autonomous busses, I would be... 1 = slower to 7 = faster.

Driving faster is... 1 = unimportant - 7 = important to me.

If I used autonomous busses, companies would have... 1 = higher to 7 = lower control over my behaviour.

The fact that companies do not control me is... 1 = unimportant to 7 = important to me.

If I used autonomous busses, I would be... 1 = more stressed to 7 = more relaxed during use.

Traveling in a stress-free way is... 1 = unimportant to 7 = important to me.

A full list of the items is available in Section 3.3 of the present document. These items will be used to primarily evaluate expected consequences across different populations in the following sections.

Participants were also asked to imagine that large sections of the population use autonomous vehicles. Then they were prompted to express their agreement with 28 statements, which represent the general consequences of using CAVs. Each statement was again paired with an item, which measured the degree to which the participants considered the respective general consequence important. Samples can be viewed in Figure 5.

Figure 5. Sample statements and importance measure, condition 3.

Now imagine that LARGE SECTIONS OF THE POPULATION use autonomous busses. What effect would that have?

If large sections of the population used autonomous busses, jobs in general would be... 1 = less secure to 7 = more secure.

Secure jobs are... 1 = unimportant to 7 = important to me.

If large sections of the population used autonomous busses, the general quality of life would be... 1 = lower to 7 = higher.

High quality of life is... 1 = unimportant to 7 = important to me.

Again, a full list of the statement pairs is available in Section 3.3.

Upon completing this part of the survey, the respondents indicated their agreement with three statements, designed to measure their mood when imagining that large sections of the population would use CAVs. Again, the respondents expressed their agreement with the statements on a 7-point Likert scale, anchored at “disagree/agree completely”. Two additional statements served as an attention check. A complete list of the items is in Section 3.3.

After that, the respondents indicated their agreement with 5 statements, which were represented different positive behaviours, associated with the availability and adoption of CAVs, as can be seen in Figure 6. Negative behaviours were assessed consequently, as seen in Figure 7

Figure 6. List of positive behaviours.

I would be comfortable letting my relatives with physical disabilities use autonomous busses.

I think I could do well with autonomous busses.

I would let my children use autonomous busses.

I am willing to accept the effort to switch to autonomous busses (e.g. special courses).

If autonomous busses were available, I would use them.

The possible answers for these questions are 1 = “disagree completely” to 5 = “agree completely” or “does not apply”.

Figure 7. List of negative behaviours.

I can imagine that I would have problems using autonomous busses.

I would not allow my children to use autonomous busses.

I would hesitate to let my relatives with physical disabilities use autonomous busses.

I would not like to use autonomous busses.

The switch to autonomous busses is unacceptable.

In my opinion, politics should prevent the introduction of autonomous busses.

I would try to disrupt autonomous busses actively if possible.

I would try to avoid autonomous busses as much as possible.

The possible answers for these questions are 1 = “disagree completely” to 5 = “agree completely” or “does not apply”.

Upon completion, the respondents provided information regarding their current mobility status: number of miles covered per week, the means of transport they currently use, whether they had a driving licence, whether they use car sharing services and public transport. The participants also rated their satisfaction with the means of public transportation in their region.

Next, the participants answered a series of questions, which measured their knowledge of autonomous vehicles, as can be seen in Figure 8.

Figure 8. Measure of knowledge of autonomous vehicles.

The following questions relate to your experience and knowledge of autonomous vehicles.

I think I am very well informed about the latest trends in autonomous mobility.

I read a lot and regularly about autonomous vehicles.

When it comes to autonomous vehicles, I do not know anything at all

I have already had experience with autonomous mobility.

The possible answers for the questions above are 1 = “disagree completely” to 5 = “agree completely” or “does not apply”.

I have used autonomous technologies before, namely:

A function in my/a car. Please indicate which function(s):

A completely autonomous car. Please indicate which car (make, type):

A completely autonomous shuttle or a minibus. Please describe where/which:

A completely autonomous bus. Please describe where/which:

A completely autonomous train. Please describe where/which:

Another option. Please describe which and where:

I have never used autonomous technology.

After that, the respondents were asked to imagine that they were buying a new conventional car, and their willingness to pay more or less for the same car but equipped with fully autonomous technology was assessed. Similar questions measured the respondents’ willingness to pay more (or less) for autonomous public transport per ticket and kilometre travelled.

A series of following questions assessed the importance of mobility for the respondents’ work, whether they drove as a profession, whether they had a visual impairment, and whether they used a mobility tool when driving (e.g. GPS).

Demographic markers such as age, gender, income, location, etc. were collected.

## Survey participant sample

1636 respondents took part in the survey. Valid entries amounted to 1461 after removal of all participants that had failed an attention test item within the questionnaire. 527 respondents were randomly assigned to the first experimental condition (receiving information about autonomous cars), 484 were presented with the same information, and additional details about the consequences of CAVs adoption (condition 2), and 450 respondents were received information on autonomous buses (condition 3).

The subpopulations that were chosen were defined in the DoA of PASCAL already with an eye towards feasibility and consortium partner interests. In the context of WP3, OPLY as a carsharing provider, the European Blind Union, and ACI and RED as connection to professional drivers helped with the data collection.

Within the survey, items asked participants about their status regarding these traits, i.e. we asked participants about their use of carsharing services, about their visual impairments, and about their job as professional drivers. We also asked them whether they used a non-motorized manner to cover most travel, i.e. whether they were pedestrians/bicycle users.

Based on these questions, the subsets that will be further explored were extracted from the entirety of the sample. This led to some overlap between participants in the samples, for example a blind person using a car sharing service would be included in both subsamples. This should be considered when interpreting the results.

Except for the panel population, the other samples were convenience samples and were not stratified based on any demographics. They can therefore not be considered representative and the results should be interpreted with care.

222 participants used a car-sharing service (most were recruited with the help of a car sharing service provider OPLY), 315 indicated a visual impairment (most had been recruited with the help of the European Blind Union), and 63 were professional drivers (most were recruited with the help of driving schools ACI and RED). The remaining 861 participants did not fall into the abovementioned categories, as they were recruited via a panel.

288 respondents were Germans, 266 British, 212 French, and 295 were Italian. All respondents were recruited via the panel only and comprise stratified samples for these countries based on age and gender. We decided to analyse country differences due to the fact that various cultural influences might play a role in expectations derived from CAV introduction.

## Survey items related to expected CAV consequences

This section contains the relevant statements, which served as basis for providing user-centred recommendations on the implementation of CAVs. Respondent agreement on the statement indicates people’s opinion on the consequences, which the adoption of CAVs would have on their own lives, and on society in general. The statements were organised in 16 major categories, which represent important personal and general life aspects, such as job security, data privacy, personal comfort, etc.

A total of 56 statements assessed the participants’ opinion on the consequences CAV use and adoption may have. 18 statements represented the personal consequences of using CAVs on regular basis, and another 18 the consequences of mass CAVs adoption for society. Each statement was paired with an item, which measured the importance of each consequence, as judged by the respondents.

The following tables contain the exact wording of each statement and the respective importance items, organised by category and by the instruction, which the participants received before providing responses. Table 1 contains all statements related to the personal consequences of using CAVs, and Table 2 the consequences of mass CAVs adoption for society.

Table 1. Full list of personal consequences of using CAVs.

**Instruction :** Now imagine that YOU would regularly use autonomous cars. What effect would that have on you?

**Statement Category:** Personal consequences from using autonomous cars and buses

|  Item | Statement |
| --- | --- |
| JOB SECURITY |  If I used [an autonomous car or bus], my job would be... less secure/more secure. |
| JOB SECURITY |  Having a secure job is... unimportant/important to me. |
| JOB SECURITY |  If I used [an autonomous car or bus], my opportunities on the job market would be... less/more. |
| JOB SECURITY |  Good opportunities on the job market are... unimportant/important to me. |
| JOB PERFORMANCE |  If I used [an autonomous car or bus] my work would be... more cumbersome/easier. |
| JOB PERFORMANCE |  The fact that I can do my work without any problems is... unimportant/important to me. |
| JOB PERFORMANCE |  If I used [an autonomous car or bus], I would be... less productive/more productive at work. |
| JOB PERFORMANCE |  Being productive at work is... unimportant/important to me. |
| DATA PRIVACY |  If I used [an autonomous car or bus], my personal data would be... less secure/more secure. |
| DATA PRIVACY |  A high level of security for my personal data is... unimportant/important to me. |
| DATA PRIVACY |  If I used [an autonomous car or bus], there would be a... higher/lower risk that my personal data would be misused. |
| DATA PRIVACY |  The fact that my data is protected against misuse is... unimportant/important to me. |
| FREEDOM |  If I used [an autonomous car or bus] I would be less free/more free in my decisions. |
| FREEDOM |  To decide freely what to do is... unimportant/important to me. |
| FREEDOM |  If I used [an autonomous car or bus], I would be... more dependent/more independent of other people. |
| FREEDOM |  To be independent from other people is... unimportant/important to me |
| ENJOYMENT |  If I used [an autonomous car or bus] my driving fun would be... lower/higher. |
| ENJOYMENT |  Driving fun is... unimportant/important to me. |
| ENJOYMENT |  If I used [an autonomous car or bus] my driving pleasure would be... lower/higher. |
| ENJOYMENT |  Driving pleasure is... unimportant/important to me. |
| COMFORT |  If I used [an autonomous car or bus] my travel comfort would be... lower/higher. |
| COMFORT |  A high level of travel comfort is... unimportant/important to me. |
| COMFORT |  If I used [an autonomous car or bus], my travelling would be... less pleasant/more pleasant. |
| COMFORT |  Travelling in comfort is... unimportant/important to me. |
| SOCIAL LIFE |  If I used [an autonomous car or bus], my attendance at events (e.g. concerts, parties) would be... less frequent/more frequent. |
| SOCIAL LIFE |  Frequent visits to events are... unimportant/important to me. |
| SOCIAL LIFE |  If I used [an autonomous car or bus], meetings with friends (e.g. friends, family)... would be less frequent/more frequent. |
| SOCIAL LIFE |  Frequent meetings with acquaintances are... unimportant/important to me. |
| ROAD SAFETY |  If I used [an autonomous car or bus], my personal risk of accident would be... higher/lower. |
| ROAD SAFETY |  A low risk of accident is... unimportant/important to me. |
| ROAD SAFETY |  If I used [an autonomous car or bus], traveling on the road would be... more dangerous/safer for me. |
| ROAD SAFETY |  A high level of safety while travelling is... unimportant/important to me. |
| TRAVEL TIME |  If I used [an autonomous car or bus], my travel time would be on average... longer/shorter. |
| TRAVEL TIME |  A short travel time is... unimportant/important to me. |
| TRAVEL TIME |  If I used [an autonomous car or bus] I would be... slower/faster. |
| TRAVEL TIME |  Driving faster is... unimportant/important to me. |
| TRAVEL COSTS |  If I used [an autonomous car or bus], my costs per journey would be... higher/lower. |
| TRAVEL COSTS |  Low travel costs are... unimportant/important to me. |
| TRAVEL COSTS |  If I used [an autonomous car or bus], my total mobility costs would be... higher/lower. |
| TRAVEL COSTS |  Keeping my overall mobility costs down is... unimportant/important to me. |
| LIFE QUALITY |  If I used [an autonomous car or bus] my quality of life would be... lower/higher. |
| LIFE QUALITY |  A high quality of life is... unimportant/important to me. |
| LIFE QUALITY |  If I used [an autonomous car or bus] my life satisfaction would be... lower/higher. |
| LIFE QUALITY |  High life satisfaction is... unimportant/important to me. |
| AFFECT |  If I used [an autonomous car or bus], my travelling experience would be... less pleasant/more pleasant. |
| AFFECT |  A pleasant travelling experience is... unimportant/important to me. |
| AFFECT |  If I used [an autonomous car or bus], I would be... more stressed/more relaxed during use. |
| AFFECT |  Travelling in a stress-free way is... unimportant/important to me. |
| SUBJECTIVE NORM |  If I used [an autonomous car or bus] my reputation in society would be... lower/higher. |
| SUBJECTIVE NORM |  A good reputation in society is... unimportant/important to me. |
| SUBJECTIVE NORM |  If I used [an autonomous car or bus], my friends would find it.. bad/good. |
| SUBJECTIVE NORM |  The fact that my acquaintances like what I do is... unimportant/important to me. |
| DATA COLLECTION |  If I used [an autonomous car or bus], the control over my behaviour by companies would be... higher/lower. |
| DATA COLLECTION |  The fact that companies do not control me is... unimportant/important to me. |
| DATA COLLECTION |  If I used [an autonomous car or bus], monitoring by third parties (e.g. companies, government agencies) would be... more/less. |
| DATA COLLECTION |  The fact that I am not monitored by third parties is... unimportant/important to me. |

Table 2. Full list of general consequences of using CAVs.

**Instruction:** Now imagine that LARGE SECTIONS OF THE POPULATION use autonomous cars. What effect would that have?

**Statement Category:** General consequences from using autonomous cars and buses.

|  Item | Statement |
| --- | --- |
| JOB SECURITY |  If large sections of the population use [autonomous cars or buses], jobs in general would be... less secure/more secure. |
| JOB SECURITY |  Secure jobs are... unimportant/important to me. |
| JOB SECURITY |  If large sections of the population use [autonomous cars or buses], the opportunities on the job market would be... lower/higher. |
| JOB SECURITY |  Good opportunities on the job market are unimportant/important to me. |
| ENVIRONMENT GENERAL |  If large sections of the population use [autonomous cars or buses], the environment would be... more polluted/less polluted. |
| ENVIRONMENT GENERAL |  Low environmental pollution is... unimportant/important to me. |
| ENVIRONMENT GENERAL |  If large sections of the population use [autonomous cars or buses], the environment would be... worse/better. |
| ENVIRONMENT GENERAL |  The fact that the environment is doing well is... unimportant/important to me. |
| EMISSIONS |  If large sections of the population use [autonomous cars or buses], greenhouse gas emissions would be... higher/lower. |
| EMISSIONS |  Low greenhouse gas emissions are... unimportant/important to me. |
| EMISSIONS |  If large sections of the population use [autonomous cars or buses], the pollution caused by exhaust gases and particles would be... higher/lower. |
| EMISSIONS |  Low exposure to fine particles is... unimportant/important to me. |
| CONGESTION |  If large sections of the population use [autonomous cars or buses], traffic congestion would be... higher/lower. |
| CONGESTION |  Low traffic congestion is... unimportant/important to me. |
| CONGESTION |  If large sections of the population use [autonomous cars or buses], finding a parking space would be... more difficult/easier. |
| CONGESTION |  Finding a parking space easily is not important/important to me. |
| CIVIL LIBERTY |  If large sections of the population use [autonomous cars or buses], civil liberties would be... lower/higher. |
| CIVIL LIBERTY |  Civil liberties are... unimportant/important to me. |
| CIVIL LIBERTY |  If large sections of the population use [autonomous cars or buses], the internal security in my country would be... lower/higher. |
| CIVIL LIBERTY |  Internal security is... unimportant/important to me. |
| CIVIL LIBERTY |  If large sections of the population use [autonomous cars or buses], state control would be... lower/higher. |
| CIVIL LIBERTY |  The fact that the state controls the citizens a little is... unimportant/important to me. |
| ROAD SAFETY |  If large sections of the population use [autonomous cars or buses], travel for all citizens would be... more dangerous/less dangerous. |
| ROAD SAFETY |  Safe travel for all is... unimportant/important to me. |
| ROAD SAFETY |  If large sections of the population use [autonomous cars or buses], the number of traffic accidents would be... higher/lower. |
| ROAD SAFETY |  Low accident figures are... unimportant/important to me. |
| TRAVEL TIME |  If large sections of the population use [autonomous cars or buses], the driving speed of the citizens would be... slower/faster. |
| TRAVEL TIME |  High driving speeds are... unimportant/important to me. |
| TRAVEL TIME |  If large sections of the population use [autonomous cars or buses], the travel time of the citizens would be... longer/shorter. |
| TRAVEL TIME |  Short travel times are... unimportant/important to me. |
| ECONOMY |  If large sections of the population use [autonomous cars or buses], the economic output in my country would be... lower/higher. |
| ECONOMY |  A high economic output is... unimportant/important to me. |
| ECONOMY |  If large sections of the population use [autonomous cars or buses], the economic output in Europe would be... worse/better. |
| ECONOMY |  A good economic output in Europe is... unimportant/important to me. |
| PUBLIC HEALTH |  If large sections of the population use [autonomous cars or buses], the citizens would be... less healthy/more healthy. |
| PUBLIC HEALTH |  Healthy citizens are... unimportant/important to me. |
| PUBLIC HEALTH |  If large sections of the population use [autonomous cars or buses], the health burden for the population would be... higher/lower. |
| PUBLIC HEALTH |  A low health burden on the population is... unimportant/important to me. |
| HOMEAREA INFRASTRUCTURE |  If large sections of the population use [autonomous cars or buses], the city and landscape would be... uglier/more beautiful. |
| HOMEAREA INFRASTRUCTURE |  A beautiful city and landscape is... unimportant/important to me. |
| HOMEAREA INFRASTRUCTURE |  If large sections of the population use [autonomous cars or buses], the infrastructure would be... worse/better. |
| HOMEAREA INFRASTRUCTURE |  A good infrastructure is... unimportant/important to me. |
| LIFE QUALITY |  If large sections of the population use [autonomous cars or buses], the general quality of life would be... lower/higher. |
| LIFE QUALITY |  High quality of life is... unimportant/important to me. |
| TERRORISM |  If large sections of the population use [autonomous cars or buses], my fear of hacker attacks would be... higher/lower. |
| TERRORISM |  A low danger of hacker attacks is... unimportant/important to me. |
| TERRORISM |  If large sections of the population use [autonomous cars or buses], the danger of terrorism would be... higher/lower. |
| TERRORISM |  Low danger of terrorism is... unimportant/important to me. |
| LUDDISM |  If large sections of the population use [autonomous cars or buses], the risk of vehicles being wilfully damaged would be... higher/lower. |
| LUDDISM |  The fact that vehicles are not wilfully damaged is... unimportant/important to me. |

# Consequences of CAV adoption judged by the visually impaired population

In this section, we will describe the consequences of CAV introduction, as judged by the panel sample we collected, as an opinion of the persons with visual impairment in Europe today.

The section will be structured into two parts: first, we will discuss a few of the most important consequences for the persons with visual impairment, i.e. what issues panel respondents agreed were most pressing, and, in detail, whether they thought these issues would worsen or improve with CAV introduction.

In a second part, we will discuss further issues that are considered important by the persons with visual impairment, where we observe majority opinions towards either improvement or worsening, i.e. we will present those issues where people think CAV introduction will definitely affect the situation in either a positive or a negative way (as opposed to the status quo remaining unaffected).

## Most important consequences of CAV introduction, presented by solution

Table 3, Table 4 and Table 5show the importance, which the persons with visual impairment assign to the different consequences from adopting autonomous cars and buses: both for themselves, and for the general public. The tables are divided by experimental condition: Table 3 shows the order of consequences from CAV adoption, when the respondents imagined they used autonomous cars regularly, and that CAVs are adopted by a large portion of the general population (condition 1). The next Table 4 represents the same importance ratings, but from the experimental condition where the respondents received additional information on the consequences from CAV adoption, in addition the general description of CAVs (condition 2). The last Table 5 shows the respondents’ opinion about the importance of the personal and social consequences from using and adopting autonomous buses (condition 3).

The tables are ordered by the mean of the importance (sorted by importance, i.e. third column): the most important consequences are at the top.

Where consequences are ordered by importance for the car solution, it can be observed that consequences such as “number of accidents”, “job security” and “social status” are the most important ones in the basic CAV condition.

Table 3. Visually impaired population: top 10 most important consequences of autonomous car adoption condition 1 (sorted by importance).

|  |  |  |
| --- | --- | --- |
| Item | Mean(1 – 7) | Importance(1 – 7) |
| GC\_number\_accidents | 4.800 | 6.697 |
| GC\_job\_security | 3.738 | 6.656 |
| PC\_social\_status\_society | 5.008 | 6.566 |
| PC\_social\_party | 5.795 | 6.557 |
| GC\_gov\_control | 2.752 | 6.557 |
| GC\_job\_chances | 4.735 | 6.557 |
| PC\_life\_satisfaction | 5.513 | 6.557 |
| PC\_mobility\_cost | 4.475 | 6.533 |
| PC\_pleasure\_driving | 4.726 | 6.525 |
| GC\_public\_safety | 4.623 | 6.492 |

Table 4 showcases the survey consequences ordered by importance for autonomous cars, but when consequences were presented as well.

Table 4. Visually impaired population: top 10 most important consequences of autonomous car adoption condition 2 (sorted by importance).

|  |  |  |
| --- | --- | --- |
| Item | Mean(1 – 7) | Importance(1 – 7) |
| PC\_subjective\_stress | 5.262 | 6.697 |
| GC\_risk\_terrorism | 4.172 | 6.656 |
| PC\_road\_safety | 4.912 | 6.566 |
| GC\_parking\_sapces | 5.675 | 6.557 |
| GC\_EU\_economy | 4.288 | 6.557 |
| PC\_mobility\_cost | 3.504 | 6.557 |
| PC\_social\_peers | 6.049 | 6.557 |
| PC\_surveillance | 2.575 | 6.533 |
| GC\_job\_security | 4.460 | 6.525 |
| GC\_life\_quality | 4.763 | 6.492 |

Table 5 shows the most important survey consequences for the bus solution.

Table 5. Visually impaired population: top 10 most important consequences of autonomous bus adoption condition 3 (sorted by importance).

|  |  |  |
| --- | --- | --- |
| Item | Mean(1 – 7) | Importance(1 – 7) |
| GC\_scenery | 4.500 | 6.663 |
| PC\_social\_status\_peers | 5.426 | 6.650 |
| PC\_social\_party | 5.726 | 6.613 |
| PC\_surveillance | 2.533 | 6.575 |
| GC\_fear\_hacking | 3.200 | 6.538 |
| PC\_per\_trip\_cost | 3.673 | 6.513 |
| PC\_social\_status\_society | 4.858 | 6.513 |
| GC\_public\_health | 4.648 | 6.500 |
| PC\_travel\_feel | 3.875 | 6.488 |
| PC\_pleasure\_driving | 4.025 | 6.475 |

In the following, more specific information about important CAV consequences will be presented. We will present Figure charts that will represent the distribution of judgement for each important item. This means that we will present what percentage of the visually impaired population thought that the CAV solution would contribute to a worsening or an improvement in this selected issue.

For the visually impaired respondents, the most important issue was the number of accidents on the road as a consequence from mass CAV adoption. Overall, 70% of the respondents believed accidents would be less common once large portions of the population started using CAVs.

Next in importance were concerns about the security of jobs in general, where the majority of the visually impaired respondents (70%) believed that the mass adoption of CAVs would make jobs more secure. (Table 6 - PC\_ job\_security)

If the participants received additional information about the consequences from CAV adoption, their experiences of stress and relaxation during driving became most important. 66% of the respondents believed that using a CAV regularly would make their driving experience more relaxed, while only 19% thought the opposite. (Table 6 - PC\_subj\_stress).

Table 6. Visually impaired population: top three most important items for cars.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| GC number accidents | 70.49 % | 17.21 % | 12.30 % |
| GC\_job\_security | 45.90 % | 46.72 % | 7.38 % |
| PC\_subjective\_stress | 66.37 % | 14.16 % | 19.47 % |

When the participants imagined that autonomous buses would be adopted by large portions of the population, most important for them were the infrastructure of the city and landscape. For this issue, opinions are divided: 50% of the respondents thought that cities and landscapes will become more beautiful, while 40% believed mass CAV adoption would have no impact on the aesthetic qualities of their surroundings (Table 7 - GC\_scenery).

The opinion of others as a consequence from using an autonomous bus regularly follows in importance, where more than half of the respondents (55%) thought their friends and acquaintances would find using a CAV good, and 33% believed others would think better of them (Table 7 - PC\_social status\_peers).

Table 7. Visually impaired population: top 2 most important items for busses.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| GC scenery | 50.00 % | 40.00 % | 10.00 % |
| PC social status peers | 33.75 % | 11.25 % | 55.00 % |

## Major improvement or worsening expected from CAV introduction

In this section, we will present an overview over major improvement or worsening expected from CAV introduction; for this purpose, only those tables will be presented which showcase that over 40% of the population agree that an issue is positively or negatively impacted by CAVs.

Similar to the other subgroups, safety was also a major concern for visually impaired people – in particular, as can be seen in Table 8, number of accidents and road safety were mentioned to benefit from CAV introduction by a majority of the respondents. However, 10-20% of the responds also felt that CAVs might worsen safety.

Table 8. Visually impaired population: improvements for accidents and road safety.

| Item | Improve | No impact | Worsen |
| --- | --- | --- | --- |
| GC number accidents (car) | 70.49 % | 17.21 % | 12.30 % |
| PC road safety(car with more information) | 57.52 % | 23.01 % | 19.47 % |

Just as for road co-users, visually impaired people placed a high importance on participation in social life and the job environment. In particular for this subgroup, it seems that high hopes were placed in CAVs to improve this area of life, with cars as the vehicle that are expected to bring about the most change; maybe expected, busses were not considered to have such an impact.

Table 9 showcases the vast improvement that were expected from CAVs in job security, job changes, as well as social party and peer attendance, and even social status. Only a very small minority believed that CAVs might worsen the situation.

Table 9. Visually impaired population: positive expected consequences of job-related areas of life and social life and social status.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| GC job security (car) | 45.90 % | 46.72 % | 7.38 % |
| GC job chances (car) | 52.46 % | 40.16 % | 7.38 % |
| PC social status society (car) | 49.18 % | 45.08 % | 5.74 % |
| PC social peers(car with more information) | 74.34 % | 23.01 % | 2.65 % |
| PC social party (car) | 77.05 % | 18.03 % | 4.92 % |

More pronouncedly than other subgroups, visually impaired people felt that the introduction of CAVs might have a negative impact on people’s privacy (over 75% on average, as compared to 50-55% from the panel population. As can be seen in Table 10, government control, surveillance as well as hacking were all expected to get worse, for both cars and busses.

Table 10. Visually impaired population: negative expected consequences on privacy.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| GC gov control (car) | 9.02 % | 13.11 % | 77.87 % |
| PC surveillance(car with more information) | 13.27 % | 14.16 % | 72.57 % |
| GC fear hacking (bus) | 12.50 % | 40.00 % | 47.50 % |
| PC surveillance (bus) | 16.25 % | 23.75 % | 60.00 % |

As the only subgroup, visually impaired people felt that CAV introduction would affect the cost of mobility, as can be seen in Table 11 – interestingly, for cars, the cost of mobility was expected to worsen, whereas for the bus, the per trip cost was expected to improve.

Table 11. Visually impaired population: negative expected consequences on mobility cost for cars, and positive on mobility cost for busses.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| PC mobiliti cost(car with more information) | 21.24 % | 26.55 % | 52.21 % |
| PC mobility cost (car) | 25.41 % | 22.13 % | 52.46 % |
| PC per trip cost (bus) | 41.25 % | 48.75 % | 10.00 % |

Finally, from Table 12, it can be observed that visually impaired people felt that CAVs would improve a few other areas of life, such as public health and public safety, as well as overall life satisfaction and life quality. Only a small percentage of people felt that these aspects would be worsened through CAV introduction.

Table 12. Visually impaired population: expected improvements in public health, life satisfaction/quality and public safety.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Improve | No impact | Worsen |
| GC public health (bus) | 50.00 % | 37.50 % | 12.50 % |
| PC life satisfaction (car) | 72.13 % | 22.13 % | 5.74 % |
| GC public safety (car) | 40.98 % | 45.90 % | 13.11 % |
| GC life quality(car with more information) | 57.52 % | 32.74 % | 9.73 % |

# User-centered recommendations

In this section, we summarize the results and highlight the design implications for improving CAV acceptance regarding the existing motivators and barriers.

## Summary of results

Our results replicate and extend previous findings in the literature (see Section 1). We substantiate these findings employing the first demographically stratified sample on CAV acceptance and applying the same measurement (i.e. questionnaire) across multiple countries. We further extend previous findings in that we do not rely on overall evaluations or willingness to pay. Instead we extensively investigate which anticipated consequences tend to be seen favourably or unfavourably. This provides more instructive information on how to design CAV systems.

Finally, we extend previous findings with reporting results on three particularly relevant subpopulations: car-sharing users as a population used to connected mobility, professional drivers as a population highly proficient in mobility and visually impaired persons as a population with possibly substantial improvements in their mobility situation on the table.

For this section, we take the perspective of policy makers designing the CAV ecosystem. Therefore, we do report evidence, for the general population and the subpopulations of special interest (with the caveat that such subpopulations were not recruited in a stratified sample format). We do not engage in segmentation of the population along demographic or other characteristics more common in individual marketing approaches.

###  Most important expected consequences

Several consequences of CAV usage and large-scale introduction were rated as most important across the subpopulations. They are reported ordered by the average importance they received. As judged by the most important issues, expectations were overall quite positive, except for privacy.

**Privacy** was identified as the domain most importantly affected by the use and introduction of CAVs. In our survey, this meant surveillance and control by governments. For individual cars as well as for busses, the high importance of privacy was usually paired with **negative expectations**.

Further, **road safety** featured prominently in participants’ thinking about CAVs. This involved general road safety for cars and busses, accident numbers for cars and acts of interfering with public transport vehicles. With regard to these safety issues, respondents held **mainly positive expectations**. Some safety aspects, such as the treat of terroristic attacks, did not seem of high importance.

Another highly important, yet ambivalent, aspect was the travel experience. While **stress and enjoyment** went along with **positive expectations**, **driving** itself was expected to be **less fun**. Interestingly, this was not only true for cars but also for busses, highlighting the fact that CAVs could improve the stress levels in public transport.

Relatedly, the overall **life quality**, including subjective overall stress levels and life satisfaction,was considered of high importance, especially when thinking about CAV as cars. In this case, **expectations where mostly positive**.

The possibility that **environmental issues** were affected by the large-scale introduction of CAVs also ranked relatively high in importance, especially for cars where environmental concerns seem more pressing than for busses. Expectations were again **mostly positive** with regards to implications for pollution.

Broader implications for the **physical infrastructure** in the public space also received some high importance ratings. These included the availability of parking spaces for cars, which were **expected to increase**.

Finally, the **participation in social life**, meeting peers and going to parties, was considered as important, especially for cars. Here **expectations were mostly positive**.

### Special observations with subpopulations.

For some aspects,these general trends were qualified within the subpopulations of special interest to CAV introduction.

In the subpopulation of **visually impaired** respondents, the **participation in social life** was of particular importance. In this population, this included **economic participation,** was present for **cars and busses**,and went along **pronounced positive expectations**.As the only subpopulation, **worries about increasing cost** for both types of mobility emerged.

In the subpopulation of **currently car-sharing** respondents, **more agreement** on the negative impact of CAVs on **privacy** was found than in the more general populations. This might reflect past considerations of privacy aspects in relation to car-sharing services. Further, in this subpopulation, there was **more agreement** on the positive expectations about the positive impact of CAVs on **safety**. This might reflect more exposure to connected and semi-autonomous functions in car-sharing vehicles.

In the subpopulation of respondents in driving related professions, such as freight drivers and driving instructors, there was **more agreement** on the possibility of **comfort improvements**. This might reflect higher proficiency with technologies of lower levels of automation. This was also the only subpopulation where elements of the infrastructure featured prominently. Especially with regards to busses, respondents expected **improvements for scenery and traffic congestion**.

Finally, in the subpopulation of road co-users, i.e. respondents who self-identified mainly as **pedestrians and bicycle users**, **heightened ambivalence** for all the important aspects was found.

Finally, there were some **less pronounced** **country differences**. Respondents from France and Italy had more positive expectations overall than those from Germany and the UK. Italian respondents, for example, were the only ones where privacy issues seemed not prominent. Yet, even for French and Italian respondents there were less favourable aspects. For example, French respondents were less sure than those from other countries that road safety would improve. Italian respondents saw the issues of lowered driving fun and improved travel comfort as particularly important.

## Capitalizing on existing motivators

In this section we provide some thoughts on the design implications to increase the acceptance for CAV solutions. We expect that capitalizing on motivators might increase acceptance.

First off, one of the issues that were not strongly targeted in the survey was that the experience of automated vehicles could a motivating factor in the uptake of CAVs. Nordoff *et al*. (2018) have found positive rating for usefulness and satisfaction of automated vehicles after respondents experienced a ride in an automated shuttle.

CAVs offer enhanced mobility for elderly, young and impaired people. The ability to share transport, decreased traffic congestion and ability to spend time on other activities have been found to positively affect user acceptance towards CAVs (Kaan, 2017).

From the literature, we also know that aspects such as innovation, technological progress, and transport mobility are also important factors that positively affects peoples’ perception towards CAVs (Hilgartner and Granig, 2020).

The significance of perceived usefulness and perceived ease of use of CAVs as well as AVs has been highlighted in several studies (Jing *et al.*, 2020; Xu *et al*., 2018; Herrenkind *et al*., 2019). These factors are important for the users along with trust in AV technology (Xu *et al*., 2018).

Together with the levers from the literature, some levers to increase the acceptance of autonomous vehicles themselves are obvious from our study. Citizens associate autonomous cars and busses with increased comfort, social participation and quality of life. As such they are typical carriers of the established technological promises (Borup et al., 2006). Putting an emphasis on possible comfort increases will most likely appeal to parts of the population.

Aspects of the CAV ecosystems might also be designed to increase acceptance. In particular, designing the operations of CAVs to be environmentally friendly and to lower the burden on the traffic infrastructure is one lever. Environmental concern is a significant factor that has been found to positively affect the CAV uptake. This has been found to be important along with perceived usefulness and perceived ease of use of the automated vehicles (Jing *et al.*, 2020). This might imply measures to regulate how CAVs operate without occupants and how they make use of parking spaces.

With life quality and sustainability as core issues, CAVs and mobility as a service might mutually reinforce each other. While autonomous systems might help the mobility sharing business models, the transition away from ownership-based mobility might increase sustainability.

As a note of caution, these positive expectations can be the basis for aversive emotions like anger when frustrated by the experience with CAVs. Vehicles that cause stress and anxiety when driving, an increase in traffic jams and idle CAVs seeking parking spaces could be such experiences. These frustrations might be especially pronounced for partially sighted citizens, for whom expectations are particularly positive.

## Addressing existing barriers

Some to-be-avoided features of CAVs also suggest themselves.

In various studies aimed to identify barriers towards uptake, respondents have shown, just as in our study, significant concern with traffic safety, security in CAVs such as violence and robbery, other security issues such as hacking and terrorism (Roche-Cerasi, 2019; Jing *et al*., 2020).

Similar to our survey, respondents have also stated job loss, lack of acceptance and awareness, technological reliability, and infrastructure problems as some of the perceived challenges related to AV and CAV uptake (Hilgartner and Granig, 2020; Kaan, 2017).

Considering the automated vehicles as not to be very safe or not as safe as manual driving is an important barrier towards the uptake of CAV technology (Jing *et al*., 2020). While low speed of the automated vehicle is crucial for safety of the vehicle, especially in its initial stages, this has been considered as a factor negatively affecting user acceptance of the automated shuttle, along with the space for luggage (Nordoff *et al*., 2018). Moreover, about half of the respondents in another study did not evaluate driverless shuttles to be useful (Roche-Cerasi, 2019).

Studies have also shown an ‘inertia effect’ in respondents where respondents have chosen not to select automated vehicles irrespective of the attributes shown by the automated vehicle. These studies have found that thought to a limited extent, some respondents do not tend to select AVs or CAVs because they do not like change ([Cartenì](https://www.sciencedirect.com/science/article/pii/S2590198220301354%22%20%5Cl%20%22%21), 2020).

In a study conducted to know the attitude of disabled people towards autonomous vehicles, about 66% of respondents considered the automated vehicles to be ‘dangerous’. It was also found that with prior knowledge of the automated vehicles, more respondents with disabilities showed an increased dislike towards autonomous technology. Respondents also showed concern on the vulnerability of autonomous vehicles as it would share the same road and traffic conditions as a conventional vehicle (Bennett *et al*., 2019). Disabled respondents showed a higher level of anxiety towards the safety of the automated vehicle while respondents who were not disabled showed concern on road and traffic conditions as well as poor driving behaviour of conventional vehicle drivers (Bennett *et al*., 2019).

Both from the viewed literature and our survey, it seems obvious that CAVs need a convincing privacy solution in place, especially regarding control by governments and less by companies. Even though citizens routinely voice privacy concerns, for example regarding location tracking in smartphones (Sipior *et al*., 2014), more than they act by them (Ketelaar & van Balen, 2018), CAVs might be a special case. Autonomous vehicles depend on remote control in such obvious and attention-grabbing ways, that privacy concerns might endure longer than with other novel technologies. One aspects of a convincing privacy solution might be decentralized approaches to data storage.

Finally, cost might prove a divisive issue. In the survey, cost emerged as a concern mostly for partially sighted citizens. Yet, the introduction of CAVs might impart costs not only on those using them, but on society as a whole. Data and road infrastructures might need further investments that ultimately every user might contribute to. As such CAVs risk becoming a symbol for an ever more divided society. Regulations that ensure basic access for everybody to the benefits of CAV solutions might be considered.

## Conclusion

The present deliverable aimed to provide some insights into subjectively experienced consequences of wide-spread CAV adoption by respondents, particularly of various subpopulations that we managed to recruit. The findings from a user-centered survey conducted in the context of WP3 gave some first indications as to which consequences are important for populations, and whether those consequences are experienced as mostly positive or negative ones. While we have presented the evidence, we have gathered based on our data, and drawn some recommendations from these findings in the context of already existing literature, there remains the questions why various subpopulations differ in their interpretation of the expected consequences, and why they differ in the importance they assign to such consequences. Future studies could well attempt to provide further insights into these questions in order to further refine policy recommendations for a CAV introduction that better includes a variety of viewpoints and takes into consideration the requirements of all stakeholders.

# Appendix

Table 13. Percentages for top ten most important items of panel participants.

| Item | Improve | No impact | Worsen | Condi­tion | Popu­lation |
| --- | --- | --- | --- | --- | --- |
| PC\_social\_party | 27% | 54% | 19% | car | panel |
| PC\_social\_status\_society | 32% | 52% | 16% | car | panel |
| GC\_number\_accidents | 56% | 20% | 24% | car | panel |
| GC\_job\_security | 34% | 51% | 15% | car | panel |
| GC\_pollution | 50% | 37% | 13% | car | panel |
| PC\_pleasure\_driving | 26% | 22% | 52% | car | panel |
| GC\_public\_safety | 40% | 41% | 19% | car | panel |
| PC\_road\_safety | 44% | 24% | 32% | car | panel |
| PC\_social\_status\_peers | 35% | 48% | 17% | car | panel |
| PC\_travel\_pleasant | 47% | 30% | 22% | car | panel |
| PC\_social\_peers | 30% | 55% | 14% | car with info | panel |
| GC\_parking\_sapces | 44% | 33% | 24% | car with info | panel |
| GC\_life\_quality | 46% | 39% | 14% | car with info | panel |
| PC\_subjective\_stress | 43% | 22% | 34% | car with info | panel |
| PC\_mobility\_cost | 31% | 39% | 30% | car with info | panel |
| PC\_road\_safety | 41% | 28% | 31% | car with info | panel |
| PC\_social\_party | 31% | 52% | 17% | car with info | panel |
| PC\_surveillance | 19% | 22% | 59% | car with info | panel |
| PC\_social\_status\_peers | 33% | 52% | 15% | car with info | panel |
| GC\_public\_health | 38% | 44% | 18% | car with info | panel |
| PC\_social\_status\_peers | 33% | 50% | 18% | bus | panel |
| PC\_surveillance | 21% | 32% | 47% | bus | panel |
| GC\_pollution | 57% | 30% | 13% | bus | panel |
| GC\_luddism | 34% | 34% | 33% | bus | panel |
| PC\_per\_trip\_cost | 41% | 35% | 24% | bus | panel |
| GC\_gov\_control | 14% | 30% | 55% | bus | panel |
| PC\_social\_party | 28% | 50% | 22% | bus | panel |
| GC\_public\_safety | 29% | 49% | 22% | bus | panel |
| PC\_travel\_comfort | 37% | 42% | 21% | bus | panel |
| GC\_public\_health | 42% | 41% | 17% | bus | panel |
| PC\_travel\_feel | 36% | 30% | 34% | bus | panel |

Table 14. Percentages for top ten most important items of car sharing users.

| Item | Improve | No impact | Worsen | Condition | Population |
| --- | --- | --- | --- | --- | --- |
| GC\_job\_chances | 28% | 68% | 5% | car | car share |
| GC\_gov\_control | 5% | 26% | 69% | car | car share |
| PC\_road\_safety | 84% | 10% | 6% | car | car share |
| PC\_life\_satisfaction | 51% | 39% | 10% | car | car share |
| GC\_job\_security | 23% | 66% | 11% | car | car share |
| GC\_number\_accidents | 89% | 8% | 4% | car | car share |
| PC\_pleasure\_driving | 24% | 24% | 53% | car | car share |
| GC\_public\_safety | 35% | 55% | 10% | car | car share |
| PC\_social\_party | 38% | 60% | 3% | car | car share |
| PC\_social\_status\_society | 25% | 75% | NA | car | car share |
| PC\_road\_safety | 58% | 27% | 15% | car with info | car share |
| PC\_mobility\_cost | 39% | 52% | 9% | car with info | car share |
| PC\_social\_status\_peers | 36% | 61% | 3% | car with info | car share |
| PC\_per\_trip\_cost | 52% | 39% | 9% | car with info | car share |
| GC\_risk\_terrorism | 14% | 61% | 26% | car with info | car share |
| PC\_social\_peers | 29% | 68% | 3% | car with info | car share |
| GC\_parking\_sapces | 85% | 14% | 2% | car with info | car share |
| GC\_health\_burden | 67% | 26% | 8% | car with info | car share |
| PC\_social\_party | 30% | 67% | 3% | car with info | car share |
| GC\_job\_security | 11% | 76% | 14% | car with info | car share |
| PC\_surveillance | 3% | 50% | 47% | car with info | car share |
| PC\_social\_status\_peers | 47% | 43% | 9% | bus | car share |
| PC\_surveillance | 4% | 16% | 80% | bus | car share |
| GC\_life\_quality | 61% | 26% | 13% | bus | car share |
| PC\_per\_trip\_cost | 29% | 38% | 33% | bus | car share |
| PC\_social\_party | 41% | 55% | 4% | bus | car share |
| GC\_luddism | 22% | 53% | 25% | bus | car share |
| GC\_pollution | 61% | 21% | 18% | bus | car share |
| GC\_public\_safety | 42% | 46% | 12% | bus | car share |
| PC\_social\_status\_society | 29% | 68% | 3% | bus | car share |
| PC\_social\_peers | 37% | 59% | 4% | bus | car share |

Table 15. Percentages for top ten most important items of visually impaired participants.

| Item | Improve | No impact | Wor­sen | Con­di­ti­on | Popula­tion |
| --- | --- | --- | --- | --- | --- |
| GC\_number\_accidents | 70% | 17% | 12% | car | visually impaired |
| GC\_job\_security | 46% | 47% | 7% | car | visually impaired |
| PC\_social\_status\_so­ciety | 49% | 45% | 6% | car | visually impaired |
| PC\_social\_party | 77% | 18% | 5% | car | visually impaired |
| GC\_gov\_control | 9% | 13% | 78% | car | visually impaired |
| GC\_job\_chances | 52% | 40% | 7% | car | visually impaired |
| PC\_life\_satisfaction | 72% | 22% | 6% | car | visually impaired |
| PC\_mobility\_cost | 25% | 22% | 52% | car | visually impaired |
| PC\_pleasure\_driving | 65% | 25% | 11% | car | visually impaired |
| GC\_public\_safety | 41% | 46% | 13% | car | visually impaired |
| PC\_subjective\_stress | 66% | 14% | 19% | car with info | visually impaired |
| GC\_risk\_terrorism | 21% | 41% | 38% | car with info | visually impaired |
| PC\_road\_safety | 58% | 23% | 19% | car with info | visually impaired |
| GC\_parking\_sapces | 58% | 14% | 28% | car with info | visually impaired |
| GC\_EU\_economy | 37% | 51% | 12% | car with info | visually impaired |
| PC\_mobility\_cost | 21% | 27% | 52% | car with info | visually impaired |
| PC\_social\_peers | 74% | 23% | 3% | car with info | visually impaired |
| PC\_surveillance | 13% | 14% | 73% | car with info | visually impaired |
| GC\_job\_security | 34% | 52% | 14% | car with info | visually impaired |
| GC\_life\_quality | 58% | 33% | 10% | car with info | visually impaired |
| GC\_scenery | 50% | 40% | 10% | bus | visually impaired |
| PC\_social\_status\_peers | 34% | 55% | 11% | bus | visually impaired |
| PC\_social\_party | 28% | 50% | 23% | bus | visually impaired |
| PC\_surveillance | 16% | 24% | 60% | bus | visually impaired |
| GC\_fear\_hacking | 13% | 40% | 48% | bus | visually impaired |
| PC\_per\_trip\_cost | 41% | 49% | 10% | bus | visually impaired |
| PC\_social\_status\_so­ciety | 30% | 58% | 13% | bus | visually impaired |
| GC\_public\_health | 50% | 38% | 13% | bus | visually impaired |
| PC\_travel\_feel | 24% | 40% | 36% | bus | visually impaired |
| PC\_pleasure\_driving | 20% | 56% | 24% | bus | visually impaired |
| GC\_number\_accidents | 70% | 17% | 12% | car | visually impaired |

Table 16. Percentages for top ten most important items of professional drivers.

| Item | Improve | No impact | Worsen | Condi­tion | Popula­tion |
| --- | --- | --- | --- | --- | --- |
| PC\_social\_party | 27% | 62% | 12% | car | prof. drivers |
| GC\_job\_security | 38% | 42% | 19% | car | prof. drivers |
| GC\_parking\_sapces | 42% | 42% | 15% | car | prof. drivers |
| GC\_gov\_control | 4% | 19% | 77% | car | prof. drivers |
| GC\_public\_safety | 31% | 50% | 19% | car | prof. drivers |
| PC\_social\_status\_society | 31% | 46% | 23% | car | prof. drivers |
| PC\_pleasure\_driving | 15% | 19% | 65% | car | prof. drivers |
| GC\_number\_accidents | 69% | 19% | 12% | car | prof. drivers |
| GC\_environmental\_cost | 65% | 27% | 8% | car | prof. drivers |
| PC\_job\_productive | 27% | 31% | 42% | car | prof. drivers |
| PC\_social\_peers | 27% | 58% | 15% | car | prof. drivers |
| PC\_social\_peers | 17% | 69% | 14% | car with info | prof. drivers |
| GC\_GHG\_emmissions | 48% | 21% | 31% | car with info | prof. drivers |
| PC\_travel\_comfort | 52% | 34% | 14% | car with info | prof. drivers |
| GC\_health\_burden | 34% | 41% | 24% | car with info | prof. drivers |
| GC\_public\_health | 34% | 41% | 24% | car with info | prof. drivers |
| GC\_life\_quality | 41% | 38% | 21% | car with info | prof. drivers |
| GC\_pollution | 45% | 31% | 24% | car with info | prof. drivers |
| PC\_social\_status\_peers | 38% | 45% | 17% | car with info | prof. drivers |
| PC\_mobility\_cost | 28% | 41% | 31% | car with info | prof. drivers |
| GC\_environmental\_degra­dation | 52% | 24% | 24% | car with info | prof. drivers |
| PC\_job\_hassle | 38% | 52% | 10% | car with info | prof. drivers |
| GC\_scenery | 75% | 13% | 13% | bus | prof. drivers |
| PC\_surveillance | 13% | 50% | 38% | bus | prof. drivers |
| PC\_travel\_pleasant | 50% | 38% | 13% | bus | prof. drivers |
| GC\_infrastructure | 63% | 25% | 13% | bus | prof. drivers |
| PC\_social\_party | 38% | 50% | 13% | bus | prof. drivers |
| GC\_traffic\_congestion | 75% | 13% | 13% | bus | prof. drivers |
| PC\_subjective\_stress | 75% | 25% | NA | bus | prof. drivers |
| PC\_social\_status\_peers | 25% | 63% | 13% | bus | prof. drivers |
| PC\_life\_quality | 38% | 50% | 13% | bus | prof. drivers |

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