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Abstract
D4.8: User Acceptance assesses user requirements, concerns and expectations with a view to ensure their acceptance and trust. This is achieved by means of a multi-country online survey targeting naïve users, which enquires about the users' perspective towards a selection of services tested in AUTOPILOT. This report introduces the survey design and summarises the results of the user evaluation. The findings are translated into actionable recommendations for future research projects.

Legal Disclaimer

Abbreviations and Acronyms

Acronym	Definition
AD	Automated driving
CAD	Connected Automated Driving
EC	European Commission
GA	Grant Agreement
IoT	Internet of Things
PO	Project officer
PoI	Point of interest
UK	United Kingdom
WP	Work Package

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Executive Summary

This deliverable summarises the user acceptance evaluation carried out within AUTOPILOT task 4.5 at five European pilot sites.
The aim of the evaluation task 4.5 “User Acceptance” in AUTOPILOT is to analyse requirements, expectations and concerns of potential users of different use cases of automated driving progressed by the Internet of Things (IoT).

The methodology used for the evaluation is twofold: first, the tested scenarios were evaluated from the perspective of potential users (who did not experience the services), based on a multi-country online survey.

Building on the findings of the first analysis, an evaluation of the tests at the pilot sites from the perspective of potential/test users was carried out. By undertaking an exploratory approach to the user evaluation, this report aims at providing insights and recommendations from the user perspective for the future development of IoT-enhanced automated driving functions.

Users have positive expectations towards the tested services, deeming them useful and beneficial for road safety. While they do not expect a change in their existing mobility patterns, they would be willing to use the demonstrated services and would recommend them to their friends and colleagues.

Users are most concerned about system failure, unexpected behaviour or an uncomfortable driving style of the vehicle as well as more specific properties of the driven vehicles, such as the HMI or uncomfortable seatbelts. In addition, users are concerned about the handling of their personal data and liability issues.

The possibility to take over control from the vehicle is an essential requirement for most users. Users furthermore require adequate information that can be customised to their needs and environment.

Based on these findings, the report recommends giving special attention to the provision of fitting information for users of IoT-enhanced automated vehicles, thus enhancing user comfort and trust in the technology. Furthermore, the users’ requirement to take control of the vehicle when desired should be considered during function development. Likewise, concerns over data handling and liability should be respected.

In addition to insights stemming from the collected data, useful lessons were learned by the researchers during the user evaluation. The ambitious set-up of the technical testing proved to be a challenge for the user evaluation, requiring adaptation of the study design.

To mitigate potential challenges in future projects, information silos within the project should be actively avoided by ensuring a direct line of communication between the developers of the tested functions and the evaluators.

When involving users in technically ambitious functionalities that have not reached the consumer market yet, managing user expectations is vital. To this end, special attention should be paid to properly introduce the users not only to the demonstrated technology but also to the specific use case and its limitations.
Lastly, the test area can be of use in introducing users to the piloted technologies.

2 Introduction

Purpose of the document

This document presents the results of an analysis of user requirements, concerns and expectations conducted under task 4.5 led by the FIA.

Terminology

Users	are understood here in a broader definition as "*anyone who uses the AUTOPILOT functions and services*".
Other road users	are road users that are indirectly affected by the use of the AUTOPILOT technology, e.g. cyclist, pedestrian, drivers of conventional vehicles; this group can be also interpreted as a part of the stakeholder groups.
Acceptance	Degree of intention to use or of incorporation of AUTOPILOT services.

Structure of the report

The report is structured as follows:

Chapter 2 gives an overview of the background of the survey, locating it among the existing research on user acceptance, and formulates the aim of the analysis.

Chapter 3 outlines the AUTOPILOT Use Cases that form the basis of the user acceptance survey.

Chapter 4 sets out the underlying methodology, building on the framework delivered in D4.1.

Chapter 5 summarises the results of the survey. Building on the prior analysis published in D4.7, the results are grouped into insights on user requirements, concerns and expectations with regards to the piloted use cases.

Chapter 6 discusses the results in the light of the piloting set-up at the participating Pilot Sites and transcribes these results into concrete recommendations for future projects testing automated and connected driving.

Chapter 7 draws summarising conclusions, highlighting the most striking results and points to future research needs.

3 Background and aim of the user survey

Background

This deliverable examines the user expectations, requirements and concerns with regards to the use cases tested in AUTOPILOT (see chapter 4 for descriptions of all AUTOPILOT use cases). The deliverable forms part of the user acceptance evaluation conducted in Task 4.5.

User acceptance forms a crucial part in the introduction of new technologies, being a determining factor for their potential to gain market traction and be inclusive. User acceptance can be defined as the demonstrable willingness within a user group to employ an information technology for the tasks it is designed to support (Kaan, 2017).

As using the Internet of Things (IoT) to enhance automated driving functions is still a very recent application, both the users' understanding of potential services, and the industry's experiences in designing them are limited. With this limitation in mind and considering the rapid pace at which the domain is evolving, the user acceptance Task in AUTOPILOT evaluated the tested services in a multiple-step process. In the first step, a multi-country online survey with a focus on users' requirements, concerns and expectations towards some of the tested services was conducted before the actual piloting took place. In the second step, the developed and tested services were evaluated in pilot site tests involving potential users of the services.

Therefore, the work in task 4.5 User Acceptance was twofold – the first analysis addressed requirements, expectations and concerns from the perspective of potential users who are not familiar with and have not experienced the services in an international online survey. The results from these analyses are summarised in deliverable D4.7. The second and main part in this task evaluated requirements, expectations and concerns at the test sites, i.e., the evaluation from the perspective of users who experienced the services or part of the services during the pilot tests. This deliverable summarises the results of the latter analysis. The overall content of both deliverables is outlined in table 1.

Seeing that the topics as well as the applied methods of the User Acceptance task overlap with those of Business Impact Assessment (T4.3), Quality of Life Impact Assessment (T4.4), and Legal Issues (T4.6), insights gained from the conducted evaluation were frequently shared with those Tasks.

Table 1: Overview of deliverables in T4.5 User Acceptance

D4.7 – User Requirements	D4.8 – User Acceptance
• General deliverable • Multi-country general public survey • Potential input to T4.3, T4.4, T4.6	• Pilot site deliverable • Tailored focus group interviews • Main output of T4.5

Aim of the public user testing

As established in D4.1, the objectives of user acceptance assessment in AUTOPILOT are to:

- Formulate IoT-related improvements for automated driving functions based on user feedback, and to
- Determine whether there are improvements or added value in automated driving

functionalities with and without the assistance of the IoT regarding user acceptance.

Within this overarching goal, the aim of the following analysis is to evaluate the user requirements, expectations, and concerns with a view to ensuring their acceptance and trust in future IoT-enhanced automated driving functions.

4 Description of Use Cases

As mentioned above, the scenarios follow the storylines summarised in the Pilot simplifying them in order to make them more understandable for the participants. Not all use cases developed and tested in "AUTOPILOT" were considered. The user acceptance task selected only scenarios where IoT plays a crucial role in the service presented.

The following use cases have been tested with users. These short descriptions present the action that the participants in the user-test encountered. More elaborate descriptions, and the way the scenarios in the tests were implemented can be found in Deliverable D3.5, on the testing in the pilot sites. Note that the technical role of IoT is not given in these descriptions, as for the users this was not very important, they were presented with a service, and technical details were not discussed before nor during the tests.

Automated valet parking (Vigo and Tampere, not tested with users in Brainport) - Automated parking at parking space:

- The automated vehicle automatically books a parking place near the drop-off point.
- Cameras check if a parking spot is free and whether there are any obstacles on the route
- The vehicle parks itself in the parking place
- The user sends the request to return the car
- The car drives to the pick-up point

Highway pilot (Brainport and Livorno) - Detection of road incidents and obstacles to ensure safe automated driving on highways:

- Cars with sensors and roadside camera detect obstacles, potholes, bumps, and other hazards
- Information is sent to traffic management, which determines when traffic should be informed
- Semi-automated vehicle receives a message about a hazard and adapts its driving (i.e. braking, lane-change)

Platooning (Brainport and Versailles) - Automated (short-distance) following of vehicles for more efficient traffic and comfort:

- In Brainport:
    - Via app, two vehicles make contact to drive in a platoon
    - Both get information on the meeting point and speed advice
    - When the vehicles meet, they drive in a platoon on the highway, the lead car driving manually, the following vehicle driving in automated mode
    - At the destination, or in case of interfering traffic, the platoon is broken

- In Versailles:
    - The fleet management systems tell the fleet operator which vehicles have to be moved to another car-sharing station
    - The following automated vehicles are positioned behind the lead vehicle
    - The lead vehicle drives manually while the following vehicles are operating in automated mode
    - The platoon drives through the city centre and crosses simple and complicated intersections
    - The vehicles are dropped off at the destination station

Urban driving (at all pilot sites) - Detection of pedestrians and cyclists, and managing traffic lights with automated driving:

- In Brainport:
    - An automated vehicle is called via the app
    - The vehicle arrives at the call point
    - The vehicle drives automated to destination
    - Vehicle detects pedestrians (not visible, e.g. standing around a corner) and adjusts driving behaviour (stops or slows down), by picking up smartphone signal
    - The Vehicle detects crowds by picking up smartphone signals and adjusts its route
- In Tampere and Vigo:
    - An Automated vehicle approaches a traffic light, gets a signal state and adapts vehicle speed
    - The vehicle detects a pedestrian and waits for them to cross
    - The vehicle starts moving when the pedestrian has crossed
- In Livorno:
    - An automated vehicle is driving and other road users, including connected bicycles, notify their presence to the AD vehicle
    - A bicyclist falls down
    - The AD vehicle, informed by IoT of the dangerous situation, smoothly decreases its speed and stops before reaching the accident area
    - The automated vehicle uses signals from smart traffic light to adjust driving behaviour according to the presence of other road users
- In Versailles:
    - Automated vehicle drives in the palace garden
    - Receives tourist information at points of interest
    - A pedestrian walks in the middle of the road in front of the vehicle
    - A bicycle crosses the road in front of the vehicle
    - Vehicle adjust driving behaviour (stops or slows down)

5 Methodology

Research approach

As the services and features considered in AUTOPILOT were in an early development phase, the evaluation of the user acceptance in terms of willingness to use the technology followed a user-centric approach. Participation of users in the design process can take place at different levels including conducting surveys with potential users about their wishes and needs and letting users testing prototypes and giving feedback to the researchers (Friedhof, 2016). As mentioned above, the user acceptance study in AUTOPILOT integrates two main parts for the evaluation of the developed services – the first one is assessing user preferences of the general public in an online user survey (D4.7) and the second one is using the results as recommendations for developers and as input for pilot testing of the developed services with potential users within the "AUTOPILOT" projects (the focus of this deliverable).

Many studies on user acceptance in the context of automated and connected driving are based on theoretical approaches on acceptance of new technologies, such as the Technology Acceptance Model (TAM) developed by Davis (1985) and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003). This study is not directly based on this approach. However, it is in line with its main concepts, which suggest that user acceptance (in terms of willingness to use a service or function) is determined by evaluation of the usefulness and the ease of use of the technology.

Following this approach, the report identifies functions or features of services that use IoT which are desirable for the users and which are the main concerns or acceptance barriers related to them. Thus, the assessment focusses on how services can be developed in a way to be perceived as useful and easy to use from a user perspective. In this sense, an explorative pre-phase assessment of user acceptance determinants was added by addressing the expectations and requirements of potential users in the development stage of new services. Since the focus of the study is on the IoT part of services and IoT primary enables exchange of information and data, we explore deeper the requirements of the users on required information (e.g., real-time traffic or vehicle operation information) as well as concerns related to data exchange (e.g., data privacy or cybersecurity).

Finally, conclusions from the analyses were derived about how IoT will enhance, enable and accelerate AD when considering user acceptance and user expectations, requirements, and concerns.

In summary, the assessment focusses on how services can be developed in a way to be perceived as useful and easy to use from a user perspective using a user-centric participatory approach.

Methodological Approach

Public testing of the technologies developed in AUTOPILOT was carried out at five European test sites across the first 6 months of 2019, as set out in Table 1. These were preceded by pilot tests (with employees of project partners) designed to test the method in late 2018, the findings of which informed refinement of the process for public testing.

Table 2: Public Testing carried out in AUTOPILOT

	Automated Valet Parking	Urban Driving	Highway Pilot	Platooning
Brainport	n/a	April 2019	March 2019	June 2019
Livorno				
Tampere	October 2018	May 2019		
Versailles		April 2019		July 2019 (no surveys)
Vigo	First iteration: February 2019 Second iteration: June 2019	First iteration: May 2019 Second iteration: July 2019		

It was important to ensure (as far as possible) that the tests were uniform across all sites and use cases, so that data could be pooled across all tests for high-level observations. As such a Pilot Site Protocol was developed (see Appendix 1). The intended audience for this was the pilot site leaders who were responsible for organizing the user tests and the technology developers who would be involved in running the tests, as well as the evaluators from WP4 involved in the tests. The protocol was tailored for each pilot site/ use case which may have had region- or technology-specific restrictions or opportunities.

In addition to the user tests, short questionnaires were handed out to visitors of the AUTOPILOT demonstrations during the European ITS Congress, 3rd – 6th June 2019 in Brainport, NL. The survey involved 47 ITS visitors, and questions were asked about the ranking of the service, the importance of IoT in the development of automated driving, the concerns of automated driving using IoT, and future impacts of the service. In addition, at the public event on 2 June short questionnaires were collected from 20 members of the general public who attended a general AUTOPILOT demonstration.

Data Collection

Data to assess user acceptance of the AUTOPILOT services was gathered through surveys of members of the general public who had experienced one of the AUTOPILOT services in a controlled test at the AUTOPILOT pilot sites.

The intention was also to survey the professional/safety drivers of the AUTOPILOT technologies, as detailed in the Protocol. However, there was not the opportunity to do so as they had tight schedules and were involved in technical adjustments between tests. They were asked to note any technical issues that occurred during tests.

Description of Pilot Sites and AUTOPILOT services

There were six pilot testing sites involved in the AUTOPILOT project (see Figure 3). These were Tampere in Finland, Brainport in the Netherlands, Vigo in Spain, Livorno in Italy and Versailles in France. An associated test site in South Korea was not involved in the User Tests.

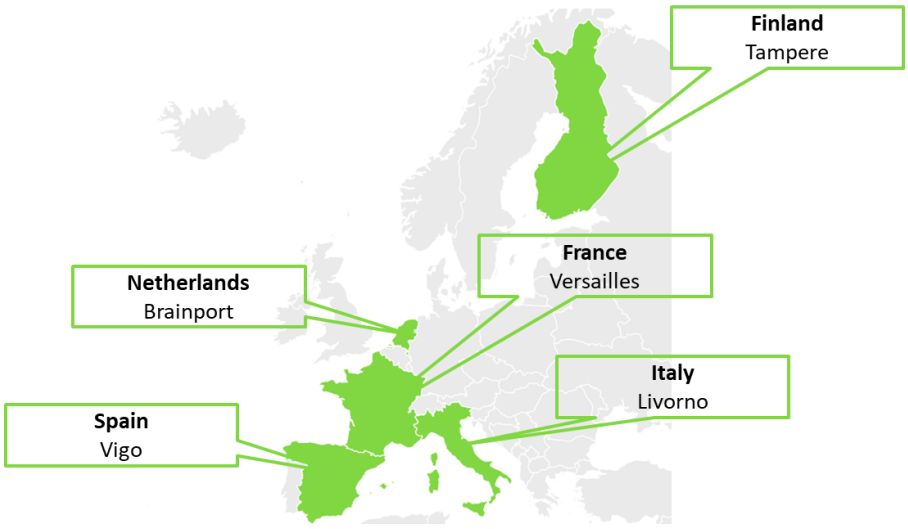

Figure 1: Location of Pilot Sites

Each site operated independently, led by different project partners/technology developers, though there were five common technology use cases (hereafter termed 'services') which exemplified the benefit of IoT for AD. A short description of each service is provided in Table 2, though the reader is advised for more detail on the pilot sites and services to refer to the Deliverables of Work Package 3:

- D3.1 - Initial Pilot Sites Specifications
- D3.2 – Pilot Test Specifications
- D3.3 – Pilot Site Adaptation Validation Report
- D3.4 – Pilot Tests Reports
- D3.5 – Pilot sites tests activity report (period 2)

Table 3: AUTOPILOT Services generic and site-specific specifications (Adapted from D1.1 Tables 1 and 2)

	Automated Valet Parking	Urban Driving	Highway Pilot	Platooning
Generic				
Enabled by IoT	Routing and scheduling of vehicles	Road condition and hazards monitoring	Optimization of platoon planning	Speed optimisation for road network with multiple intersections; Prevention of VRU interactions
Enhancements by IoT	Reduced parking time, more efficient use of parking locations	AD adaptation relatively to road conditions and hazards; Controlled transition from AD to manual driving	Platoon forming process and platooning performance	Improve VRU collision avoidance
Accelerated development by IoT	Reduced vehicle sensor set required	Reaching AD performance level fulfilling user expectations	Electronic lane allocation	Earlier deployment of V2I functions
Main end-user benefit	Effortless drop-off and just-in-time vehicle delivery	Comfortable and reassuring automated driving under all conditions	Platoon management service and trading	Vehicle rebalancing services
Pilot Site Specific				
Tampere, Finland	Parking lot	n/a	n/a	Controlled Intersections
Versailles, France	Road-side dedicated parking	Car sharing VRU (pedestrian & cyclist) detection and Points of Interest (PoIs) notifications	n/a	Road network, controlled intersections
Livorno, Italy	n/a	Integration with real Highway Traffic Control Centre	n/a	Controlled intersections
Brainport, Netherlands	Parking lot	Motorway	3 vehicle variants, 100 km/h, 'meet up' function	VRU smartphone detection
Vigo, Spain	Parking garage	n/a	n/a	Controlled intersections

Pilot User Testing

In line with standard experimental procedures, the user tests were subjected to pilot testing before public user testing. In a pilot test, the procedure, experience and survey were carried out with internal participants (e.g. employees of partner organisations not involved in AUTOPILOT), in order to identify if the evaluation procedure works in the way it was designed or if any improvements can be made. Pilot tests were not for technical evaluation or validation, though technical leaders were able to gather technical data if needed.

At Brainport, pilot testing of all four services was carried out with employees of organisations working at the Brainport Automotive Campus in December 2018. As a result, the evaluation team and the technical partners were much more acquainted with the procedure and able to better predict technical problems which may arise in the public testing. It appeared that all of the use cases still had technical problems which had to be solved before the real user testing could take place. Furthermore, the survey was found to take too long and have some technical problems with the display of questions on the iPad. This resulted in streamlining and adaptations of survey questions.

The data from these pilot tests were not included in the final analyses.

User Tests not carried out

A number of planned user tests were not taken to final public testing due to technical difficulties.

- In Brainport, AVP was cancelled at the last minute as technical staff could not attend from Germany, pilot site leaders would not be present and appropriate legal permissions had not been obtained.
- In Livorno, the last user testing was cancelled because of technical problems with the vehicle. Conducting the user test at a later time point was not considered any more as the data would come too late to be considered in the final analyses.
- In Versailles, no platooning was carried out with users in the vehicle, due to security concerns and the length of the platooning test runs (ca. 1 hour).
- In Vigo, UD was not tested with the public due to safety reasons. Tests were performed with CTAG employees at the CTAG test track.

General overview of user test experience

Reports on each user test are available in Appendix 2. The number of participants and tests carried out per user test varied by service and pilot site but is detailed in the user test report. Some tests were held over numerous consecutive days. At all sites, the primary language used was the native language of the country, with an additional English version of the questionnaire provided to international participants.

Upon arrival at the test site, participants were given a briefing of the AUTOPILOT project and introduction to the technology that they were going to experience. This was led by T4.5 partners. Following this, the participants read and signed consent forms (available in the test report) and were given a participant number. They were then asked to fill in a “Pre-Test” Survey, which assessed their expectations towards the technology/experience.

The Use Case leader of the technology being tested would then lead the participants

through the actual test experience. They were taken to the AV equipped with the IoT technology and given a short further briefing with an opportunity to ask any questions. Participants would then experience the technology individually or in small groups (as appropriate). A Professional Test Driver was seated behind the wheel (a regulatory safety requirement in all countries), and participants would generally be seated in the back seat. At some sites, participants viewed the technology in operation rather than seated in the vehicle. Use Case Leaders were required to note the participant numbers in each separate test and report on any technical issues which occurred in each test. In this way, for those tests which experienced serious technical errors (and so the participant did not have the full Use Case experience), their survey responses could be eliminated from the analysis. Both the Use Case Leader and the Test Driver were advised to avoid detailed discussions on the technical operations of the use case.

When the experience was completed the participants returned to the briefing room and completed two more surveys: a "post-test" survey to capture their reactions to the experience and future use of the technology and a "background" survey to gather socio-demographic information. If time allowed and participants were willing, informal discussions on the technologies may have taken place.

Participants were then thanked for their time with a small gift (e.g. at Brainport a reusable water bottle as well as raffle of dinner and movie vouchers and two movie tickets at Tampere). The whole experience lasted approximately 1-2 hours.

Livorno pilot site user tests

A different procedure was used at the Livorno pilot site as the only user tests were conducted as a part of a public event organized by the pilot site. Here, the experience with the technology and the use case was an indirect one – in a short demonstration or using a video which introduces the use case to the participants. All participants received the same introduction to the use case. After the demonstration, the participants had to fill out the "post-test" questionnaire (a paper-pencil survey). The incentive for the general public was participating in this public event and a lunch on the pilot site.

Vigo pilot site user tests

In Vigo, AVP users filled in the questionnaire online through SurveyMonkey. These respondents were end users, recruited via CTAG's external participant database. The test was performed in the parking lot pertaining to the Vigo city hall. No incentives were provided to the participants, who joined the tests out of interest in the demonstrated technology.

The tests for UD were performed on CTAG test track with CTAG employees only, using an online questionnaire as well.

General overview of the survey

As explained in the previous section there were three parts to the user survey. These three parts address expectations, requirements and concerns of potential users. The majority of questions were categorical and/or interval (either qualitatively or Likert scales), with a small number of free-text answers. The survey was co-designed with Task 4.4 (Quality of Life), with input from T4.3 (Business Impact) and T4.6 (Legal Assessment). So that answers across surveys could be collated, the first question on each test was to provide the participant

number. To see the original survey questions for each user test, see Appendix 3.

Although an initial common questionnaire protocol for survey questions was developed (see Appendix 1), in reality, there was a need to tailor these to each region, pilot site and use case. As a result, there was deviation between pilot sites. A full list of questions included across all use test surveys is available in Appendix 4. As can be seen in Table 2, despite a large number of questions in total, there is ultimately a limited number which is common across all (or all but 1) user tests. When focusing on the three areas of investigation we see that the common questions are even more limited. There are only 6 common questions for expectations, 8 for concerns and none for requirements. Additionally, concerns are not all directly comparable due to differing categorical response options.

Table 4: Common Questions across user tests

	Number of Questions across all 8 user tests *(free text/categorical)*	**Number of Common Questions**	**Number of extra Common Questions with 7 user tests**
PRE	9 *(3/6)*	5 *(0/5)*	n/a
POST	208 *(11/197)*	10 *(2/8)*	18 *(1/17)*
BACKGROUND	102 *(0/102)*	13 *(0/13)*	7 *(0/7)*
TOTAL	**319** ***(14/305)***	**28** ***(2/26)***	**25** ***(1/24)***
Expectations	55 *(0/55)*	2 *(0/2)*	4 *(0/4)*
Requirements	64 *(3/61)*	0	0
Concerns[1]	33 *(3/30)*	5 *(1/4)*	3 *(0/3)*
All[2]	27 *(7/20)*	8 *(0/8)*	11 *(1/10)*
Other[3]	140 *(0/140)*	13 *(0/13)*	7 *(0/7)*
TOTAL	**319**	**28**	**28**

(excludes participant number question)
[1]Although question is common, answers were termed differently so not directly comparable
[2]Relevent to all three assessment areas
[3]Not relevant to assessment areas (technology development or background questions)

Surveys were conducted in different ways at the pilot sites, depending on local resources. These differences may have some impact on variances between user tests. All surveys were collected using an online survey tool, "Lime Survey", using the same framework, though adapted for each user test. The data is stored in the Lime Survey online data repository, with data downloaded for analysis by each T4.5 partner (and stored on their organisational networks). To ensure GDPR adherence, no identifiable personal data (e.g. name, contact details) of any participant was included in these surveys. This data was held separately by Pilot Site Leaders.

- In Brainport, the surveys were collected on hand-held tablets (iPads), individually by participants.
- In Tampere, desktop PCs were used
- In Vigo, the surveys were filled in by each participant in an online questionnaire

using SurveyMonkey.
- In Versailles, questionnaires were filled in by hand and later transcribed by to an online survey based on LimeSurvey
- In Livorno, the survey was conducted as a paper-pencil survey

Pre-Test

The pre-test survey was a short semantic differential questionnaire. Participants were asked to rate their expectations of the test experience (after they had been briefed but before they started with the test) on 5-point scales: positive/negative; exciting/boring; safe/dangerous, relaxing/stressful, as well as rating the service useful/useless. These questions were repeated in the Post Test survey to assess how the experience of the Use Case compared to the expectations.

For all but the Brainport user tests, participants were also given an opportunity to describe their motivations for taking part in the study and any other comments or expectations. These were removed from the Brainport testing following the pilot tests. As iPads were used it was felt that free-text answers should be limited due to the relatively complex and time-consuming typing on tablets.

Two user tests also had additional pre-test questions:

- *Tampere UD* recorded if the participant had also taken the AVP user test
- *Vigo AVP* asked about city parking concerns

Post-Test

The post-test survey was specific to the use case but was designed to capture the expectations, requirements and concerns of the participants. Only a limited number of the questions were common across all use cases. All post-test surveys consisted of three basic sections: the experience of use; future use and future development.

Experience of use

The first questions of the post-test surveys related to the experience of use. This was related to the actual experience of the technology or service that the user had just witnessed. All user tests, first of all, gave participants the opportunity to describe their immediate reaction to the test experience and report anything that made them feel uncomfortable. Following this, they were asked to rate the experience using the same 5-point Van der Laan Scale (Van der Laan et al., 1997) as the pre-test (except Vigo AVP who changed safe/dangerous to timesaving/ consuming). This allowed an estimate of how the technology may meet expectations. An extension of the Van der Laan test is the rating of 9 areas that allows an estimation of technology satisfaction and usefulness (useful/useless; pleasant/unpleasant; bad/good; nice/annoying; effective/superfluous; irritating/likeable; assisting/worthless; undesirable/ desirable; raising alertness/ sleep-inducing). All user tests but Vigo AVP included these survey questions.

Still, regarding the experience of use, questions were then asked about how *comfortable* the participants felt regarding various aspects of the vehicle behaviour, using a 5-point scale (ranging from “very comfortable” to “very uncomfortable”). None of these was common

across all sites, though three were only missing from one user test (smoothness; acceleration; braking). Other aspects included:

- distance kept from road markings, obstacles, potholes, pedestrians, following/preceding vehicle;
- behaviour approaching pedestrians/cyclists;
- turning behaviour, speed.

These were selected based on the use case. For two user tests, participants were also given the opportunity to provide detail on any other behaviour that made them feel uncomfortable.

From comfort, the survey then turned to *concerns*. Using a similar 5-point scale, participants were asked how concerned they were about topics related to IoT:

- data privacy;
- data security;
- in-vehicle safety;
- liability.

All surveys included these four topics. In addition, four of the user tests asked about the safety of VRUs and other vehicles. However, not all of these can be directly compared due to differences in the categorization of responses. For Brainport, the scale was unconcerned/neutral through degrees of concern towards very concerned. For other sites, the scale had "neutral" in the middle of the five-point scale. The difference is due to language and understanding – the concept of "unconcerned" cannot be gradated into slightly or very as unconcerned is a fundamentally neutral stance. However, in some languages, the translated concept can be assigned degrees of "unconcern". For Brainport Urban Driving, there was an additional question regarding the smartphone app that was used in the user test, which was requested by the technology designers.

Future Use

Participants were then asked various questions regarding potential future use of the technology or service, given the scenario that the use case was fully operational and available on the road. The first set of questions was focused on potential travel behaviour change. Participants were presented with various five-point scales that could describe how they felt their current behaviour could be affected by the availability of this technology or service. These were designed in such a way that they could be related to the current travel habits of the participants that are captured in the background survey. Some questions were worded slightly differently in between surveys due to survey technology restrictions, language translation and by streamlining/improved usability of questions following pilot testing. Only two questions were common across all user tests, with an additional question missing only at one user test. Others may be comparable during analysis. The categories assessed were:

- increase/decrease –
    - number of trips;
    - private car use;
    - urban car use;

- peak hour car use;
- walking/cycling;
- public transport use;
- taxi use;
- pedestrian safety;
- user safety;
- travel comfort;
- driving stress;
- motor way use;
- trip length (time);
- trip length (distance)

Related to this, the participants were also asked how beneficial the technology or service would be for different trip types, which could also be related directly to the background questions.

Regarding *Requirements*, participants were asked how important certain features of the technology or service would be. This was again on a five-point scale, with "neutral" as a mid-point choice. The features were generally specific to use case, but include:

- receiving information in own language;
- personalize information;
- take control whenever you want;
- control vehicle speed;
- control vehicle distance;
- choose parking spot;
- park yourself.

For three user tests, participants were also given the opportunity to comment on other features they would like.

Across all user tests except from Vigo AVP, participants were asked how likely they would use the service themselves or recommend to a friend (Again on a 5 point scale), and if they were willing to pay for it (yes/no/not sure – as a service or included within the car purchase price). For most tests, participants were also given the opportunity to explain their answers. Depending on the use case, participants were also asked how much they would pay – compared to conventional services or extra to car base price, and what was too expensive.
There were a number of future use questions which applied to only one user test. Brainport Platooning asked about incentives to be a platoon leader and usefulness as a platoon follower in certain circumstances. The usefulness of services specific to the use case was also asked at both Tampere user tests.

Future Development

Although there were many questions asked across all of the surveys about future development, these were on the whole very specific to the use case. The majority of the questions were related to the importance of information and features, again rated on a five-point scale. In the majority of the user tests, participants were also given the opportunity to specify any other information that they would like.

Importance of information (Very Important – Neutral – Very Unimportant) included:

- detected hazards and vehicle response *(Highway Pilot, in Brainport and Livorno);*
- route guidance;
- wait time;
- data requirements;
- time to destination;
- time left in platoon;
- headway;
- assistance available;
- time to manual driving;
- leader messages (*Platooning, in Brainport*);
- route guidance and monitoring;
- arrival time;
- upcoming manoeuvres;
- detected VRUs;
- traffic lights;
- waiting time;
- parking status;
- point of interest;
- parking fees.

Importance of Features *(only Platooning in Brainport):*

- adjust headway;
- stop platooning;
- communicate with others;
- take control.

For two user tests, there were questions added on future use that were requested by the use case leaders for their technology development:

- Brainport Highway Pilot – "*How would you expect the vehicle to react to certain road defects?"*
- Brainport Urban Driving – functionality of smartphone application regarding crowds

Finally, for the majority of user tests (other than Versailles UD and Vigo AVP), participants were given the opportunity to provide any other feedback to the developers of the system.

Background questions

The final survey carried out was designed to gather socio-demographic details of the participants, including current travel habits, personal preferences and relevant experience. This background data was important in order to understand the post-test questions related to how the tested technology may influence travel habits, as well as to identify any population clustering or significant correlation to socio-demographic characteristics, past experience or preferences. Identification of this could be a significant input into the future technological design or business model development.

Participants were first asked about their access to/ use of a car, and subsequently about

their *current travel habits* for commuting trips, non-commuting trips and short-business trips. The original protocol allowed participants to choose up to three transport modes (Car, Bus/Train, Taxi/Uber, Motorbike/Scooter, Bicycle/Walk), and non-commuting trips were further divided into errands and leisure activities. This approach was adopted at the Tampere pilot site user tests. It was adapted by the Brainport task force to include only one option and additionally asked frequency of use. This was based on pilot test findings – when considering the analysis, it was realized that the original format was not useful for relating to the post-test questions. Versailles, Vigo and Livorno adopted a mix of the original and adapted questions. Related to this, participants were also asked about how often they drive on specific road types (motorway, rural, urban).

Experience of new systems asked participants if they have access to and their frequency of use of new automotive technology systems (parking assist, self-parking, cruise control, adaptive cruise control, navigation) and new mobility services (taxi/Uber, shared bikes, shared vehicles). These can be used to cluster populations and also identify any correlation with technology acceptance.

There were many questions related to *driving preferences* (e.g. parking habits, driving decision factors, congestion experience, and motion sickness). These however varied widely across all user tests due to specific relation to the use case being tested. In terms of *Driving experience,* most user tests captured years of driving, annual mileage and expected next car purchase type.

Finally, standard socio-demographic information on age, gender, household size and income were gathered.

Variances between user tests

There are a number of variances between the user tests that may inhibit cross- and meta-analysis of the data. Some of these have already been mentioned in the previous section but are summarised here.

Pilot site-specific issues

As the pilot sites were located in five different EU countries, there were language and cultural differences that required adjustment to the protocol survey questions.

Use Case specific

Although all use cases use IoT to enhance AD, they have adopted different approaches and were developed by different technology partners. Each type of use case was a service or technology for a particular situation and would thus have different baselines for comparison – e.g. AVP is comparative to non-automated parking whereas platooning is comparative to long-distance driving. Further, even use cases carried out at different pilot sites were developed separately, focusing on different technological challenges – e.g. UD at Tampere was concerned with signalized intersections, but at Brainport the focus was the detection of VRU smartphones.

Survey technology

Due to pilot site resource restrictions, surveys were carried out in different ways (see section 1.2.6). This required adjustment of the questions to the capability of the software.

Collaboration with use case teams / pilot site leaders / other T4.5 partners

There were different relationships between partners of the use case developers, pilot sites and T4.5 partners at each pilot site. This was due to organizational factors but also related to the necessity to have evaluators who speak the local language. In some cases, these were all from the same organization (which aided communication), whereas at others these were all different organisations. As such there were different levels of engagement with the user tests and surveys.

Study Sample

The initial target of participants across all user sites was over 1.000 public users. However, due to delays in use case technology development, it became clear that this would not be realistic to achieve this within the timeframe and pilot site engagement that was available. In reality, 199 public participants took part in user tests across the AUTOPILOT project, as demonstrated in Table 5.

Table 5: Public Testing carried out in AUTOPILOT

	Automated Valet Parking	Urban Driving	Highway Pilot	Platooning
Brainport		43	37	20
Livorno			12	
Tampere	29	27		
Versailles		20		
Vigo*	11			
ITS Congress	47 congress visitors (for different/combined use case demonstrations) and 20 members of the general public (for a general AUTOPILOT demonstration)			

* Note: In Vigo, users participating in the UD testing were not from the general public but employees of CTAG.

Recruitment of participants

Members of the public were recruited to take part through different processes at each Pilot Site:

- *Brainport* - mainly through local print media, the "City of Helmond" facebook page as well as the SmartWayz "Travellers Panel"
- *Livorno* – organized by the pilot site team as a public event for selected experts and potential users (general public)
- *Tampere* - general public participants were recruited by an external company (Testaamo) which is specialised on user testing and recruiting
- *Versailles* – users were mainly recruited via social media and own professional and personal networking
- *Vigo* – Participants in the AVP pilot were recruited from CTAG's external participant database. Participants for the UD pilot were recruited internally (CTAG employees).

Study sample characteristics

Table 6 gives an overview of the socio-demographic characteristics of the participants on each pilot site.

Table 6: Demographics of study samples (in brackets: regional average)

		Brainport		Versailles	Tampere		Livorno	Vigo	
		HP (n=35)	**PT** (n=20)	**UD** (n=20)	**UD** (n=27)	**AVP** (n=29)	**HP** (n=12)	**AVP** (n=42)	**UD** (n=49)
Gender	Male	57% *(50%)*	75% *(50%)*	68% *(51%)*	59%	48%	58% (7/12)	68% (51%)	82% (51%)
	Female	43% *(50%)*	25% *(50%)*	31% *(49%)*	41%	52%	17% (2/12)	32% (49%)	18% (49%)
	Missing values						25% (3/12)		
Age	>60	15% *(30%)*	60% *(43%)*	12% *(22%)*	0	7%	8% (1/12)	12% (20%)	0% (20%)
	50-60	21% *(19%)*	35% *(28%)*	19% *(13%)*	33%	21%	58% (7/12)	19% (17%)	0% (17%)
	40-50	24% *(20%)*	5% *(29%)*	14% *(13%)*	26%	24%	16% (2/12)	14% (14%)	5% (14%)
	30-40	9% *(16%)*	n/a	14% *(15%)*	19%	28%	8% (1/12)	14% (13%)	45% (13%)
	20-30	32% *(15%)*	n/a	26% *(17%)*	22%	21%	8% (1/12)	26% (13%)	50% (13%)
	<20	n/a	n/a	14% *(20%)*	0	0	0	15% (23%)	0% (23%)
Household Income	> €100,000	6%	10%	10%	4%	7%	n/a	10%	0%
	€60-99,000	26%	20%	24%	30%	28%	n/a	25%	5%
	€20-59,000	56%	70%	39%	48%	45%	n/a	39%	73%
	<€20,000	12%	0	27%	15%	17%	n/a	26%	22%
Household size	4+	20%	20%	33%	30%	21%	n/a	33%	27%
	3	17%	5%	7%	22%	28%	n/a	7%	24%
	2	43%	7%	38%	30%	31%	n/a	39%	39%
	1	20%	5%	21%	19%	21%	n/a	21%	10%

Data Analysis

Individual User Tests

Following each user test, the data gathered in the surveys were subjected to a descriptive analysis report (available in Appendix 2) following a template, which included the following sections:

- *Background* – Detailing the time and place of the test and the number of participants
- *Test Protocol* – Describing the process carried out during the test
- *Technical Problems* – Stating any technical issues that occurred during the test that may affect the analysis of results
- *Results* – Charts visualizing the answers to each categorical question, lists of free-text answers and descriptive highlights of findings

Analysis of Expectations, Requirements and Concerns

The User Test Reports were then analysed in relation to the three analysis areas of Expectations, Requirements and Concerns. The full list of questions across all user tests was separated into these areas, and common questions for these were identified, as in Table 2 in Section 1.2.5, and are available in Appendix 4. This also details if the question is categorical or free text. Categorical questions were subjected to quantitative analysis and free text questions subjected to qualitative analysis.

Qualitative Analysis

For each user test, open coded thematic analysis of answers to free text questions was carried out separately in the context of each specific analysis area, in order to identify any themes that may emerge across use cases. These were then considered across all pilot sites. Any unique or exemplifying quotes were noted, as were any free text that was relevant to other analysis areas. The themes that emerge can be used to interpret the understanding of the analysis area.

Quantitative Analysis

For each common question related to the analysis area, the charts from individual user test report were collated and compared descriptively. Where it was possible to compare directly, the relevant data was collated for consideration at a higher level as per the individual questions.

Analysis Restrictions

- Problem of low numbers (individually and overall)
- Problem of inconsistencies between sites and use cases (survey and process)
- Above lead to limited questions that are consistent across sites

6 Results

The full reports for each publicly tested use case at each site are available in appendix 2. In this section, we summarise the overall insights on the areas of requirements, expectations and concerns of potential users on the tested use cases/ services.

Requirements

Overall

In the survey, the participants had to evaluate the relevance/ importance of different types of requirements – first, requirements on information provided by the system and features enabled due to the connectivity of the vehicle and second, requirements of the users about options of control over the system and the vehicle.

The first group of requirements focused on the following information/ features that can be provided by the service:

- Information about external factors (e.g. traffic situation, road constructions or other hazards on the road etc.)
- Information about the vehicle operation (e.g. what the car is doing or about to do)
- support information (e.g. how the system/ service works)
- Information related directly with the use of the service (e.g. estimated waiting time, travel time, price, route etc.)
- personalizing options (e.g. language or route)

The second group of requirements focused on the following requirements on the vehicle operation and especially on control functions:

- Requirements on the type and detail of information – do users want to get the same information that the vehicle receives as a basis for its decisions (especially such information that is available due to IoT)
- Requirements on options to take back the control over the vehicle/system if needed or wanted

The particular information, the features and options for control can differ across the use cases as some of them are not relevant for all use cases.

Common to all pilot sites and services was that the majority of the users (> 88%) found it (**very) important to have the option to take back control over the vehicle at any time** (see Fig. 4).

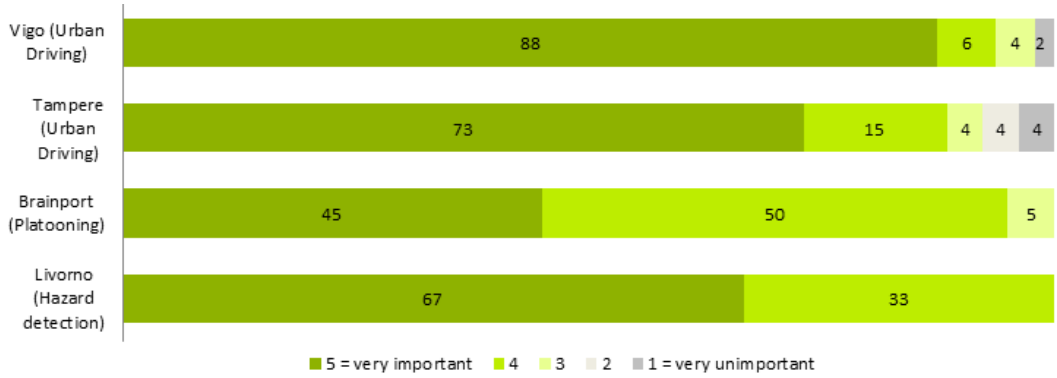

Figure 2. Evaluation of the option to take over the control over the vehicle at any time

Also, various **information that makes the trip safer and comfortable**, as well as such that makes travel time predictable (especially information on possible hazards, waiting time), was evaluated as an important/ a relevant one across all pilot sites. Last but not least, requirements on **customization options,** especially that the information is provided in the own language, were also an important feature from the user's point of view.

Looking into specific functions of the services, almost every participant who experienced the hazard detection (HD) use case in Brainport found **Information on detected hazards** and on **what the vehicle will do about the hazards** most relevant, being rated as (very) important by 36 and respectively 35 out of 38 of the potential users. The survey in Livorno came to similar results – all 12 participants evaluated information on hazards as important and 7 out of 9 require having information on the upcoming manoeuvres of the vehicle. Equally important is the option to take control over the vehicle at any time, it is rated as (very) important by all participants. These results indicate that not only the information itself or the function of the service to detect hazards is important, but considering potential users, developers can ensure trust in the service (at least in the early stages of implementation) by also providing information on the decision of the system based on this information. Further information that users would require in this use case is **general information about the traffic situation** as well as **information on other road users**. Additional information that single users reported to require from the system was acoustic/ tactile signal, Information on traffic jams, unexpected road lane changing users, moving objects, alternative routes, speed cameras, police, fire brigade, ambulance, hazards like ghost riders, slow riders, unreliable road users, large water ponds, upcoming emergency services, unusual crowds on fixed routes. The listed options suggest that users would like to see a join between the service and existing traffic systems.

Looking into another potential use case in highway traffic environment – the platooning – two perspectives were considered – the one of the platoon leader and the one of the person sitting in the following car. As a platoon leader i**nformation on estimated waiting time** to form a platoon and **information on road guidance** is (very) important for all respondents surveyed in Brainport (n=20). Furthermore, **adjusting the distance between the cars** is a (very) important feature to nearly every (16 out of 20) participant. Regardless of the perspective, **the possibility to stop the platooning anytime** is considered (very) important for almost all respondents. As a follower, the **information on estimated waiting time** is rated (very) important by nearly all participants as well, while information on road guidance seems to be slightly less important as a follower. However, from the follower's perspective, it is (very) important to **receive a pre-warning about manual driving** and **to be able to drive the vehicle yourself at any time**. These results indicate a demand for control options when

using the service.

In an urban environment, features that improve travel time reliability and increased safety, but also control functions were evaluated overall as (very) important. In Brainport, 70% of participants (30 out of 43) reported that the **information on crowds of pedestrians that could affect the route of the car was (very) useful** but **information on said crowds for other reasons than route was rated rather useless or neutral by 60%** (26 out of 43) of the respondents. Other desired information mentioned by the participants includes **information about waiting/travel time** and **information on what the car does and why**. In Tampere, for the majority of participants (23 to 26 out of 27) **information on route monitoring**, **estimated arrival time, detected pedestrians and cyclists** and **traffic light status is (very) important**. Furthermore, 23 to 24 participants consider **driving the vehicle whenever they want** as well as **controlling the speed and the distance to the car in front** of them (very) important. Similar results can be found in Vigo - for the majority of participants (> 40 out of 48) information on detected pedestrians or cyclists and on upcoming driving manoeuvres as well as the possibility of driving the vehicle manually at any time and receiving all information in your own language are considered (very) important.

The use case tested in Versailles was a special use case of UD as it represents a touristic experience matched together with a carsharing service. Also, the automated driving part of the use case takes place in the Gardens of the castle in Versailles and not on city streets. For almost every respondent (at least 18 out of 19) i**nformation about parking space availability** and **location**, **detected hazards, estimated waiting time** in case no vehicle is available and **estimated time left in self-driving mode**, as well as route guidance, is (very) important. Additionally, respondents assess features like **receiving information in one's language** and being able to **take control of the vehicle** at any time as relevant. These findings indicate that easier access to the service, customization as well as control options are important features of the service.

For the AVP, in Tampere as well as in Vigo, information on the parking process and parking availability is considered as important. In Tampere, **confirmation that the car is successfully** parked is rated very important by most participants (25 out of 28). In addition, **information on estimated waiting time** in case no parking space is available and **waiting time** to retrieve the car on return are considered (very) important by almost every respondent as well (27 out of 28). A quarter of respondents find it important to get **information in their own language** and to **be able to stop the parking process** and park the car themselves. In Vigo, similar to Tampere, the majority of participants (>35 out of 41) believed that **information about the estimated waiting time** in case no parking spot was available and **waiting time** to retrieve the car on return as well as confirmation that the car is successfully parked would be (very) important.

Use Case Observations

Hazard detection (HD)

The main function of the service – detection of hazards and provision of information of detected hazards – is considered as an important one by the users. Still, users require additional information about what the vehicle will do about the hazards suggesting that potential users would like to remain in control over the driving situation. This result suggests also the attached high importance to the option to take over the control at any time.

Platooning (PL)

Potential users evaluated the waiting time for a platoon match as important information

which they would like to receive from the service. Additionally, users would like to have the option to stop/disconnect the platooning at any time and take back control over the vehicles if needed/ wanted. These results might indicate that platooning might be a useful or desirable service when it is reliable and easy to use as well as when people still have certain flexibility when using it.

Urban Driving (UD)

Driving in an urban environment is a complex task which requires a high level of concentration by the drivers and interaction with different other road users. The results of the AUTOPILOT surveys suggest that potential users of urban driving require having the option to drive the vehicle whenever they want as well as controlling the speed and the distance to the car in front of them. At the same time, users evaluate as very relevant/ important receiving information on detected VRU and/or other potential hazards. These results indicate a willingness to remain in control over the driving task but the importance of assisting functions such as the provision of additional traffic and driving-related information enabled by IoT. Last but not least, people attach high importance to receiving relevant information in their own language.

Automated Valet Parking (AVP)

Similar to the other use cases, potential users of AVP require remaining in control over the driving task, in this case, the parking procedure. High importance is consequentially attached to the option to stop the parking process and park the car themselves if needed/ wanted, to receive a confirmation that the car is successfully parked, and to get information on waiting time. In this use case, receiving the information in the own language is, similarly to the other use cases, required by a high percentage of the potential users.

Expectations

Overall

Expectations before the actual user testing (see Fig. 5) were collected. The variation is not great among pilot sites (mean value range no more than .5). Users expected their participation to be safe in all UCs, meaning they trusted the researchers. The usefulness of the different services is univocally positive.

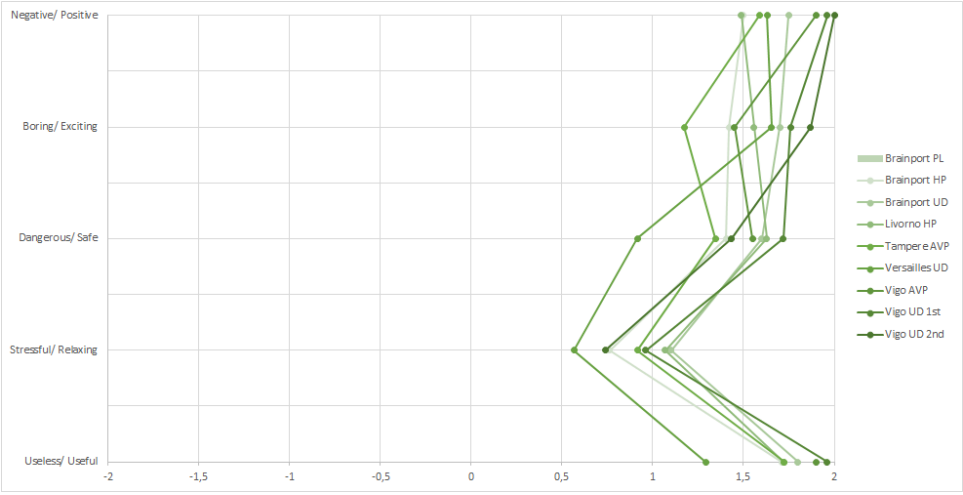

Figure 3: Mean expectations score per pilot site

The evaluation across pilot sites and UCs is positive with higher mean variation noted in

expected stress and excitement. **A very small increase is expected to happen in the use of cars in urban areas** mainly when the AVP service will be used. In addition, **no change is anticipated in the use of public transport**. **A difference between Vigo UD and Brainport UD** was found; in the first site **no changes in taxi taking habits are anticipated but in the second a slight decrease is expected**. **UD services**, overall, **are expected to increase more the traffic safety of VRUs compared to AVP services**. In addition, they might **expect to get faster, even if their routes will be longer**.

Similarly, the use of UD services as found in Brainport and Vigo will not affect their existing habits of walking and or cycling. Expected **perceived safety is probably the greatest positive increase across pilot sites** and in the analysis on UC level. **Comfort is expected to increase for services** and UCs but more for UD related services. In addition, the **comfort is expected to change very little for the leader of a platoon formation**; maybe because they will be still in the driving seat. **Parking related stress is expected to decrease most** because of using the AVP service; however, **all stress is expected to decrease** apart from the l**eader's in the platoon formation, which is expected to slightly increase**. Users do believe that using IoT services, regardless of the services, will increase their safety. This finding is important when investigating professional users' trust in the IoT solutions.

No change is expected in existing mobility patterns and use of transport modes across pilot sites and UCs, apart from Versailles UD pilot, where an increase in walking/cycling, as well as an increase in the use of public transport and a decrease in passenger cars is anticipated. Tourists might be easier to change their habits as a tourist when they are away from their established mobility habits. Users believe that the use of UD services would **decrease the use of the motorway** and that they will **certainly be able to take up other activities** when the car is in self-driving mode (based on results collected only in Vigo UD pilot). UD services were perceived as **more beneficial for commuting and short business trip**s, but all UC services were reported beneficial for non-commuting trips. Most users (88%) believe that the **AVP services are beneficial to run errands** compared to 53% of UD services. Users believe that **the UD and AVP services are beneficial for leisure activities** (65% and 64%, respectively) and over half the users (56%) stated that they believe the **AVP service is beneficial for travel trips** and over 75% that are beneficial for **business trips.** Users believe that **AVP services will be very beneficial for long-term parking** (97%).

Users across pilots and UCs are **willing to use the services in the future and especially the UD services (84%)** and **recommend the service to their friends and colleagues**. Most users are willing to pay for the AUTOPILOT services. However, in Brainport pilot, many users (45%) were not sure if they would pay for the HP service as well as another 55% were not sure if they would pay for the platooning service. 60% of users are willing to pay between 100 and 1000 Euros for the addition of such functionalities when purchasing a new car, while14% do not want to pay. Users would pay up to 5 Euros to use the services with almost 40% of them not wanting to pay. Users are willing to pay for the integration into the vehicle but not much if the service was offered as an extra option to a vehicle bought new.

No change in the frequency of use of public transport, passenger car, walking/cycling, taking a taxi or driving in urban environments is reported.

Use Case Observations

Highway Pilot (HP)

In the Highway Pilot users are willing to increase the number of trips they take because of using the respective service. No increase in car use and private car use is expected. The highest increase in perceived safety is anticipated when compared to other pilot sites (see Fig. 6) Users are willing to use and recommend the services, but 45% of them (Brainport) are not sure if they would pay for the service

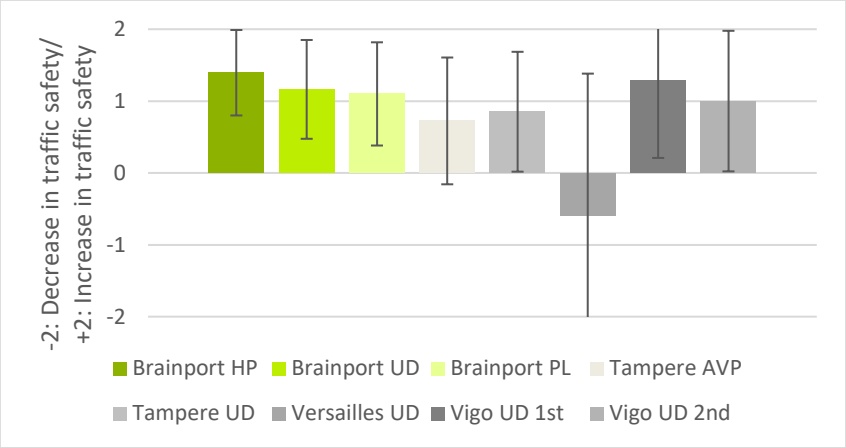

Figure 4: Mean change in perceived traffic safety across pilot sites

Platooning (PL)

The platooning service is expected to bring small change to trips taken. Car use is not increasing because of using this service. A slight decrease in public transport use is expected (-.49±.98) in a -2 to 2 scale. Expectations about changes in duration and distance of trips taken were recorded only for the Brainport PL pilot. A very small decrease in duration is expected (-0.16±1.01) with a small increase in distance (.25 ± .79), meaning users expect to get faster to their destination, even if potentially re-routes occur and even if they decide to go to a destination further away. The smallest increase in travel comfort (-.15 ± .93), but with great variation was reported for the leader role in the platoon formation in the Brainport PL pilot (see Fig. 7). As for comfort, stress is slightly increasing for the leader of the platoon formation but decreases for all other services and the users of the UCs are neutral about the benefit of the service for commuting trips (Brainport PL; 21/39). Users are willing to use and recommend the services but 55% of them (Brainport) are not sure if they would pay for the service. In the Highway Pilot in Brainport, almost 60% of users are willing to pay between 100 and 1000 Euros on top the cost of the car in order to have the HP service. 14% of them do not want to pay and another 14% are not sure if they want to pay or not.

Urban Driving (UD)

Increase in anticipated trips taken because of UD and AVP services are positive but still small with great variations. The increase in car use is too small to be of consideration. Expectations for change in frequency of car use in urban environments were investigated in only in Tampere UD plot. Driving in urban areas like the city centre is expected to increase (.85±0.91) because of the use of the UD service. A small increase is anticipated in using cars during peak hours. In addition, users do not anticipate that the UD service will affect their existing habits of walking or cycling. No change in walking or cycling is expected because of the UD services in Brainport (-.14 ± .74). In fact, a very small decrease is anticipated. Perceived safety increases in all cases, except the Versailles pilot (UD), where the users

thought that it would slightly decrease it (-.59±1.97) (see Fig. 6). No change in public transport use is anticipated based on Vigo pilot results. In Brainport UD, a slight decrease in taxi taking is anticipated (-.44±1.16; scale -2 to 2) but in Vigo, in both pilot phases (1st and 2nd), users are not expecting to change their taxi-taking habits. Overall, no change in public transport use apart from Versailles, where an increase is expected (12/18). In other words, they might believe that the mode they experienced was perceived as public or at least for public use. Again, no change of car use is expected, apart from Versailles UD site, where most users reported expected decrease of use the passenger car and/or taxi and use of motorways and increase in walking and cycling.

This finding is mostly related to the car-sharing service offered to tourists. However, we need to keep in mind that tourists might not often select to drive when visiting a foreign country and any related mobility behaviour might differ from their existing and already daily mobility patterns. However, an increase in driving in urban environments is not expected. Users responded that the use of the UD service in Vigo would certainly allow users to take up other activities when the car is in self-driving mode (strongly agree N=12/13). The UD services were perceived as more beneficial (N=90/117; 77%) for business trips than the platooning (14/45; 31%) or the AVP services (15/29; 52%). They are beneficial for commuting and non-commuting trips alike. More than half the users (53%) believe that the UD services are beneficial for running errands and for any other leisure activities (65%). Users across pilots and UCs are willing to use the services in the future and especially the UD services (84%) and to pay for the service (57% of users would pay extra to use the UD services). The maximum price expected a user to pay for UD services is 7 Euros with variation across sites, as the services considerably differ. In Versailles, a mean price for the UD service of 12 Euros would be regarded as expensive.

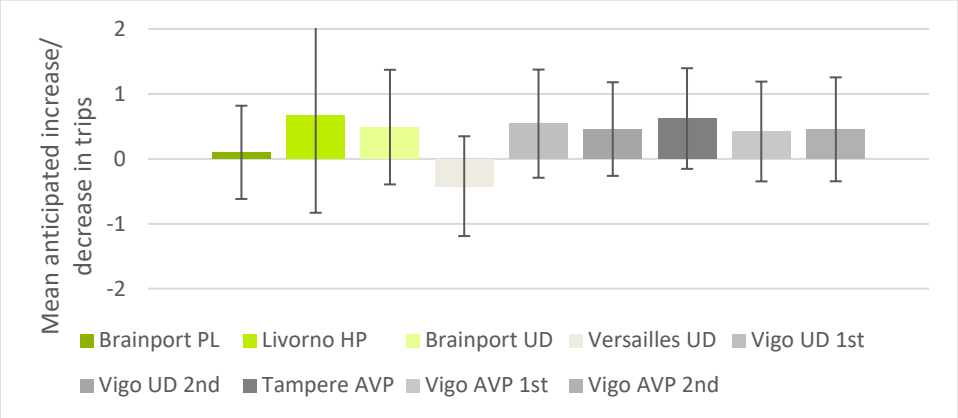

Figure 5: Mean anticipated increase/decrease of trips per user testing pilot

Overall, an increase in the safety of other VRUs is expected more for UD services (see Fig. 8).

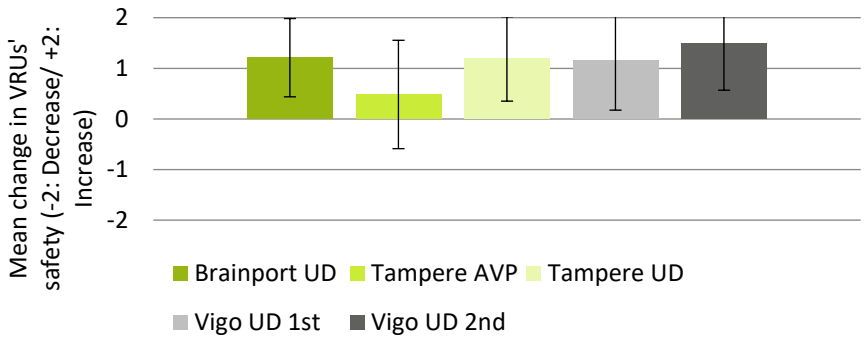

Figure 6: Mean perceived change in safety of pedestrians and cyclists per pilot

No site reported a decrease in travel comfort (see Fig. 9). The highest increase was found in Vigo UD pilots in both phases (1.71±.46 and 1.63±.58).

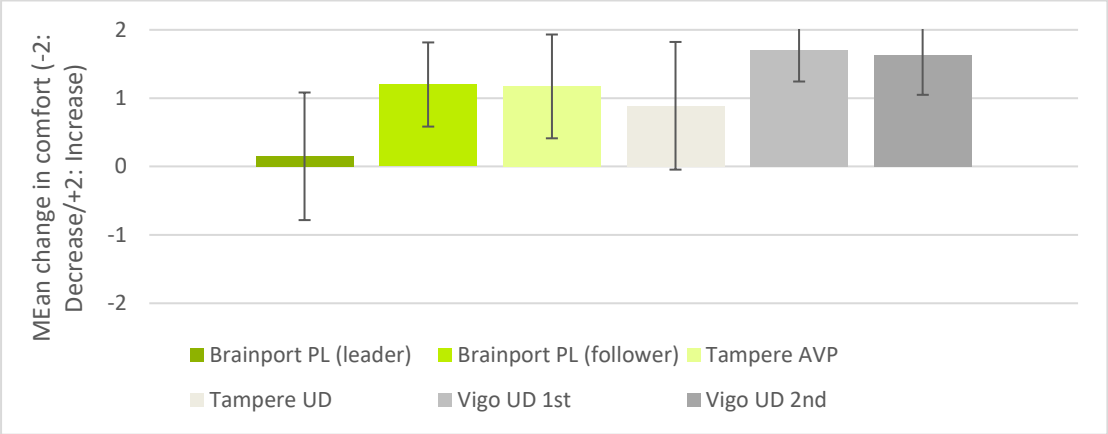

Figure 7: Change in comfort across pilot sites

Automated Valet Parking (AVP)

Users testing the Automated Valet Parking (AVP) in Tampere, expect to take an increased number of trips compared to their current trip frequency. Increase of car use is expected because of AVP. A small increase is anticipated in using cars during peak hours. A small increase in perceived traffic safety is expected (see Fig. 6). Safety of other VRUs is expected to increase less for AVP services (.48±1.07) (see Fig. 8). Parking related stress is anticipated to decrease most (Tampere AVP; 1.48±.87) (see Fig. 10). No change in public transport use is anticipated. The service is beneficial for commuting, non-commuting trips, leisure activities, but mostly for running errands (88% of users). Over half the users (56%) stated that they believe the AVP service is beneficial for travel trips. 78% of users in both Vigo AVP pilots stated that the service is beneficial for business trips and 97% users believe they are beneficial for long-term parking (Tampere). Users are willing to use and recommend the services and to pay for the service (51% would pay extra to use the AVP services with a maximum of 5 Euros). Specifically, in Tampere, a mean price of 6 Euros for the AVP service would be considered expensive. In Vigo pilot, users were willing to use the AVP service with bonus options (74% and 59% per pilot phase respectively).

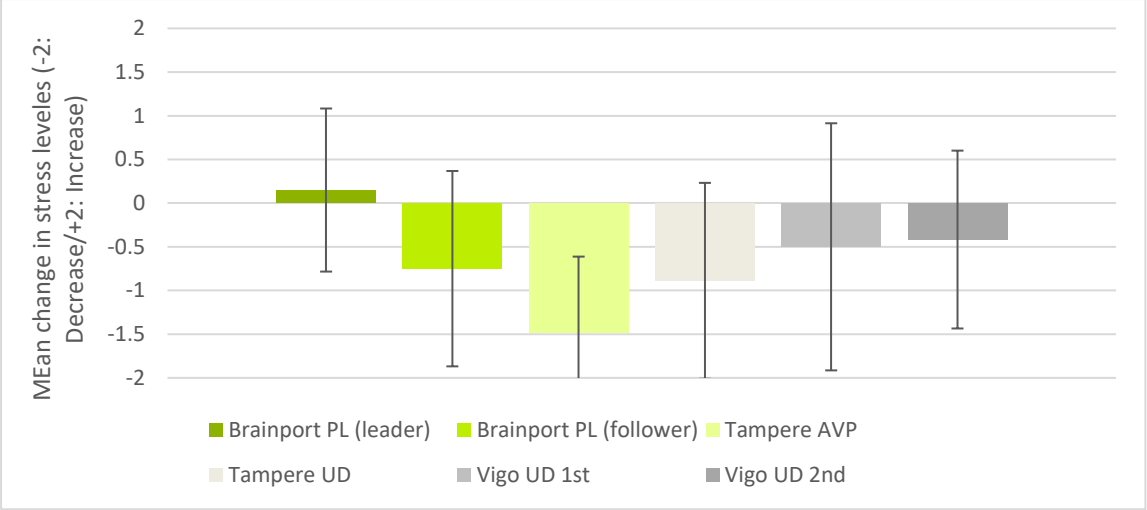

Figure 8: Change in levels of stress across pilot sites

Users were asked to elaborate on their reasons (i.e. free text answers) for being interested to use the services at each pilot site. The answers have been clustered to the categories shown in Table 7. Overall, it appears their experiences were positive, as it was expected before testing took place (see Fig. 5).

Table 7: Reasons for interest in service (free text analysis; dominant topics)

INTEREST IN SERVICE								
Brainport HP	Brainport UD	Brainport PL	Vigo UD 1st	Vigo UD 2nd	Vigo AVP 1st	Vigo AVP 2nd	Tampere AVP	Versailles UD
• Improves road safety • Pleasant and comfortable experience • Increase visibility/ Conspicuity, reduces traffic congestion, increases relaxation • Automated braking and steering are prerequisites for use • Use is cost-dependent • Possibility to intervene gives sense of control • Added value for patients or confectioners (especially carrying fragile/	• Environmental impact • Lower car ownership • No waste of time • Seamless operation, safer and more relaxed experience • Easiness to use • Useful for older travelers/drivers • Students prefer a bike • Advantages of public transport and private car in one vehicle • Cheaper and more convenient than a taxi • Avoid taxi chit chat and can focus on work (in-car work activity) • Alternative to car but not to public transport or bike	• Smoother traffic flow • Pleasant experience • Flexibility to turn on/off system • Leader does not relax but follower does • Added value for traffic jams or long journeys	• Opportunity for other in-vehicle activities • Useful for driving in road contexts that users avoid (e.g. by a cliff). • Road curvature and geometry are affecting the decision to use • Use in certain affective states' conditions (e.g. tired, sick, stressed) • TLA and speed assist is a prerequisite for use	• Thrill of driving will negatively affect the service use • Willingness to use increases if journey duration is long, road context is monotonous or on demanding busy, urban roads • A system responds better than a person and thus more desirable • Reliable and comfortable experience but still the driver needs control of the vehicle	• Liability and malfunctions are perceived as great hindrances • Personal comfort • Decreases damages to your own car (e.g. scratches) when trying to squeeze in a small parking space • Optimal use of parking space	• Service is Interesting, saves time, decreases stress, increases comfort • Maturity of service is an obstacle in acceptance • Use it in urban environment • Increased added value for older users	• Increased potential for use in large parking and working spaces • Fees should not exceed much existing parking fees in order for the service to be attractive • Eases parking space search and saves time • Pleasant • Reduce parking related accidents • For families with children will be very useful • User has not to remember the location of the parking space and	Pleasant, comfortable, Receiving information (i.e. PoI notifications) increases the pleasantness of the trip.

INTEREST IN SERVICE								
sensitive load) • Users with visual impairment would benefit from a car that "sees" for them • Increased usefulness to unfamiliar road contexts • Added value for commuting and long-distance journeys							loses time trying to find it. • Vicinity of service to where the person works and/or lives is important for potential use	

Concerns

Overall

The participants were asked with an open question whether something happened during the drive that made them feel unsafe or uncomfortable. The question was asked at all pilot sites and respective use cases, and 90 participants answered the question. The answers were open coded to identify common topics among the responses and five main themes could be identified:

- worry that the system will fail in some way (e.g. detection of objects, hitting pedestrians)
- unexpected or harsh braking or accelerations
- otherwise uncomfortable driving style (e.g. cut-ins, lane change, jerks, swaying, slow speed, driving close to objects)
- technical failure of the system (e.g. navigation, take-over, manual braking)
- properties of vehicle or automation/service (e.g. uncomfortable seat belts, turning of the steering wheel, HMI, automatic gear shift)

The distribution of main themes according to the pilot site and use case is presented in Figure 9. For the use case AVP (Tampere and Vigo) most of the participants worried that the system would fail in some way. The answers do not allow concluding any similarities among the other use cases. However, in Brainport most of the comments related to the driving style which was otherwise uncomfortable and in Versailles, most comments were related to unexpected or harsh braking and accelerations. For UD in Tampere, most participants mentioned unexpected or harsh braking and accelerations and an otherwise uncomfortable driving style and UD in Vigo most comments related to either an uncomfortable driving style or technical failure of the system.

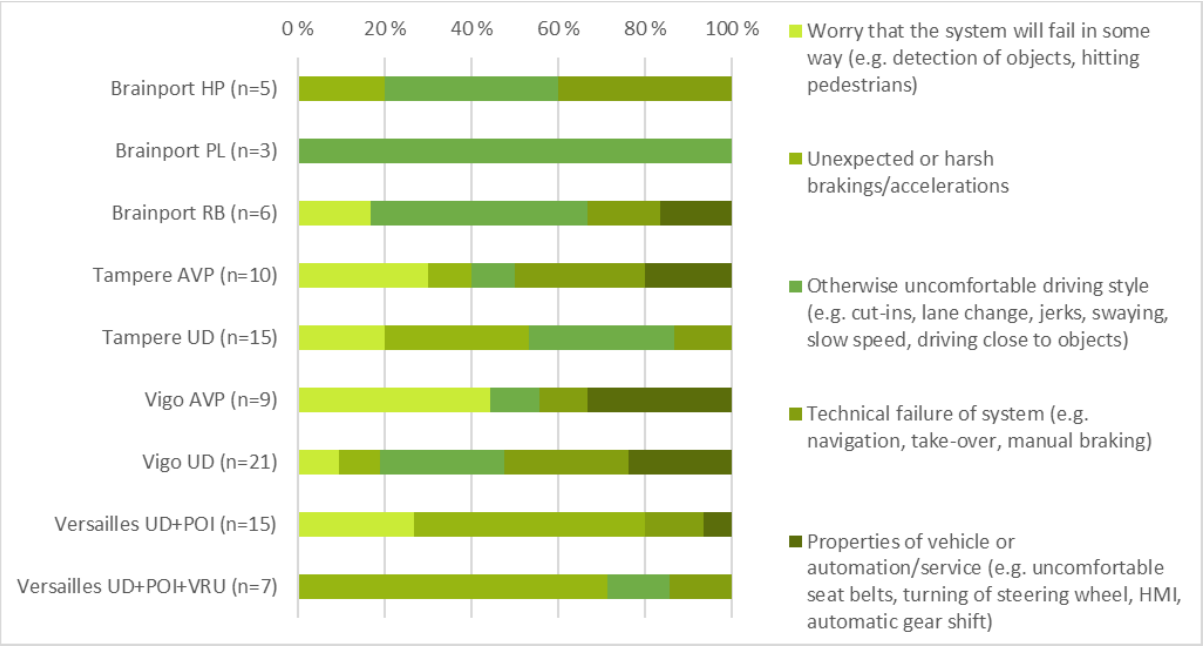

Figure 9: Common themes in other occurrences that made participants feel unsafe or uncomfortable during the test according to pilot site and use case

Participants were asked to comment on their concerns about various aspects of the service. The same question was asked at all test sites and use cases but it included different aspects. The aspects were ranked on a five-point scale, but the scales differed among pilot sites. In Vigo and Brainport the

scale was: Not at all concerned/Neutral; slightly concerned; Somewhat concerned; Moderately concerned; Extremely concerned. In Versailles and Tampere, they were ranked from Very concerned to Not at all concerned, with Neutral as a central choice. Since different scales were used the answers were compared based on the share of maximum concern on the respective scales which were: extremely concerned (Vigo and Brainport) and very concerned (Tampere & Versailles). Common for pilot sites and use cases were the following aspects: privacy of my data, security of my data, Security of the self-driving vehicle (Brainport: My safety in the vehicle) and Liability in case of accident or malfunction.

The distribution of responses for the concern Privacy of my data is presented per pilot site and use case in Figure 10. No use case-specific similarities were found for the results, instead, the share of maximum concern seems to depend more on the pilot site. The share of maximum concern was 20–21% in Vigo, 5–9% in Brainport, 10% in Versailles and 12–19% in Tampere.

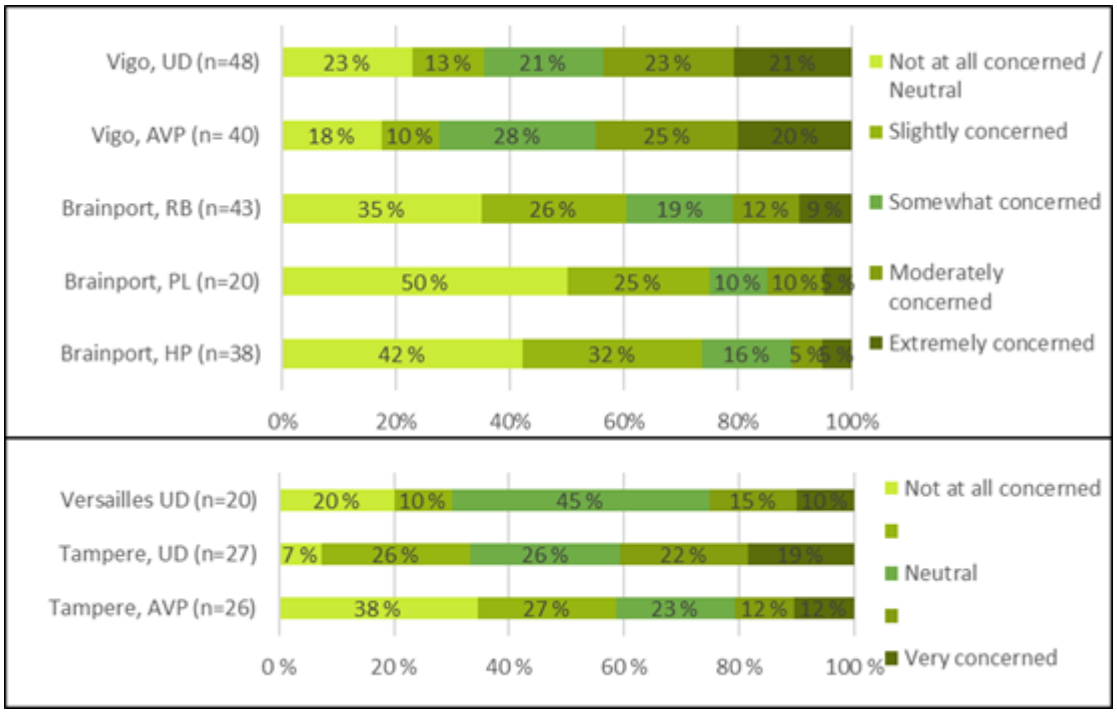

Figure 10: Concerns related to the tested service: Privacy of my data

The distribution of responses for the concern "Security of my data" is presented per pilot site and use case in Figure 11 . No use case-specific similarities could be drawn, instead, the share of maximum concern seems to depend more on the pilot site. The share of maximum concern was 23–27% in Vigo, 5–14% in Brainport, 15% in Versailles and 7–16% in Tampere.

Figure 11: Concerns related to the tested service: Security of my data

The distribution of responses regarding "Security of the self-driving vehicle" and "My safety in the vehicle" are presented per pilot site and use case in Figure 12. No use case-specific similarities were identified for the results, instead, the share of maximum concern seems to depend more on the pilot site. The share of maximum concern was 28–33% in Vigo, 0–5% in Brainport, 47% in Versailles and 7–12% in Tampere.

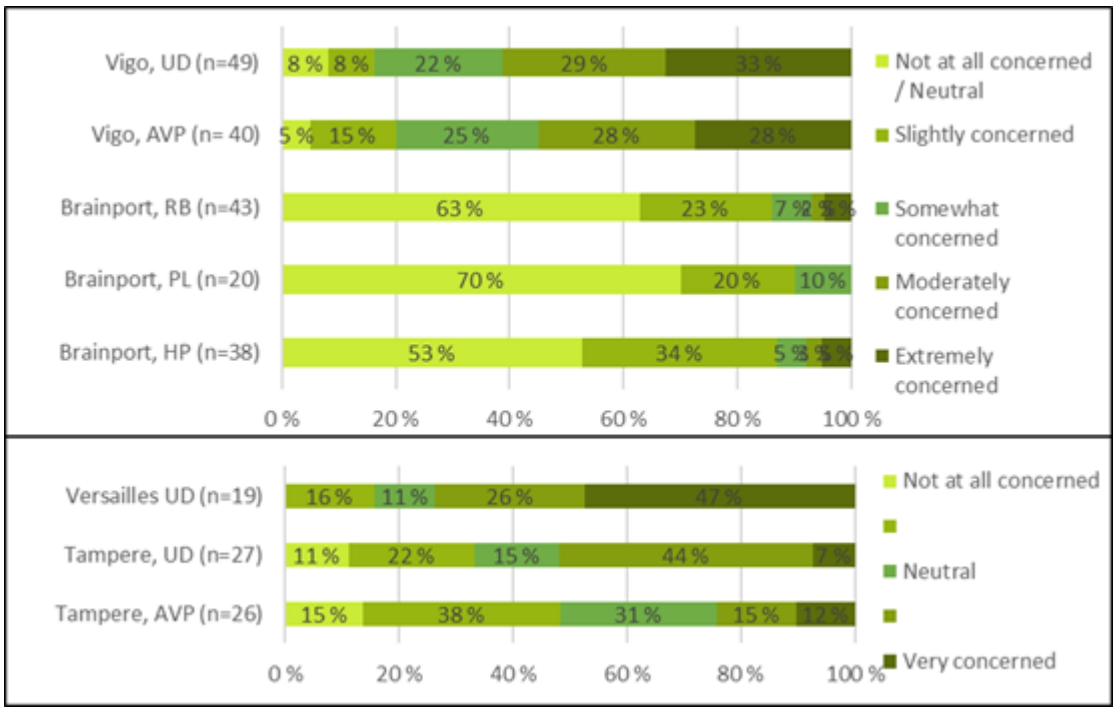

Figure 12: Concerns related to the tested service: Security of the self-driving vehicle (Vigo and Tampere) / My safety in the vehicle (Brainport)

The distribution of responses regarding Liability in case of accident or malfunction is presented per pilot site and use case in Figure 13. No specific similarities were found for the use cases, instead, the

share of maximum concern seems to depend more on the pilot site. The share of maximum concern was 0–10% in Vigo, 0–5% in Brainport, 30% in Versailles and 4–7% in Tampere.

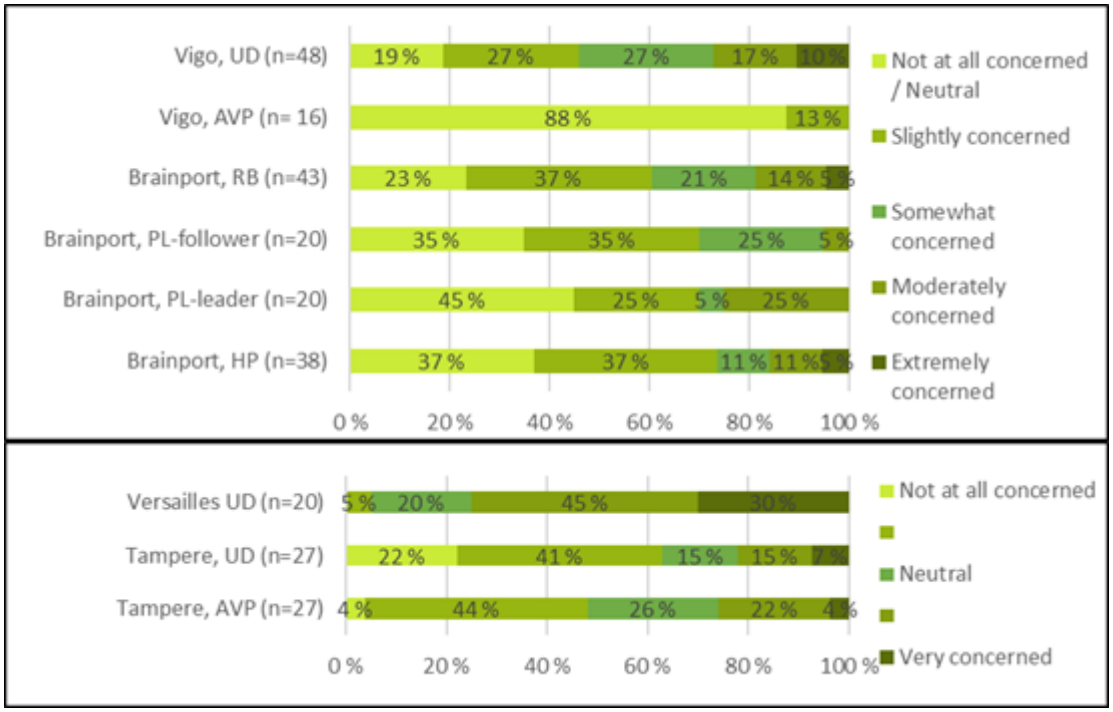

Figure 13: Concerns related to the tested service: Liability in case of accident or malfunction

The participants were asked about their concerns regarding five additional aspects in Vigo, Versailles, and Tampere:

- Safety of driver and passengers inside the vehicle
- Safety of pedestrians and/or cyclists/VRUs
- Safety of passengers in other vehicles
- Security of payment
- GPS tracking

A different scale was used in Vigo (as indicated above), so the answers were compared based on the share of maximum concern on the respective scales which were: extremely concerned (Vigo) and very concerned (Tampere & Versailles). The share of responses for the different concerns is presented per pilot site and use case in Table 8. No use case-specific conclusions could be identified. The highest share of very/extremely concerned was for UD in Vigo for security of payment, for AVP in Vigo for GPS tracking, for UD in Versailles for safety of pedestrians and cyclists and for UD in Tampere for Safety of driver and passengers inside the vehicle. Overall the share of very concerned was substantially higher in Versailles than in the other pilot sites.

Table 8: Concerns related to tested service: share of participants being Extremely concerned (Vigo) and Very concerned (Versailles and Tampere).

	Vigo UD	Vigo AVP	Versailles UD	Tampere UD
Safety of driver and passengers inside the vehicle	10% (n=48)	11% (n=37)	47% (n=19)	26% (n=27)
Safety of pedestrians and/or cyclists/VRUs	21% (n=43)	21% (n=33)	68% (n=19)	15% (n=27)
Safety of passengers in other vehicles	11% (n=44)	15% (n=34)	58% (n=19)	19% (n=26)
Security of payment	38% (n=48)	15% (n=39)		
GPS tracking		25% (n=37		

To summarise the concerns related to the tested services. Since a different scale was used among pilot sites, the answers were compared based on the share of maximum concern on the respective scales. All in all, it seems that the share of maximum concern depends more on the pilot site than the use case. The highest share of maximum concern was for the aspect Security of the self-driving vehicle in Vigo, the safety of driver and passengers inside the vehicle in Tampere, Safety of pedestrians and cyclists in Versailles and Security of my data in Brainport. Comparing pilot sites among each other, the highest share of maximum concern, in general, was in Versailles whereas the lowest share, in general, was in Brainport.

Related to comfort, participants were also asked to comment on their perceived comfort of various aspects of the service. The same question was asked at all test sites and use cases (except AVP in Tampere) but it included different aspects. The aspects were ranked on a five-point scale from Very comfortable to Very uncomfortable, with Neutral as a central choice. Common for pilot sites and use cases were the following aspects: smoothness of the ride, acceleration behaviour and braking behaviour.

The distribution of responses for the comfort of the smoothness of the ride is presented per pilot site and use case in Figure 14. In general, a majority of participants found the smoothness of ride as comfortable except for or the urban driving in Vigo and Tampere, where 74–82% of participants said they felt uncomfortable. For urban driving in Versailles, no participant indicated feeling uncomfortable.

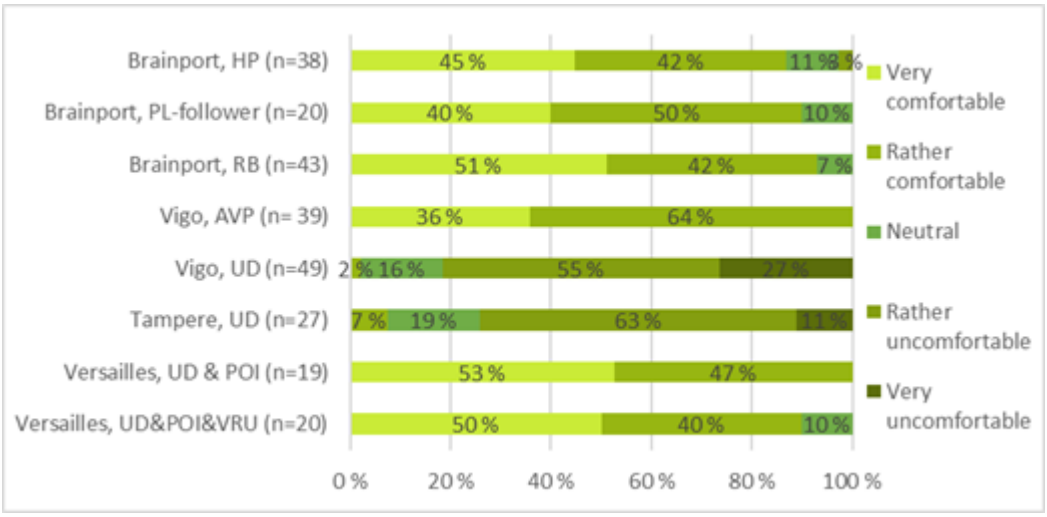

Figure 14: Comfort related to the vehicle behaviour: Smoothness of ride.

The distribution of responses for the comfort of Acceleration behaviour is presented per pilot site

and use case in Figure 15. For the urban driving, the share of participants feeling uncomfortable was 74% in Vigo and 23% in Tampere. For urban driving in Versailles and AVP in Vigo, no participant indicated feeling uncomfortable. In Brainport, 7–15% of participants found the acceleration behaviour "uncomfortable".

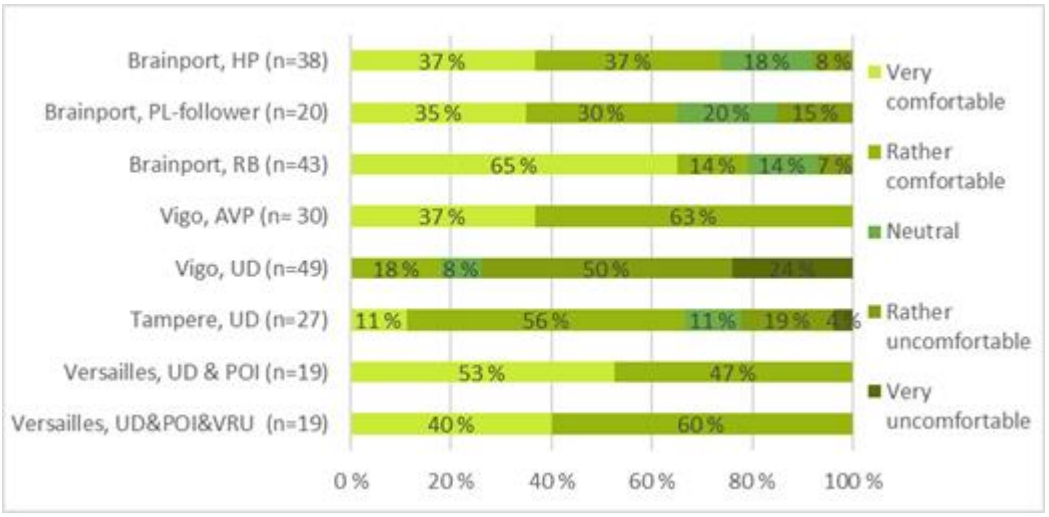

Figure 15: Comfort related to the vehicle behaviour: Acceleration behaviour.

The distribution of responses for the comfort of Braking behaviour are presented per pilot site and use case in Figure 16. For the urban driving, the share of participants feeling uncomfortable was 76% in Vigo, 66% in Tampere and 16–26% in Versailles. In Brainport, 6–13% of participants found the braking behaviour uncomfortable. For AVP in Vigo, no participant indicated feeling uncomfortable

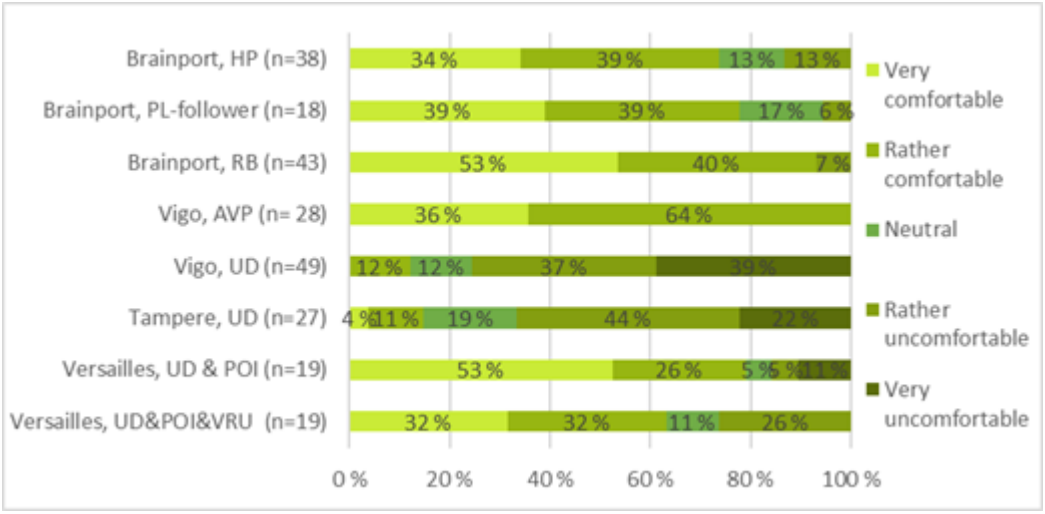

Figure 16: Comfort related to the vehicle behaviour: Braking behaviour.

The participants were asked about their comfort regarding seven additional aspects depending on the pilot site:

- turning behaviour of the vehicle
- distance kept to pedestrians / pedestrians and cyclists
- distance kept from road markings
- distance kept from obstacles
- distance kept from potholes
- distance of the following vehicle (PL leader) / vehicle in front / other vehicles
- behaviour when approaching pedestrians and cyclists at intersection/VRU approaching

behaviour

The share of respondents feeling uncomfortable (responses: rather and very uncomfortable) for the different aspects are presented per pilot site and use case in Table 9. For the turning behaviour, 48% of participants in UD-tests in Vigo felt uncomfortable. For distance kept to pedestrians 71% of participants felt uncomfortable in UD in Tampere. For distance kept to road markings 43–62% of participants felt uncomfortable for UD in Vigo and Tampere. For distance kept from obstacles, 71% of participants for UD in Vigo felt uncomfortable. The share of participants feeling the behaviour when approaching as uncomfortable for urban driving was 72% in Vigo, 42% in Tampere and 11–26% in Versailles.

Table 9: Feeling of uncomfort related to tested service: share of participants feeling rather uncomfortable and very uncomfortable

	Brainport HP	Brainport PL-follow.	Brainport PL-lead.	Brainport RB	Vigo UD	Vigo AVP	Versailles UD +POI	Versailles UD+POI +VRU	Tampere UD
Turning behaviour of vehicle		0% (n=20)			48% (n=48)	0% (n=37)			
Distance kept to pedestrians / pedestrians and cyclists				2% (n=43)		0% (n=15)			71% (n=24)
Distance kept from road markings	8% (n=38)	0% (n=20)			43% (n=49)				62% (n=26)
Distance kept from obstacles	11% (n=38)				71% (n=31)	0% (n=26)			
Distance kept from potholes	26% (n=38)								
Distance of following vehicle (PL leader) / vehicle in front / other vehicles			0% (n=20)	10% (n=20)	43% (n=7)	0% (n=18)			
Behaviour when approaching pedestrians and cyclists at intersection/VRU approaching behaviour					72% (n=18)		11% (n=18)	26% (n=19)	42% (n=26)

To summarise, the comfort related to the tested services, the answers were compared based on the share of participants feeling uncomfortable. It seemed that the use case urban driving, in general, had higher shares of participants feeling uncomfortable but the pilot sites and use cases differed too much to make any use case-specific conclusions. The highest share of participants feeling uncomfortable was for the aspect distance kept from potholes and acceleration behaviour for Brainport; smoothness of ride, acceleration behaviour, braking behaviour and distance kept from obstacles and behaviour when approaching VRU in Vigo; smoothness of ride, braking behaviour and distance kept to pedestrians in Tampere and for braking behaviour and behaviour when approaching

VRU in Versailles.

Participants were also asked if any other behaviour made them feel uncomfortable. This was done for platooning in Brainport, where in total 7/20 participants indicated some behaviour made them uncomfortable, and urban driving in Tampere where in total 12/27 participants responded. The answers were grouped to identify common themes and in total 15 out of 19 responses were related to the driving style of the vehicle e.g. jerks, swaying, unstable, sudden braking and steering, short stopping distance to pedestrian and lack of human touch. In Brainport, one participant mentioned that they felt uncomfortable due to not realizing when they were platooning or not, and another participant due to repetitively joining and leaving the platoon. In Tampere, one participant felt uncomfortable since it seemed that the vehicle would not stop once approaching the pedestrian.

Specific Use Case Observations

The ride balancing function test in Brainport included questions regarding smartphone use whilst using the service. A majority (67%) of respondents indicated that they used the smartphone application whilst using the service. Over half of participants that used the application thought that they would feel slightly or very trustful/ confident. Participants were most confident about the car safety features and the least trustful on phone GPS accuracy.

Role of individual characteristics

Because of the small sample size, no general conclusions regarding individual characteristics can be derived from the pilot tests. However, there were several individual characteristics, which affected the evaluation of the use cases/ services during the tests. Thus, we have presented in the following some of these.

Motion sickness

Participants were asked whether they experienced motion sickness in the urban driving test in Tampere and platooning test in Brainport. Two participants indicated that they experienced motion sickness in Brainport and one in Tampere. They provided the following descriptions of the situation:

- *"Yet I can imagine that this could happen on longer distances, especially in a following car."*
- *"This is mainly caused by sitting in the back."*
- *"I am very sensitive to motion sickness as a passenger, so no wonder if some of such feelings occur in such a situation."*

Considering motion sickness when driving autonomously might be important, especially when evaluating potential time use in the vehicle and potential in-vehicle services. However, we do not have sufficient information on the effect from the pilot site tests, so that potential implications have to be considered in further development phases.

7 Discussion

Results and study set-up discussion

Determining user acceptance of automated and connected vehicles (CAVs) is a complex process. CAVs are far more complex than most systems that have been subject to traditional user acceptance tests. Vehicles do not have simple functions but show a wide variety of behaviours in constant interaction with the environment and other traffic. Moreover, there are hardly any fully automated vehicles that can be tested in real traffic on European roads. In the case of AUTOPILOT, the focus of the evaluation was on IoT, whose functions cannot be easily distinguished from vehicle behaviour by a naive user.

Given the challenges, in AUTOPILOT we have created a rather unique opportunity for interested people from the general public to try out a variety of services enabled by CAVs and IoT. Although many studies have done surveys with large numbers of people, including our own online survey, not many tests have yet been performed where people can really experience driving in such a vehicle. That it is not a simple study was demonstrated by the many difficulties we encountered in obtaining permission to have people inside a CAV from the road authorities, companies providing vehicles and ethical commissions of research partners. This is the reason that most tests were either conducted with participants sitting in the back seat, while the vehicle was being driven by a professional safety driver, or participants were only allowed to observe the vehicle from the outside, except in Versailles where the participants were driving and the professional safety driver was sitting behind and had the possibility to stop the vehicle by pressing a button. Most tests were also not on public roads but were performed on dedicated areas without other traffic (although some driving was done in mixed traffic, such as in the platooning use case in Brainport). In the case of the pilot tests in Livorno, we didn´t get permission from the car provider to give test users the opportunity to sit in the automated vehicle. As a result, the user evaluation was based on an observation of a demonstration of the use case by the potential users which provide a limited real-life experience with the technology.

These set-ups required rather a lot of imagination from the participants on how the services tested could operate in the future in real situations. This was one of the reasons why participants were briefed by using storyboards, presenting a story and pictures on how the service was envisaged. Although this made the user tests quite limited and unrealistic, the AUTOPILOT project still managed to perform a good and unique set of user tests, investigating user acceptance based on experience instead of only descriptions.

Originally, it had been envisaged to use a solid methodology for organising user testing, based on the FESTA methodology for Field Operational Tests (FOT), and using technology acceptance models to formulate questions. During the project, it emerged that the tests could not be performed as FOTs, but more as demonstrations. Participants were briefed that they would experience technology that was not faultless and that their role was to provide feedback, concerns and ideas for improvement, rather than making a final judgement on the service, which is in line with the idea that users are seen as “co-designers” rather than judges in the AUTOPILOT evaluation.

In general, participants were happy to play this role and made many valuable remarks. For most of them, it was a good experience and they were positive about their participation. The positive overall evaluation is also related to the technology being exciting and novel. Most participants were interested in technology and new innovations (and for such reasons showed interest in participating). Although recruitment was different in the different pilot sites, a large proportion of

the participants were not familiar with CAD or IoT, although of course, most had an interest in new developments.

User testing was carried out mostly in the spring of 2019, i.e. later in the project. Proper piloting of user tests was not always possible and not all test sessions went according to plan.

There were several reasons why user evaluation encountered severe limitations and delays:

- The technology used in the use cases was often not ready (or only until very late in the project) to be tested by users. Testing acceptance can only be done if the system is functioning properly, with only minor errors. During the tests technical problems were still encountered, which sometimes led to the participant having to be told how the vehicle should have behaved instead of experiencing it for themselves.
- Interfaces were not always very user-friendly, as the technology development did not focus on this, but for user testing, this is not ideal.
- Getting permission to test was sometimes a long process.
- The CAVs were often only available for a very limited time, as well as technical partners and test areas, so participants could only drive for a short amount of time in the vehicles.
- The environment was often quite artificial, for example driving in areas without traffic.
- Driving was usually very slow, for safety reasons, making it not very realistic.
- Although we had initially developed a long questionnaire with lots of relevant questions, piloting showed that it was not possible to ask all questions, so test-sites had to limit the questionnaire, using only questions that were directly relevant for the particular use case in order to avoid participants becoming fatigued, bored, or demotivated, also in proportion with the time they were in the vehicle or observing the service.

Despite all the problems, we still have a very valuable data set. Hopefully, further CAD and IoT projects will be able to build on our experiences and contribute to a growing knowledge base on how users perceive these new technologies and services.

Expectations were in the majority positive, but it is important to keep in mind that people usually are not very consistent about their expectations and even more so about their predictions of what they are planning to do with these services. This notion is emphasized even more by the fact that these technologies and the AVs will not be available in the near future and they are aware of it. Considering transport issues and urban planning, the provision for IoT services in AVs should not increase or create traffic but improve wellbeing.

The results of the pilot tests show that sometimes test users felt uncomfortable due to the driving style of the vehicle, about technical aspects or worry about system failure. This indicates that the technology of automated vehicles still needs development especially regarding braking and steering behaviour.

Furthermore, no use case-specific similarities were found for the results, but instead, the share of maximum concern seems to depend more on the pilot site. This can relate to many things – one might be the type of users.

Regarding the aspect “comfort”, there was a higher share for the use case urban driving. Underlying reasons might be, again, a different type of users or the fact that the user tests were more large scale for urban driving, had a longer route and a more complex environment.

The overall positive evaluation can be also related to the technology being exciting and novel. Most participants were interested in technology and innovations (and therefore showed interest in participating). The channels used for recruitment attract technology-friendly users, but this limitation was accepted as the services were not ready for real-life pilots and also, it can be expected that technology aware users might be among the first user group of the technology, i.e. the early adopters of the technology.

Recommendations for future projects testing automated and connected driving

As discussed above, analysing user acceptance of automated and connected vehicles as a part of field test projects is a challengeable task. On the one hand due to the maturity of the technology developed and tested within research and development projects and on the other due to the challengeable task of presenting the technology to a naïve user and setting a common ground of discussion on requirements and concerns about it.

The following recommendations for future projects can be derived from the experiences and lessons learned with/ from the user evaluation made in the AUTOPILOT project:

Planning the tests:

- ***Challenges:***
    - (regular) exchange with and support from the pilot site team (esp. development team)
    - creating a feasible test protocol
    - developing measurement instruments which allow a comparison between different pilot sites and/ or use cases
    - set up a documentation format
    - gaining test permissions
- ***Recommendations:***
    - when planning pilot tests with potential users from the general public, a close exchange with the pilot site team and the technical validation team is needed in order to ensure (among others) a realistic timeline for the user tests, support for recruiting the users, planning feasible tests, etc. Besides the regular exchange, a clear division of the roles and the tasks between the pilot tests team and the evaluation team is needed, but also a mutual understanding of the needs of each task. Main points to consider include: define the need for exchange, organize regular exchanges, and divide responsibilities; also, a lesson learned from the project is that vehicles, technology and technical teams are often available for a limited time so a time alignment between the test team and the evaluation team is essential
    - when creating a test protocol, the evaluation task has to consider the feasibility of the planned activities – main points to consider are: duration of the full test experience from user perspective (including filling out the questionnaires, interviews, introduction, tests), division of the responsibilities, alignment with the technology progress of the use case – what can be really demonstrated during the pilot tests and what does the user experience during the test
    - in research project such as the AUTOPILOT project, where different pilot sites and additionally different use cases are considered, creating evaluation instruments which allow for comparable results is a challengeable task to do; we still recommend aiming for a common research focus, but allowing for a flexible structure of the instruments which enable considering pilot site or use case-specific issues (for instance, we focus on overarching research questions on how might IoT enhance, enable and/ or improve user experience and acceptance of the technology and

looked at requirements, concerns, and expectations from user perspective, however, we tailored some of the question categories according to the use case or planned tests(demonstrations)
    - prior to the tests, a common documentation format has to be defined by the evaluators in order to ensure that all relevant information is captured during the tests (e.g. ensuring a link between pre and post questionnaires from the same test person, documentation of interview responses, documentation of technical performance); this is especially important when the evaluation activities on a pilot site are considered by pilot site teams not directly involved in the evaluation task
    - Ensure users adequately familiarise with the technologies
    - plan time and resources for gaining test permissions, collect information of relevant requirements in the early planning stage; at EU level: it is important to forward the standardization of the processes for test permissions in order to accelerate the process

Involving the general public in the development process and managing expectations:

- ***Challenges:***
    - managing the expectations regarding the state of development of the technology (e.g. lowering expectations of enthusiasts)
    - motivating people to give constructive improvements suggestions rather than a pure evaluation of the tested use case
- ***Recommendations:***
    - to manage expectations of the users, the goal of the tests, a standard introduction of the use case and a realistic description of what the user can expect to happen during the test is needed; here one should ensure not setting up too high expectations (e.g. by inviting people to experience “real-life” automated driving) or promoting a technology which is in an early development stage; too much information, on the other hand, or too detailed description of what the technology *still cannot do* should also be avoided; focus better on the goal of the tests (testing use cases of the technology), the role of the test users (e.g. as a “co-designer”), and what the test will look like (e.g. a demonstration vs. sitting at the back seat of an automated vehicle)
    - Re-visit acceptance within automation, as the role of the user becomes passive and vague, control and trust might be important parameters to investigate further.

Introduction of the technology to test users:

- ***Challenges:***
    - introducing the use case in a short and understandable way
    - not affecting the evaluation of the participants too much by using evaluative descriptions (such as how “efficient”, “useful”, or “complex” the use case/ service is)
- ***Recommendations:***
    - use an understandable and simple storyboard which represent the potential real-life use of the technology, avoid very hypothetical and/ or theoretical description
    - when not possible to demonstrate/ experience the full use case, create storyboards with pictures (rather simple text) in order to provide the full story for the valuation to the user
    - provide a standardized description to the test participants in order to compared results from the tests, control (when possible) the information they receive (e.g. in some tests engineers or developers of the technology are available to answer questions of the test users, however, there is a risk to go too much into details about technical details which can distract the users from understanding the use case),

avoid evaluative descriptions; this should be an important part of the test protocol
    - align with the previous point – managing expectations – in order to avoid setting up too high (or too low) expectations on the use case which potentially affect the evaluation of the use case stronger than the experience itself, aim for an objective and simple description
    - adapting communication skills to the technology literacy of the user to ease the understanding and familiarisation process.

Assessing user evaluation of the use case:

- ***Challenges:***
    - a clear definition to the participants of what is evaluated,
    - setting up a baseline,
    - making the current state of the development transparent and understandable (e.g. lack of user-friendly or high-end human-machine-interaction- interfaces because of focus on the technology in the development process)
- ***Recommendations:***
    - make clear what is the object of the assessment by defining the implications for the users (e.g., in the case of AUTOPILOT we had to focus on the benefits of IoT for autonomous driving rather than on the evaluation of the autonomous driving as a use case itself; hence, we build up the questions on the requirements and concerns of the users around the data and information provided as well as on the features enabled due to IoT. In other words, we considered the consequences of the IoT for the users, i.e. what he/ she can observe or receive as a service from the IoT connectivity rather than explaining what IoT is and asking about potential requirements on this connectivity.)
    - make the baseline (if any) clear to the participant – do they have to compare using, for instance, a highway pilot with driving manually on the highway or with riding autonomously without connectivity on the highway? Setting up a baseline is not an easy task and it is sometimes not required, so it is essential to discuss this aspect when developing the concept for the study
    - many participants gave statements that are not directly related to the use case and the focus of the study but rather to the set-up, the vehicle, or usability characteristics of the displays or other human-machine-interaction interfaces. This clearly shows a need to consider these effects in the evaluation and the need to control for such effects. One possible solution is to stress these points explicitly in the introduction as well as in the survey (e.g. stress in the introduction that the focus of the development lied on the technology and not at the HMI parts, ask in the survey different questions on evaluation of the potential experience envisioning the service is available vs. experience of the test itself or separated questions on the evaluation of the service, the test set-up, the vehicle, the HMI). Another recommendation (applied also in our tests) is to accompany the tests very closely and to use more explorative approaches, such as thinking aloud techniques or qualitative interviews besides the questionnaire (e.g. asking not only in an open question the reasons behind the evaluation of the use case, but interviewing the test users about their experience and making a short protocol).
    - test the test user experience first, make sure that you experience the test not only as a researcher but first by putting yourself in the role of potential test user

Potential role of test fields as demonstrator and dialog platform with the society:

- ***Challenges:*** using the tests and demonstrations not only as a research tool but also as a dissemination tool for starting a dialogue with the general public on automated and

connected driving

- ***Recommendations:*** test fields of automated and connected driving can be used as a platform for communication with the general public by providing information about the technology and organizing demonstrations for the general public as well as for stakeholders; in order to use the potential of test fields or demonstration as a dialogue platform it is important first to coordinate dissemination activities and second to provide opportunities to involve the general public or experts as "co-designers"; the benefits of such activities are increasing awareness about the technology and the research projects in this field and to collect requirements on the technology from relevant stakeholder groups; examples of such dissemination and demonstration activities within the AUTOPILOT project are demonstration in the framework of the ITS Europe Congress as well as test and organisation of so-called test fests

8 Conclusion

Although there are a lot of differences between the services tested and the way in which they were tested, the outcomes are rather positive and, in many cases, similar. Levels of acceptance vary, but there was no real rejection of the services.

If we look at all the tests and services, some interesting trends emerge:

- **Control:** for many participants, the issue of control was very important. Participants wanted to be able to stop the automated driving and take over control of the vehicle. Also in the information needs, we see that there is a large need for information on what the vehicle is doing (and why), what can be expected, where the vehicle is going, what and how information about other road users is detected, what is being done with their data etc.

  The question here is whether this is because it is all new and people do not fully trust the technology or whether these needs will continue to exist even when automation becomes more commonplace, and people get more experience in using these vehicles. What is important for AUTOPILOT is that IoT enables the fulfillment of these information needs, so that in future services it may be possible to customise the information provided according to the user needs and preferences.

- **Safety and security:** Safety and security were seen as important, in discussions, in focus groups and in the user questionnaires these were seen as important and concerns were raised. Participants were concerned about safety aspects, both for the safety of the automated vehicle and for other road users, specifically pedestrians. These concerns do not always seem related particularly to the specific services but more to the capabilities of automated vehicles. There were also serious concerns about the security of data and liability. These concerns were echoed in the questionnaires from ITS European congress visitors were very serious concerns about safety were found.

- **The role of IoT**: In most user tests the role of IoT was opaque; participants were usually not elaborately briefed on where information was coming from and how the architecture was arranged. Users were also not explicitly asked about the role of IoT. However, in discussions with participants, the idea of CAV vehicles becoming a “thing” in IoT was received well and was seen as a logical step in future developments. ITS congress visitors were asked explicitly about this. As they are mostly people who are experts in the intelligent transport field, they had a better understanding of the possible role of IoT. A large majority agreed that the role was (very) important, especially for the enhancement of automated driving.

- **The usefulness of services:** In the user tests only a limited version of the envisaged services was experienced or observed. However, these services should be seen as part of a wider development, either in terms of wide-spread availability of CAV or of services in which the encountered use case was only a small part. Specifically, car sharing can be seen as a service that contains many of the use cases. In addition, the tested services are part of a wider traffic system, in which the infrastructure and other road users will play their role. Participants seemed quite willing to engage in looking at the bigger picture, and answers about future use were in general positive. Also, in focus groups, people felt comfortable to discuss a world in which such services would be widely available.

- **Public awareness:** many participants mentioned the need for awareness-raising amongst the general public about all these new developments. The participants were usually people already interested, but many of them learned new things and were of the opinion that information and debated would be both interesting but also very necessary. Demonstrations and providing opportunities for people to engage with CAD should be an important step in future development. Our user tests provided valuable experience for evaluators and pilot sites on how to organise this.

Further developments of the technology and new user tests are possible and necessary once system functionalities are fully functioning. These tests can then provide a better understanding of the user requirements, concerns and expectations related to automated driving progressed by IoT. Despite the fact that the results could not directly be used to quantify user acceptance of the use cases (due to limited testing and user types), they are very useful for further development of automated driving and IoT. The distance between the technologies existing today (e.g. ADAS) and what automation will bring in the next decades is worth exploring to further understand the usefulness, penetration trends and acceptance.

Overall, the results indicate important aspects that should be taken into account when designing different automated driving use cases and IoT services. Besides the results of the user evaluation, the measurement instruments, as well as the developed and applied methodology in AUTOPILOT, are an important basis/ tools for further evaluation tasks on CAVs. Therefore, this deliverable with the provided scales, protocols, questions etc. can be used in future research and innovation projects on a national or European level.

9 Literature

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AUTOPILOT

Appendix 1: Example questionnaire

Livorno – HP (English translation)

Part 1: Evaluation of the system

1) **V1 -**Please state briefly what your motivation for taking part in this demonstration is:

_____

2) **V2 -** What is your first impression of the service after the demonstration?
(Free association)

_____

3) **V46-V58 -** I think that the system is …

			Neutral				don't know
Useful	[ ]	[ ]	[ ]	[ ]	[ ]	Useless	[ ]
A positive experience	[ ]	[ ]	[ ]	[ ]	[ ]	A negative experience	[ ]
Exciting	[ ]	[ ]	[ ]	[ ]	[ ]	Boring	[ ]
Undesirable	[ ]	[ ]	[ ]	[ ]	[ ]	Desirable	[ ]

Part 2: Future use

In the following part, please imagine the system is already on the market and works reliably.

4) **V18 -** Would you be interested in using the system regularly if it were available to you (in full operation, as this was a limited trial)?
   - Yes/No/Don't know
     - **V19.1 -** If Yes – why yes?

       _____
     - **V20.2 -** If No –why no?

       _____

5) **V21-V40 -** Compared with my usual travels, I believe that using the system regularly would …

			don't know
increase the number of trips I make	|__|__|__|__|__|__|__|__|__|	decrease the number of trips I make	[ ]
increase my car use	|__|__|__|__|__|__|__|__|__|	decrease my car use	[ ]
increase my car use during peak hours	|__|__|__|__|__|__|__|__|__|	decrease my car use during peak hours	[ ]
increase my safety in traffic	|__|__|__|__|__|__|__|__|__|	decrease my safety in traffic	[ ]
increase the safety of pedestrians and bicyclists	|__|__|__|__|__|__|__|__|__|	decrease the safety of pedestrians and bicyclists	[ ]
increase my travel comfort	|__|__|__|__|__|__|__|__|__|	decrease my travel comfort	[ ]
increase my stress while driving	|__|__|__|__|__|__|__|__|__|	decrease my stress while driving	

6) **V85.C12 - V92.C12 -** If the service was available, how do you think it would affect your choice of travel mode?

	… less often	… as often as today	don't know
I would use public transport ….	[ ]	[ ]	[ ]
I would use a private conventional car ….	[ ]	[ ]	[ ]
I would walk or use a bicycle ….	[ ]	[ ]	[ ]
I would use a taxi service ….	[ ]	[ ]	[ ]

7) **V4 - V30 -** How important or unimportant is it for you to receive the following information from the service?

	1 Very important	2	3 Neutral	4	5 Very unimportant	Don't know
information on detected hazards	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
information on what the car will do about the hazards (change lane, slow down, stop, …)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Information on upcoming driving manoeuvres (turns etc)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Information on (personal) data needed for using the service	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Service fees	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
What assistance is available during service (eg in case of failure)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other information *(please specify)*: _____	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

8) **V60 – V63 -** How important is it for you to be able to:

	1 Very important	2	3 Neutral	4	5 Very unimportant	Don't know
drive the vehicle yourself whenever you want to	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
control speed of vehicle	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
control headway to car in front	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other information *(please specify)*: _____	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

9) **V88 – V95 -** On which type of your regular/daily trips do you think the service would benefit you?

	1 Very beneficial	2	3 Neutral	4	5 Not at all beneficial	Don't know
Commuting trips	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Business travel	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Errands (incl. school runs, grocery shopping)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Leisure, visits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

10) **V96 -** Would you be willing to pay extra for this system when buying a new car?
[ ] yes
[ ] no
[ ] don't know

11) **V97- V101 -** When thinking about the service you tested, how do you feel about the following topics?

	1 Not at all concerned	2	3 Neutral	4	5 Very concerned	Don't know
Privacy of my data (who is following where I drive and why, e.g. GPS tracking)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Security of the self-driving vehicle (e.g. against hacking)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Security of my data (how safe is my data e.g. from outside hackers)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Liability in case of accident or malfunction	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other, please specify: _____ __	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

12) **V102-** What would you tell the designers of the system to change to make the system more useful to you?

[ ] _____
_____

Background
At the end of the survey, we would like to ask you few general questions about yourself.

13) **V8-** Do you currently have a car available for your use?
[ ] yes, (nearly) always
[ ] yes, sometimes
[ ] no or hardly ever

14) **V13.C1 – V16.C1 -** Which mode of transport do you typically use for the following trip types?
Choose 1-3 often used modes. Exclude trips made by airplane.

	Passenger car	Public transport	Taxi	Motorbike or scooter	Bicycle or walking	I don´t make such trips
Commuting	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Business travel	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Leisure / hobbies / visits	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Errands (incl. grocery shopping)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

15) **V31.C2– V34.C2 -** Please state how often do you …

	(Almost) daily	Several times a week	Weekly	Monthly	Rarely or never
drive on a motorway or other 2-carriageway road	[ ]	[ ]	[ ]	[ ]	[ ]
drive on a rural 2-lane road road	[ ]	[ ]	[ ]	[ ]	[ ]
drive on urban street network	[ ]	[ ]	[ ]	[ ]	[ ]
need to find a parking space for your car at the end of the trip (no fixed spot available)	[ ]	[ ]	[ ]	[ ]	[ ]

16) **V17.C3 – V23.C3 -** Please state how often you use the following systems:

	(Almost) daily	Several times a week	Weekly	Monthly	Less often or never	I do not know this	I do not have this system
Adaptive Cruise Control (ACC)	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Navigation system or route planning	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
Other (please specify): _____	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

17) **V9-** How familiar are you with Internet of Things (IoT)?
[ ] I know a lot about it.
[ ] I have heard about it.
[ ] I work in the field
[ ] I have never heard about it.

18) **V11 -** How much do you drive annually on average? _____ km

- less than 5.000 km a year
- 5.000 up to 20.000 km
- more than 20.000 km
- don´t know
- no answer

19) **V12 -** What year were you born?

_____

20) **V24-** Please specify your gender

[ ] Male
[ ] Female
[ ] Other
[ ] Prefer not to say

21) **V25-** Where do you live? (city)

_____

Thank you for participating at the survey!

AUTOPILOT

Appendix 2: Reports on the user tests

AUTOPILOT

Brainport Highway Pilot (Hazard Detection)

1 Background

The Highway Pilot Public Testing took place the 12th – 14th March 2019 at the Automotive Campus, Helmond, NL. Thirty Eight (38) participants took part, recruited through online and social media advertisements[1]. These took place across eleven sessions over the three days in groups of between 2 and 5 participants.

2 Test Protocol

Introductory presentations were given in Dutch, as were most discussions. Description of the technology and test conditions were carried out in English (due to nationality of the engineers involved). A Dutch speaker was present at all stages to provide translation and facilitate discussions in Dutch. Questionnaires were in Dutch and carried out on an ipad by the participants, through the online survey tool, 'Limesurvey'. The questionnaire had been refined following the December pilot tests, in both content and userbility.

3 Technical problems

There were some minor issues with the technologies during the testing, and not all of the obstacles were detected on every run, as set out in the table below.

	Tour 1	**Tour 2**
Tuesday 12th March	No lane change pictogram. Just a warning sign	
Demo 1	First spb took too much time to deactivate. As a result, second spb was not active. I faked the second spb by controlling the acc speed manually.	Good. Speed reduction too late for the pothole
Demo 2	Had to restart the car	
Demo 3	Good	Had to restart the car
Wednesday 13th March	To be provided	
Thursday 14th March	To be provided	

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 5 point scale. This was rated 2 to -2 (eg Positive = 2, Negative = -2).

[1] Web: https://www.helmond.nl/1/nieuws/2019/Februari/Oproep-testers-voor-automatisch-rijden-gezocht
FB: https://www.facebook.com/123325024386589/posts/2320923817960021?sfns=mo

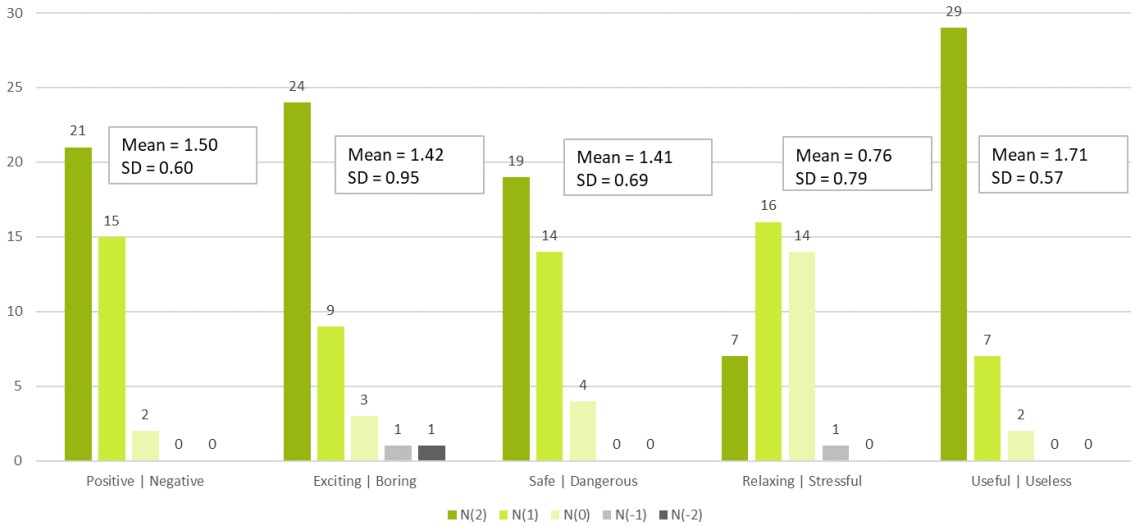


Figure 1: Participants expectations on the test and usefulness of the service

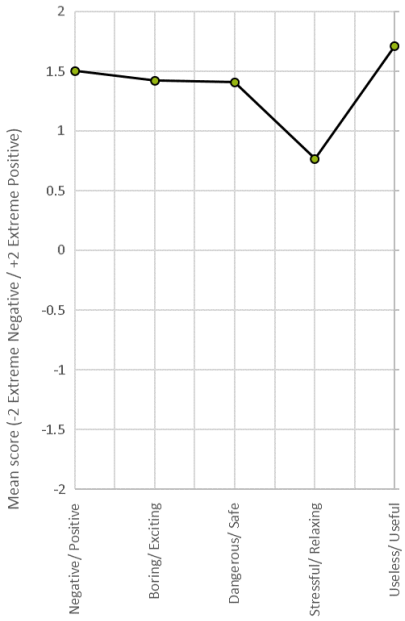


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service

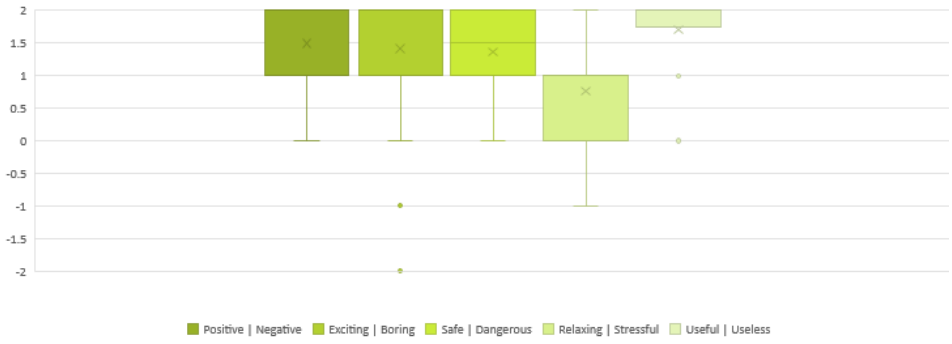


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Table 1: Standard Deviation between average score of test run groups

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless
0.33	0.58	0.43	0.35	0.31

- No participants thought that the experience would be negative, dangerous or useless
- Two participants thoughts that the experience would be boring
- One participant thought that the experience would be stressful
- Fourteen participants were neutral about how relaxing or stressful the experience would be
- The greatest variation, both across all participants and between test run groups, was about how exciting or boring the experience would be

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -2 to 2(eg Positive = 2, Negative = -2), in five areas. The same categories were used as in the Pre-Test.

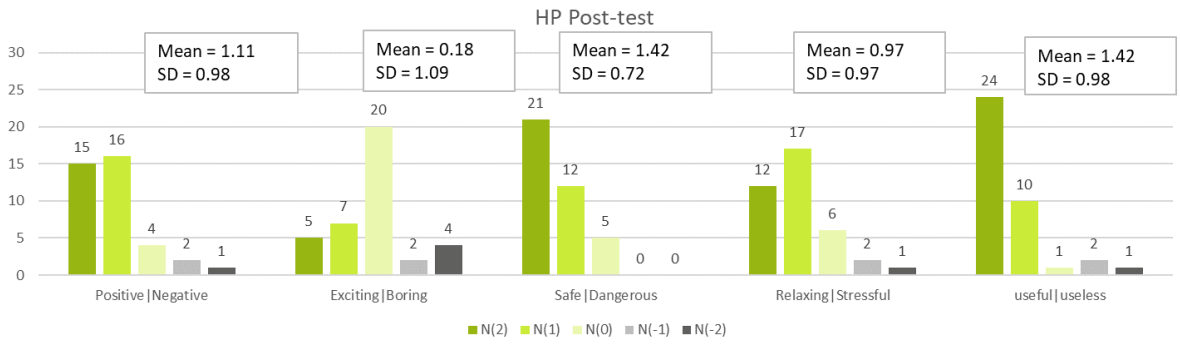


Figure 4: How participants felt about the test and usefulness of the service

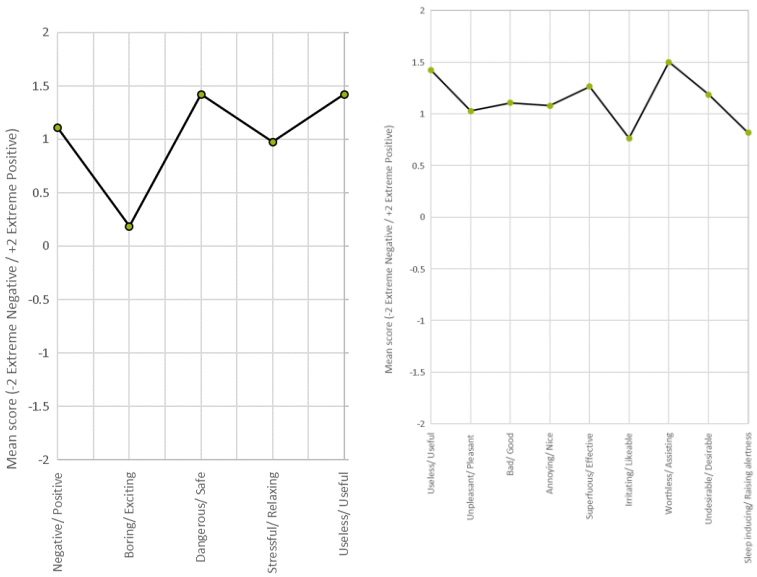


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

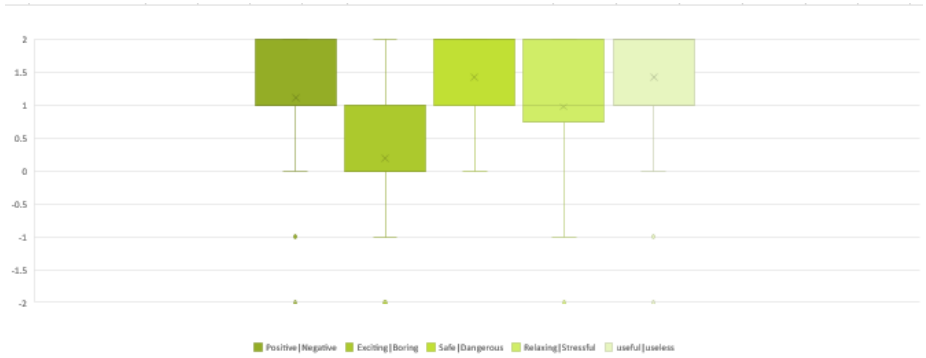


Table 2: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless
0.54	0.73	0.49	0.65	0.70

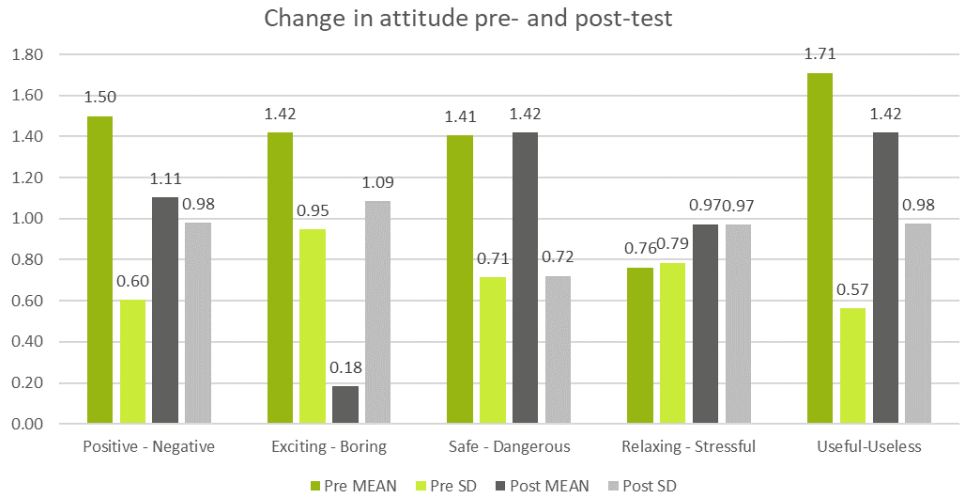
- No participants thought that the experience was dangerous
- Three participants thought found the experience to be negative, stressful or useless
- Six participants found the experience boring
- Twenty participants were neutral about how exciting or boring the experience was
- The greatest variation, both across all participants and between test run groups, was about how exciting or boring the experience was

Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[2] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more useful than satisfying

4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.

[2]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.



Positivity of Experience

- The pre-test expectations were more positive and with a smaller deviation than the post-test reactions

Excitement of Experience

- The pre-test expectation was that it would be much more exciting than the post-test reaction
- This was the biggest change from pre-test to post-test

Safety of Experience

- There was little change between the pre-test expectations and post-test reactions
- It was one of the most positive areas

Stress of Experience

- This area had the largest positive change from pre-test to post-test

Usefulness of Service

- The pre-test expectations were that the system would be more useful than it was found to be post-test.
- It was one of the most positive areas

Initial Post-Test Reactions[3]

Although the majority of the participants made a positive comment (marked green), six of the participants expressed some form of disappointment (marked red).

Technical expectations were higher.
The test went well.
Handy system
Disappointed
Clearly there is a difference, ride is more comfortable for passengers
Interesting
Nice to be with
That something like that can belong to the possibilities
What I have seen is that many of the functions are only human introduction, for example, flismister
Nice experience, too bad we were not allowed to sit behind the wheel

[3] Translated from Dutch

Special
Interesting, fun to be with. Still needs a lot of work.
Interesting
Nice development
Positive
Interesting
It is a very handy system, especially so that your car is less likely to wear
Enthusiastic
Good
The system works as explained
Comfortable
Was that all? Short ride?
Short and concise, clear explanation
Interesting, still a long way to go
I was a bit disappointed. My expectations were set too high. Very cool to see how that goes.
Useful because of preventive effect
Cool
Interesting and useful
Interesting
Nice system with many possibilities for the future
Positive, interesting, certainly useful.
They are well on the way to improving safety and damage through this technology
Useful and probably not very far in the future
Impressed and especially curious about the possibilities and future applications
Surprised about the status of implementation and the degree of user-friendliness
It is a pity that it did not work as it should, but the good explanation gave me a good idea of what is already possible
Good expansion of existing systems, Zola's adaptive cruise control
With the "self-driving" system I had imagined something else. It was more "providing information yourself"

5 participants reported feeling unsafe or uncomfortable during the test:

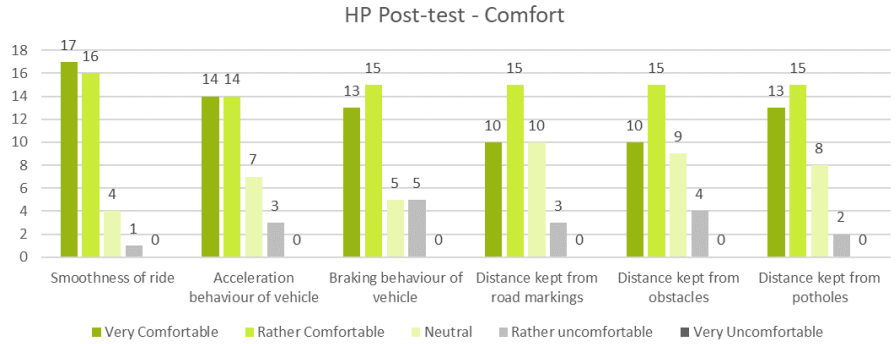
No reaction from an obstacle
Decreasing the speed of the car in automatic mode was considerable
Only in the beginning did I grab hold of the car, when the driver gave a big boost. It got used quickly.
I had to get used to the driving style of the driver in the first lap. When the car drove itself I felt safer
The system did not get going, not a problem in itself, but it does ask the question what if the PC makes it difficult or fails.

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 Comfort whilst experiencing service

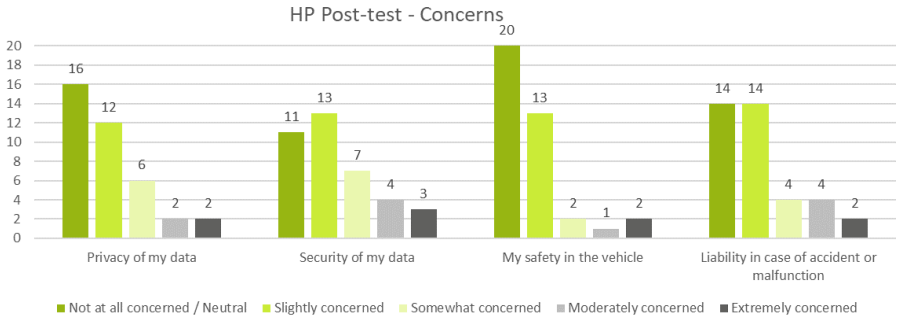
Participants were asked to comment on the perceived comfort of various aspects of the service. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice.



- All aspects has at least one participant report discomfort
- No participants found that any aspect was very uncomfortable
- The smoothness of ride had the most positive responses
- For each aspect, over two thirds of participants found it comfortable
- A quarter of participants were neutral about the distance from road markings
- The greatest number of participants who felt discomfort was regarding braking behaviour

4.4.2 Concerns whilst using service

Participants were asked to comment on their concerns regarding various aspects of the service. They were ranked from Not at all concerned / Neutral to Extremely concerned.



- There were concerns about all aspects of privacy, safety, security and liability by at least three quarters of participants
- For all aspects, over half of participants where either not concerned or only slightly concerned
- The aspect that had the greatest number of people without concerns was regarding the safety of the vehicle.
- The aspect that had the least number of people without concerns and the greatest number of participants with extreme concerns was data security.

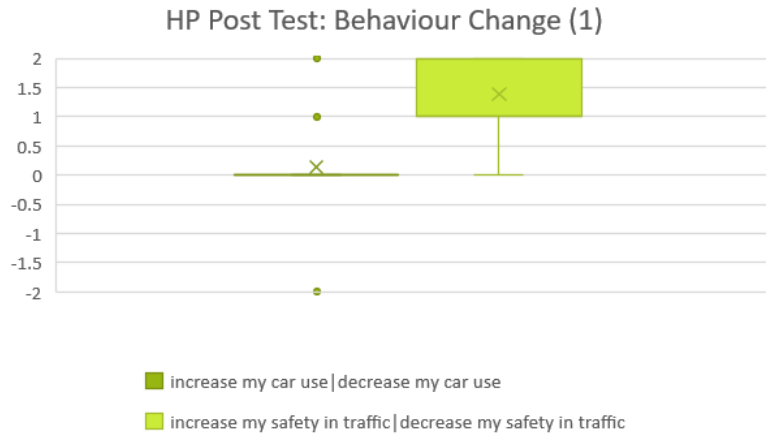
4.5 Post-Test Thoughs on Future Use

Participants were asked to comment on how they might use the service if it was available.

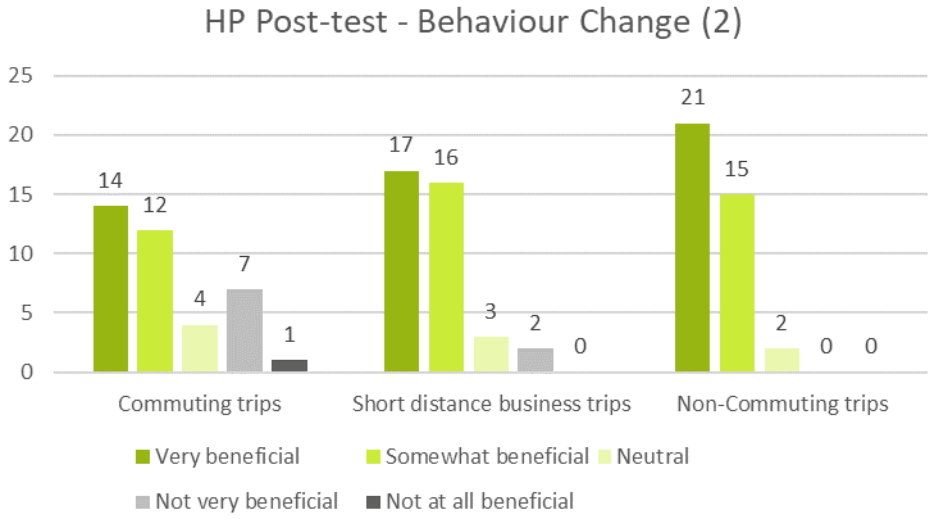
4.5.1 Behaviour Change

Participants were asked how the service might affect their usual travels. This included how car use

and traffic safety would change (ranked between -2 and 2) and how beneficial it may be to categorised trips. These were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



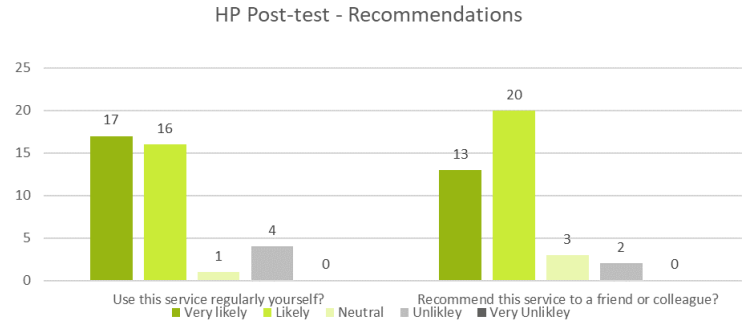
- All but 6 participants did not think the service would change their car use
- One participant thought that the service would decrease their car use
- Five participants thought that the service would increase their car use
- No participants thought that the service would decrease their safety in traffic
- All but 2 participants thought that the service would increase their safety in traffic



- The majority of participants felt that the system would be beneficial for all trip types
- Almost or over half of participants felt it would be very beneficial
- No participants felt the service would not be beneficial for either short-distance or non-commuting trips

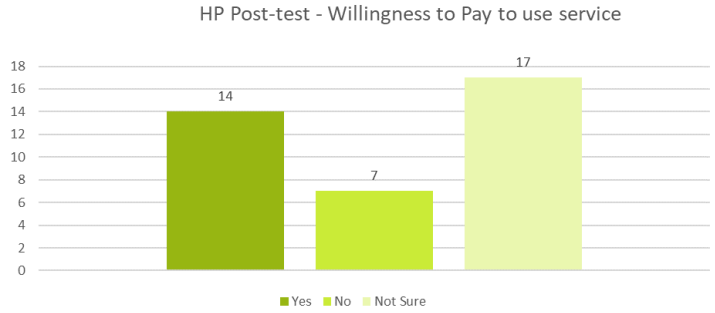
4.5.2 Interest in service

Participants were asked how likely they would use the service or recommend to a friend. This was ranked from Very likely to Very unlikely, with Neutral as a central choice.



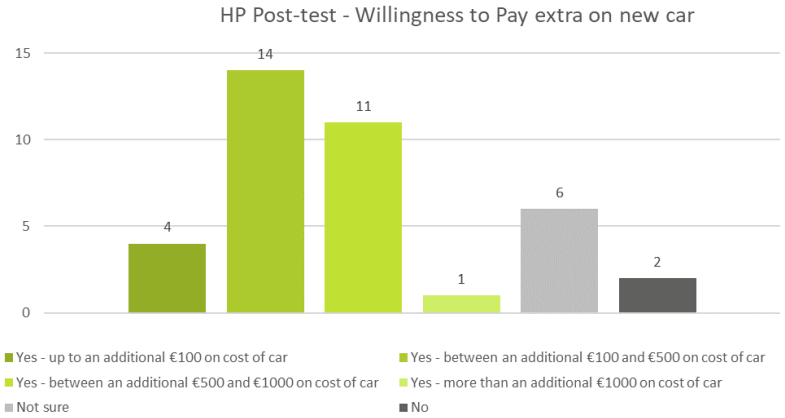
- The majority of participants would use the service regularly and recommend the service
- Over a third of participants were very likely to do so
- No participants were very unlikely to do so

The participants were asked if they would be willing to pay for the service.



- Over a third of participants would be willing to pay for this service
- Seven participants would not pay to use this service
- Over half of participants were not sure if they would pay for this service

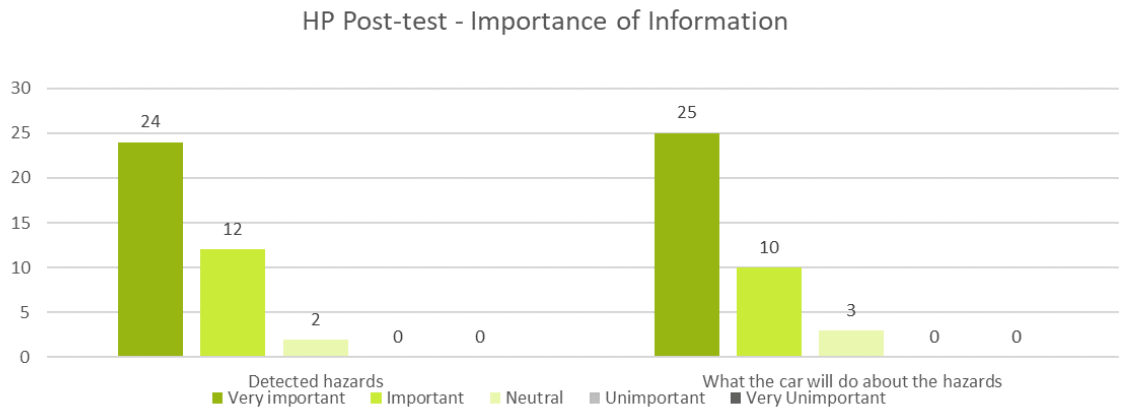
The participants were asked how much extra they would pay for the system in a new car.



- 8 participants were either unsure or would not pay extra for this on a new car
- The majority of participants would pay between €100 and €1000 on the cost of the car
- Only one participant would pay more than €1000 on the cost of a car

4.5.3 Importance of Information during Service

Participants were asked about theimportance of various aspects of information that could be provided through the service. These were ranked from Very Important to Very Unimportant, with Neutral as a central choice.



- No participants thought that either the information on detected hazards or what the car would do were unimportant
- 2 participants were neutral about the information on detected hazards
- 3 participants were neutral bout what the car would do
- Other information that participants would like to see are[4]:

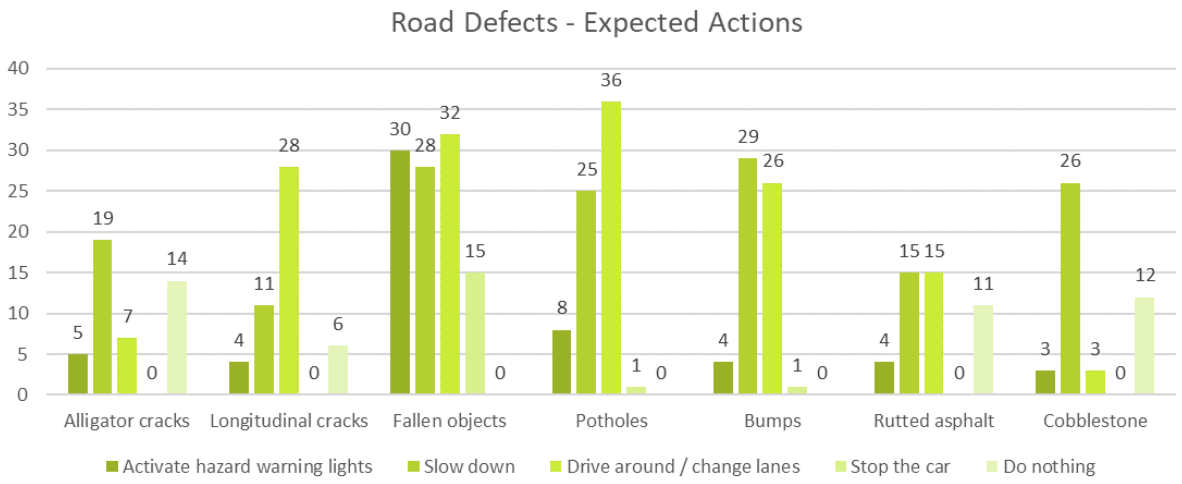
Acoustic signal
It may be a lot clearer visually (and perhaps also tactile) that there is a danger, and what the car does
Whether there are other alternatives
Traffic jams
Traffic jams, unexpected road lane changing users, etc.
Moving objects
Whether there would be a better route where you would have less impact from the risks
How long ago risks were detected
Police, fire brigade, ambulance approaching. Add gas to avoid risk.
Would not know at this time.
Ghost riders, slow riders, unreliable road users
The speed cameras, also the mobile ones
Large ponds that give high splash water, in particular to fellow road users such as cyclists and pedestrians
Continuous flow of information about what happens on your planned route
Traffic jams, work
The way the car warns
Like in combination with sound so that you do not get distracted.
Traffic jams, upcoming emergency services and unusual crowds on fixed routes
Operation of the traffic center
If detected risks are sent to the exchange

- From the above, participants would like to see a join between this service and existing traffic systems, and would like audio signals

4.5.4 Danger from road defects

Participants were asked how they thought the service should respond to various road defects. They could choose as many options as desired.

[4] Translated from dutch



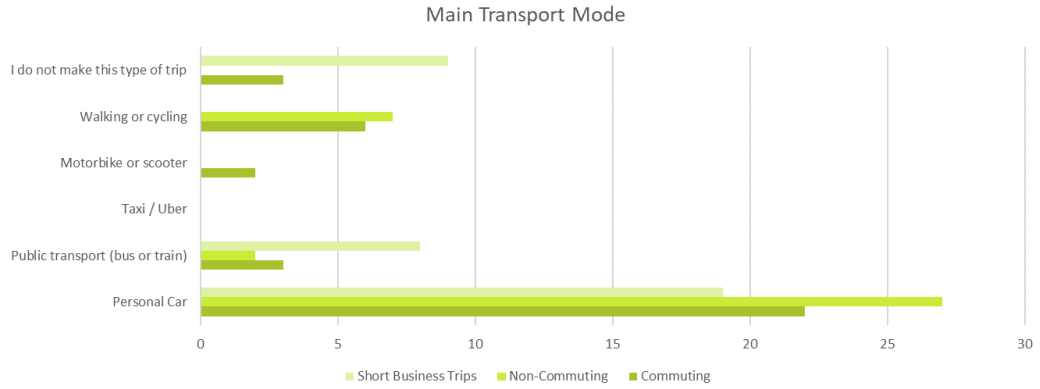
- Small numbers of participants suggested that the hazard warnings should activate for all defects, except fallen objects when the majority expected them.
- Around a third or more of participants expected the car to slow down for all obstacles, especially fallen objects, potholes, bumps and cobblestones.
- All participants expected the car to manoeuvre, with the majority expecting so for longitudinal cracks, fallen objects, potholes and bumps.
- Nearly half of participants expected the car to stop for fallen objects
- Only one participant expected the car to stop for either potholes or bumps
- No participants expected the car to stop for other defects
- All participants expected some action for fallen objects, potholes and bumps
- Around a third did not expect any action for alligator cracks, rutted asphalt or cobblestones.

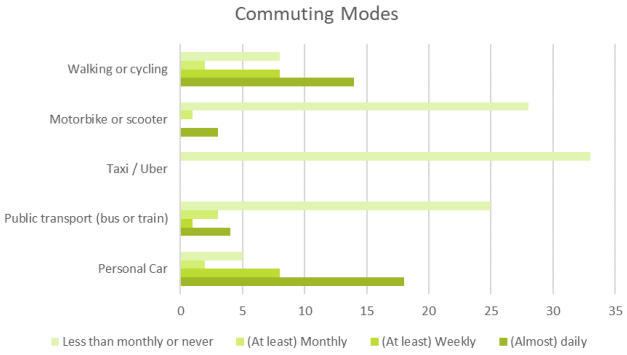
5 Background

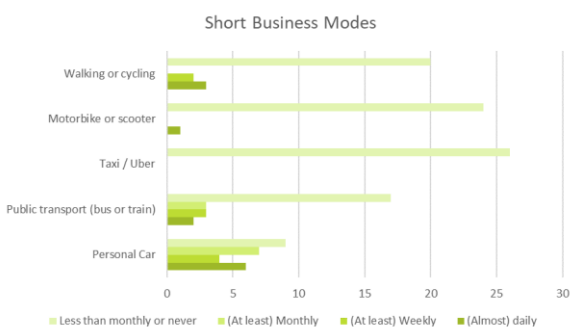
Participants were asked some background questions about their current travel habits and demographic details to set context for the findings. Due to a technical error, the background of two participants were not recorded.

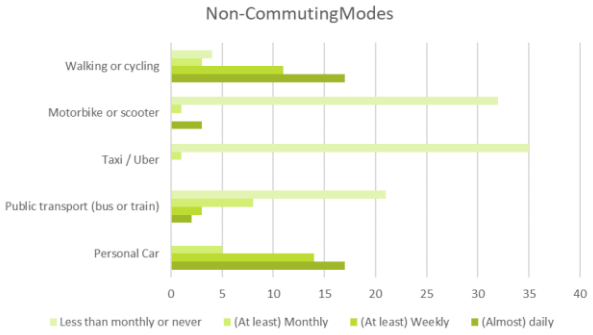
5.1 Travel Habits

Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.



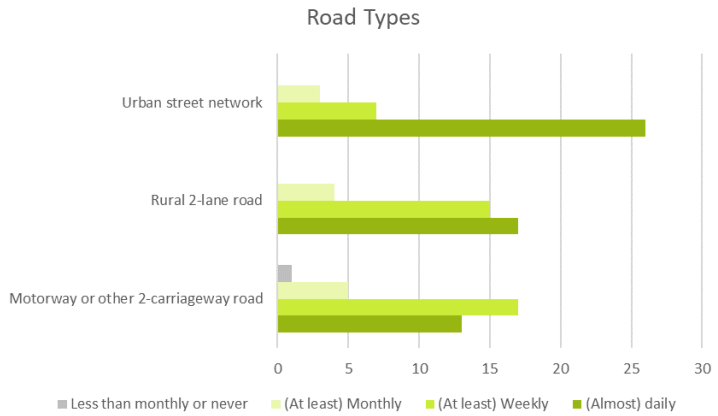






- A small number of participants do not make short business or commuting trips
- Between two-thirds and three-quarters of participants use personal car as their main transport mode for all trips types
- The majority of participants use personal car as their main mode for non-commuting trips
- No participants use taxi/uber as their main mode for any trip type.
- Small numbers of participants use public transport as their main mode, most commonly for short business trips
- Two participants use scooter/motorbike as their main mode for commuting
- Small numbers of participants use waking or cycling as their main mode, but not for short business trips

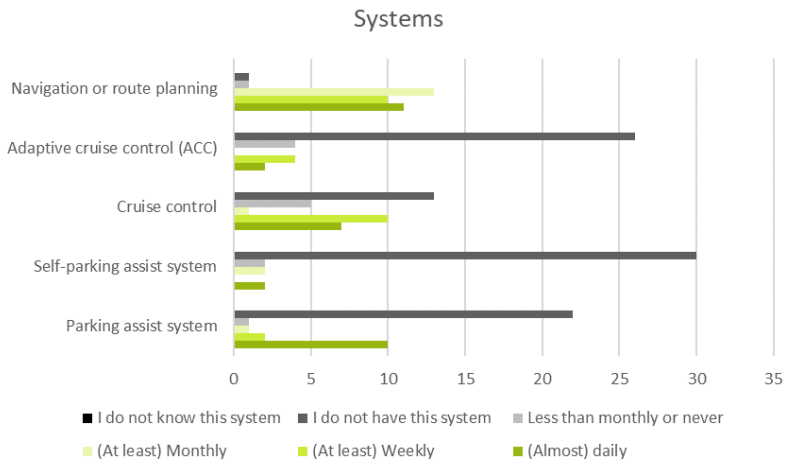
Participants were asked how often they drove on different road types.



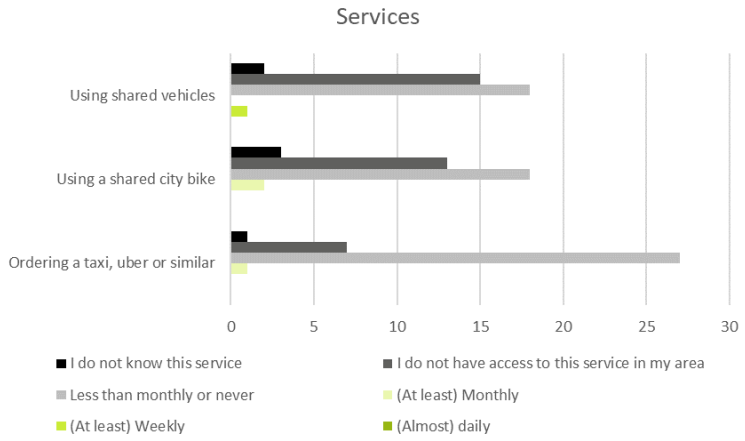
- Over half of participants drive on urban and rural networks almost daily
- Only a small number of participants drive on urban and rural networks less than weekly, but more than monthly
- The majority of participants drive on motorways at least weekly.
- Only 1 participant rarely drives on motorways

5.2 System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



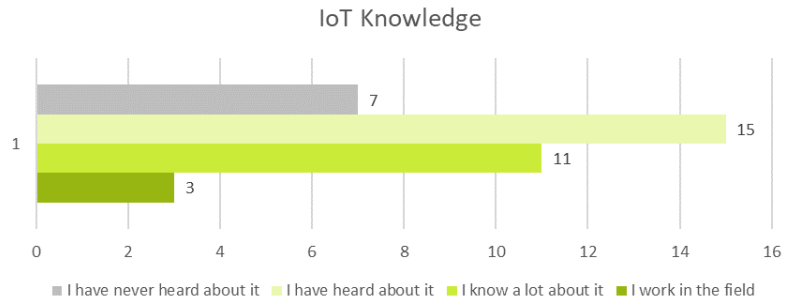
- All participants have heard of all system types
- Over two-thirds of participants do not have ACC, self-parking or parking assist systems
- Over half of participants have cruise control
- Only 1 participant does not have a navigation system
- The majority of participants with parking assist use it almost daily
- The majority of participants with cruise control use it at least weekly
- All participants with navigation system use it at least monthly



- Almost half of participants do not have access (or know of) shared bikes or cars
- The majority of those who do have access and knowledge of these services use them less than monthly or never.

5.3 IoT Knowledge

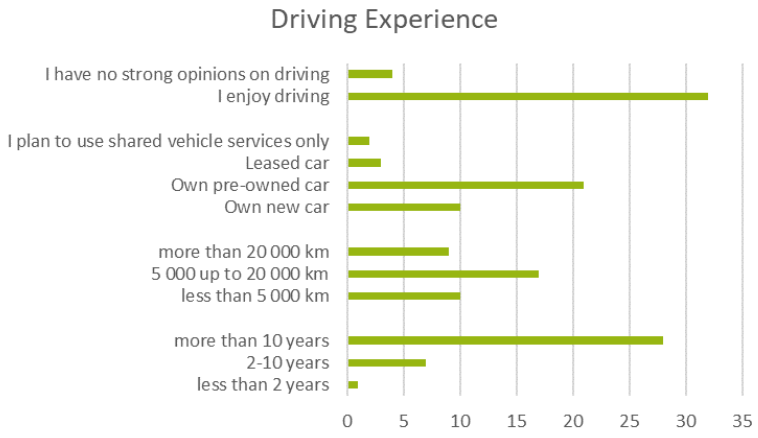
Participants were asked how aware they were of Internet of Things.



- Over half of participants have either not heard or know little about IoT

5.4 Driving Experience

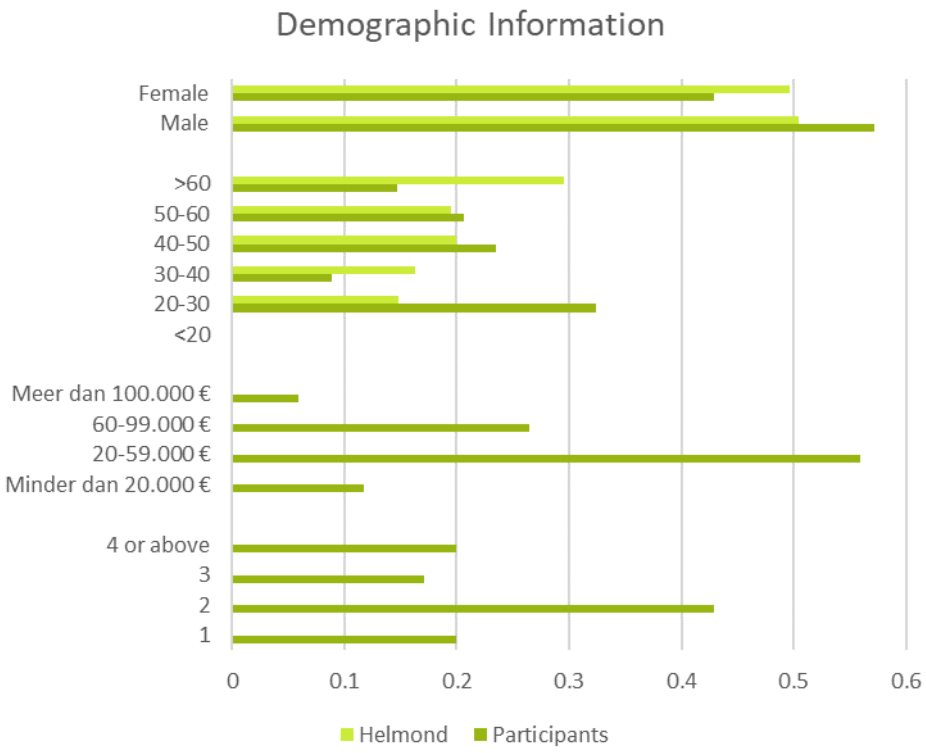
Participants were asked about their attitude and experience towards driving.



- The majority of participants enjoy driving, and no participants dislike driving
- Over half of participants plan to be a pre-owned car
- Nearly half of participants drive between 5 and 20 km a year
- Over three quarters of participants have been driving for more than 10 years

5.5 Demographic Information

Participants were asked about their background to establish representation of the test group.[5]



- The percentage of female participants was slightly lower than the Helmond region
- The 20-30 age group was over-represented
- The 30-40 and >60 age groups were under-represented

[5] https://www.citypopulation.de/php/netherlands-admin.php?adm2id=0772

Brainport Platooning

1 Background

The Brainport Platooning user testing took place the 11th- 12th June 2019 at the Automotive Campus in Helmond, NL. Twenty (20) participants took part, recruited through local paper, online and social media advertisements. These took place across five sessions over the two days in groups of 4 participants. A further eight (8) participants were recruited for 2 more test sessions but due to heavy rain leading to safety concerns, one was abandoned (session 2, day 2) and another was cancelled in advance (session3, day 2).

2 Test Protocol

Introductory presentations were given in Dutch, as were most discussions. Description of the technology and test conditions were also carried out in Dutch. Questionnaires were in Dutch and carried out on an ipad by the participants, through the online survey tool, 'Limesurvey'. The questionnaire had been refined following the December pilot tests, in both content and userbility.

3 Technical problems

There was a positioning issue of the vehicles across all tests. The platooning cars were not able to detect which lane of the highway that they were in. Therefore if another car passed them in the outer lane, the platoon would break as the detected car was considered to have come between the platoon cars. This caused significant issues during the third test run of day one. However, in discussion with the use case leader, it was agreed that this technical problem did not cause a negative impact on the user experiences and so results would still be valid.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 5 point scale. This was rated 2 to -2 (eg Positive = 2, Negative = -2).

Figure 1: Participants expectations on the test and usefulness of the service

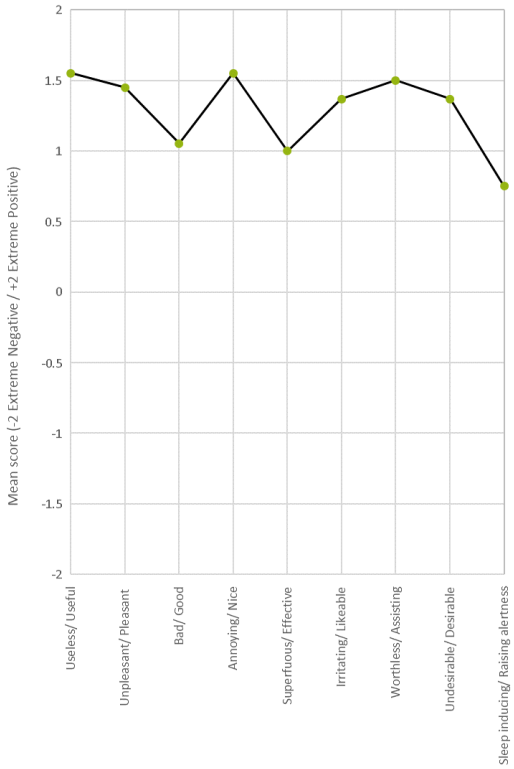


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service

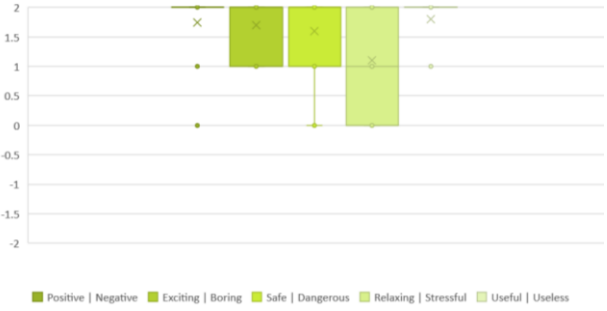


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Table 1: Standard Deviation between average score of test run groups

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless
0.18	0.21	0.34	0.58	0.11

- No participants thought that the experience would be negative, boring, dangerous, stressful or useless
- Six participants were neutral about how relaxing or stressful the experience would be
- The least positive expectation was around how relaxing the experience would be
- The most positive expectation was around how useful the system would be
- The greatest variation both across all participants and between test run groups, was about how relaxing or stressful the experience would be

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -2 to 2(eg Positive = 2, Negative = -2), in five areas. The same categories were used as in the Pre-Test.

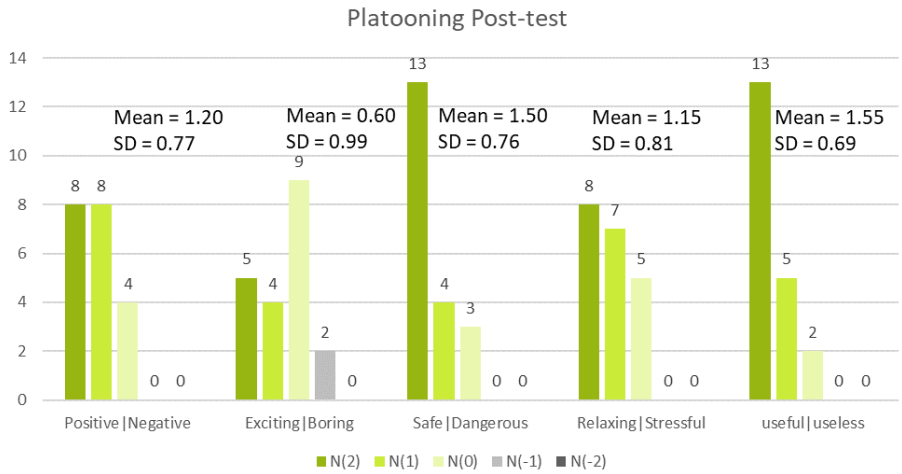


Figure 4: How participants felt about the test and usefulness of the service

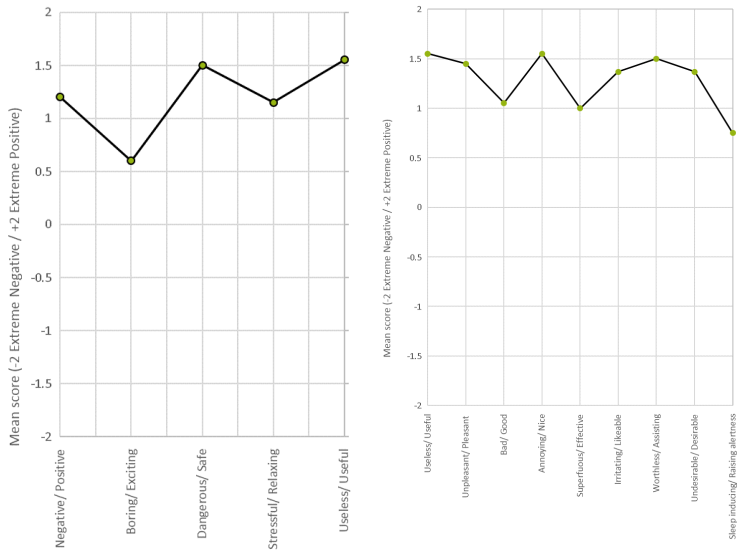


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

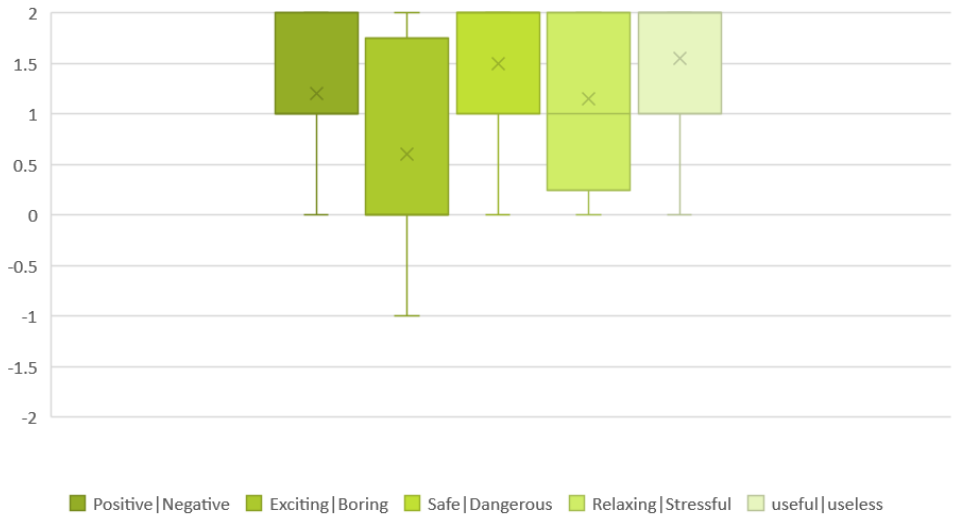


Table 2: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless
0.49	0.36	0.43	0.44	0.47

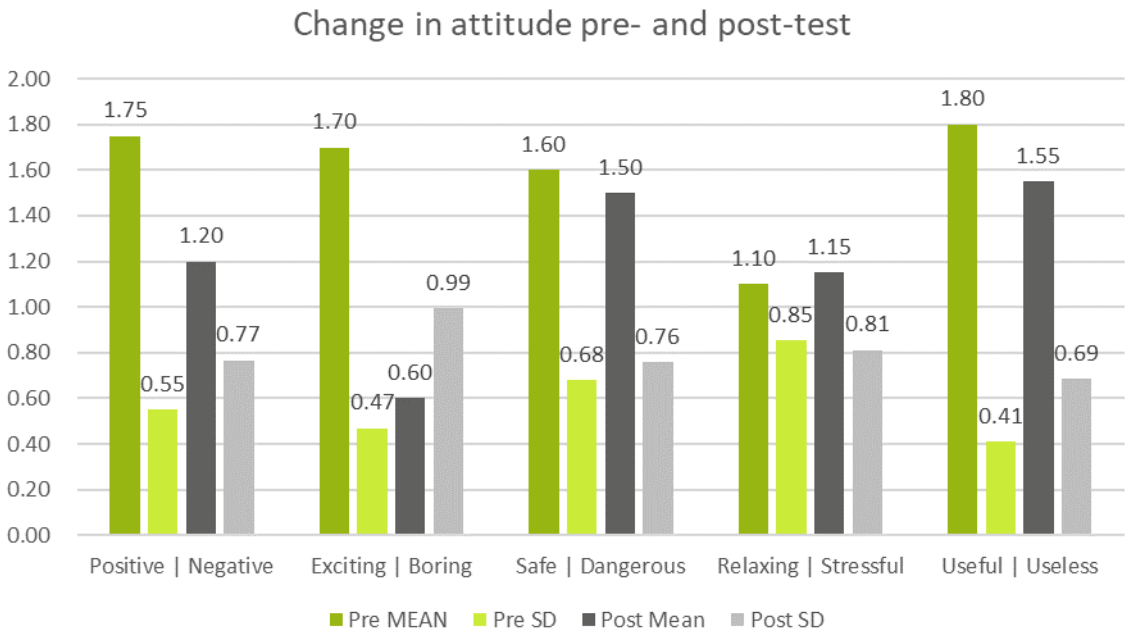
- Two participants found the experience boring
- Nine participants were neutral about how exciting or boring the experience was
- The least positive reaction was regarding how exciting the experience was
- The most positive reaction was about how safe the experience was
- The greatest variation across all participants was about how exciting or boring the experience was
- The greatest variation between test run groups was about how positive or negative the experience was

Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[1] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more satisfying than useful.

[1]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.



Positivity of Experience

- The pre-test expectations were more positive and with a smaller deviation than the post-test reactions

Excitement of Experience

- The pre-test expectation was much more exciting than the post-test reaction
- This was the biggest change in both mean and SD from pre-test to post-test

Safety of Experience

- There was little change between the pre-test expectations and post-test reactions
- It was one of the most positive areas

Stress of Experience

- There was little change between the pre-test expectations and post-test reactions
- This was the only area which had a positive change from pre to post test

Usefulness of Service

- The pre-test expectations were more useful than the post-test reactions.
- It was the most positive area both pre and post test

AUTOPILOT

Initial Post-Test Reactions[2]

Although the majority of the participants made a positive comment (marked green), four of the participants expressed some form of disappointment (marked red).

A lot of work still to be done
Interesting
Super enthusiastic
Positive. This is the future
Very fascinating
Not everything worked as it should during the entire ride
Wowww
Fascinating
Interesting and useful
Nice
Fun and educational
An amazing experience!
Interesting but not yet the level that I expected
Interesting, but had much higher expectations of automatic driving
very interesting, as a leader to see how the follower connects, as a follower fascinating how connection is established
Worked perfectly, a nice first experience with platooning
Interesting
Interesting
Very interesting and fun

3 participants reported feeling unsafe or uncomfortable during the test:

A car suddenly cut in. Here the vehicle had to be driven manually again.
While accelerating in the following car, and overtaking on the right, the car on our left wanted to come to the right-hand lane....
Not unsafe but in the following car you feel a certain "rocking" movement.

2 participants reported suffering motion sickness during the test.

Yet I can imagine that this could happen on longer distances, especially in a following car.
This is mainly caused by sitting in the back

7 participants reported other behavior that made them feel uncomfortable:

During autonomous driving the car effected corrections that as driver you would do less violently, but I didn't feel uncomfortable.
Repeatedly not realizing you're platooning does cause some unrest and a feeling of insecurity.
As a follower the moments of linking and quitting again.
Still jerky steering now
The automatic driving was wobbly, from left to right
I found driving autonomously more unstable than with a driver
Many brief steering corrections

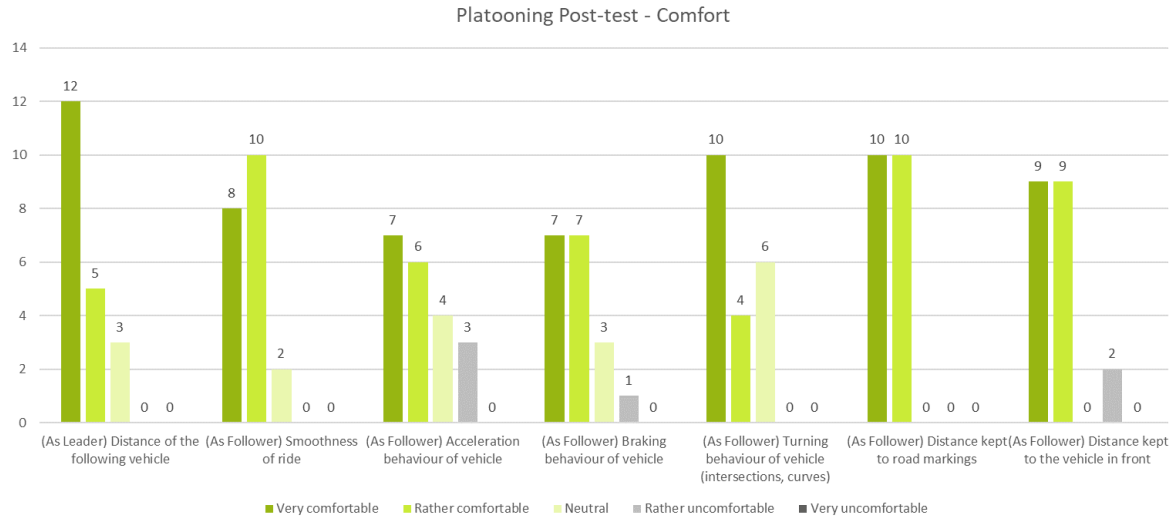
[2] Translated from Dutch

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 Comfort whilst experiencing service

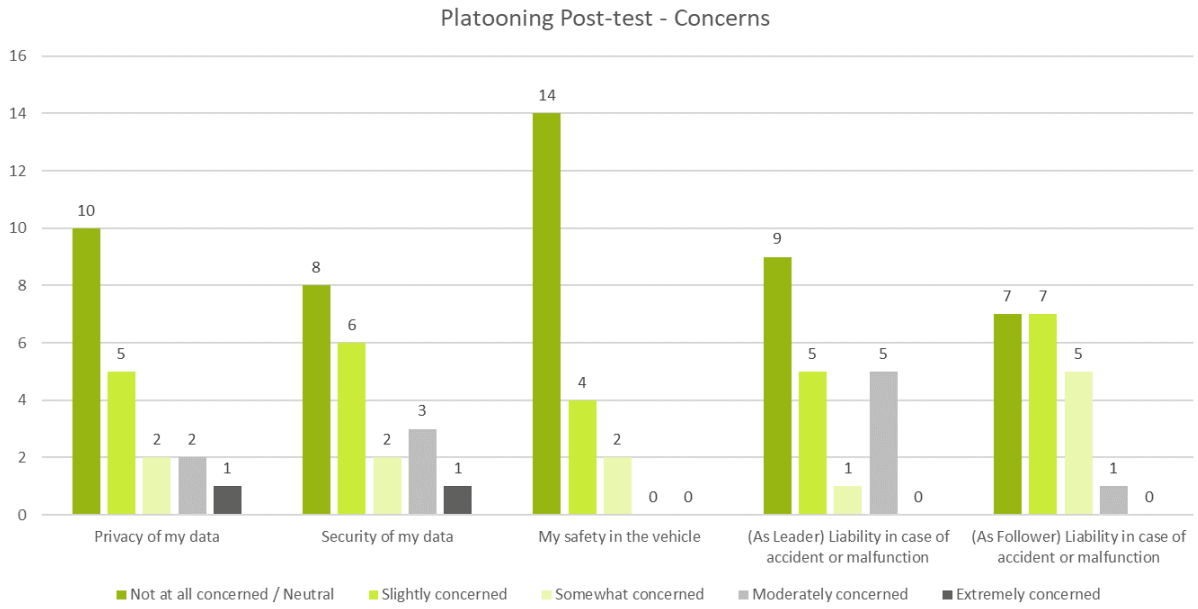
Participants were asked to comment on the perceived comfort of various aspects of the service, as both a leader and a follower. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice.



- No participants found that any aspect was very uncomfortable
- All participants found that it was comfortable in aspect of distance kept to road markings (as a follower)
- For each aspect, over 65% of participants found it comfortable
- Six participants were neutral about the turning behaviour of vehicle (intersections, curves) (as a follower)
- The greatest number of participants who felt discomfort was regarding acceleration behaviour of vehicle (as a follower)
- Participants were most comfortable about the distance of the following vehicle (as a leader) and distance kept to road markings (as follower)
- Participants were least positive about the acceleration behavior of the vehicle (as a follower)
- Other behaviours that made participants feel uncomfortable are:

4.4.2 Concerns whilst using service

Participants were asked to comment on their concerns regarding various aspects of the service as both a leader and a follower. They were ranked from Not at all concerned / Neutral to Extremely concerned.



- For all aspects, over 70% of participants where either not concerned or only slightly concerned
- The aspect that had the greatest number of people without concerns was regarding the safety of the vehicle.
- No participants were moderately concerned or extremely concerned about their safety in the vehicle
- Five participants were somewhat concerned about the liability in the case of an accident or malfunction (as a follower)
- The aspect that had the greatest number of people with concerns was regarding the liability in case of accident or malfunction (as a leader)
- The only aspects where someone was extremely concerned were privacy and security of data.

4.5 Post-Test Thoughts on Future Use

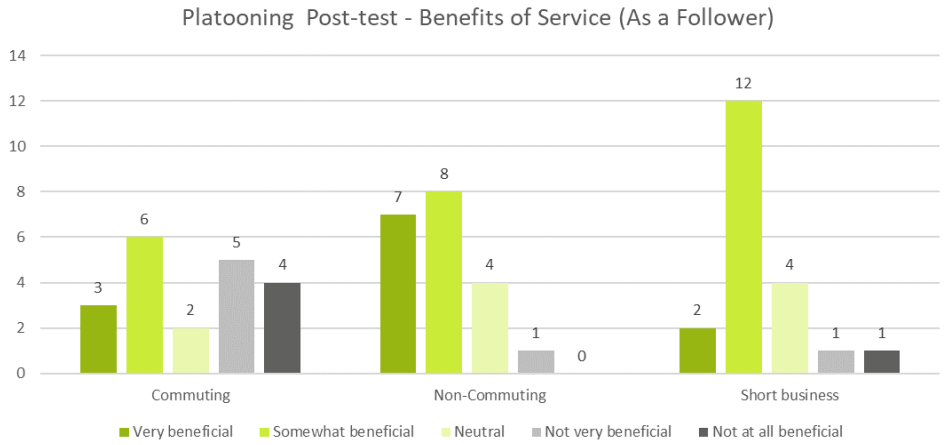
Participants were asked to comment on how they might use the service if it was available.

4.5.1 Behaviour Change

Participants were asked how the service might affect their usual travels as both a leader and a follower. This included how trips, private car use, traffic safety, stress and comfort would change (ranked between -2 and 2).

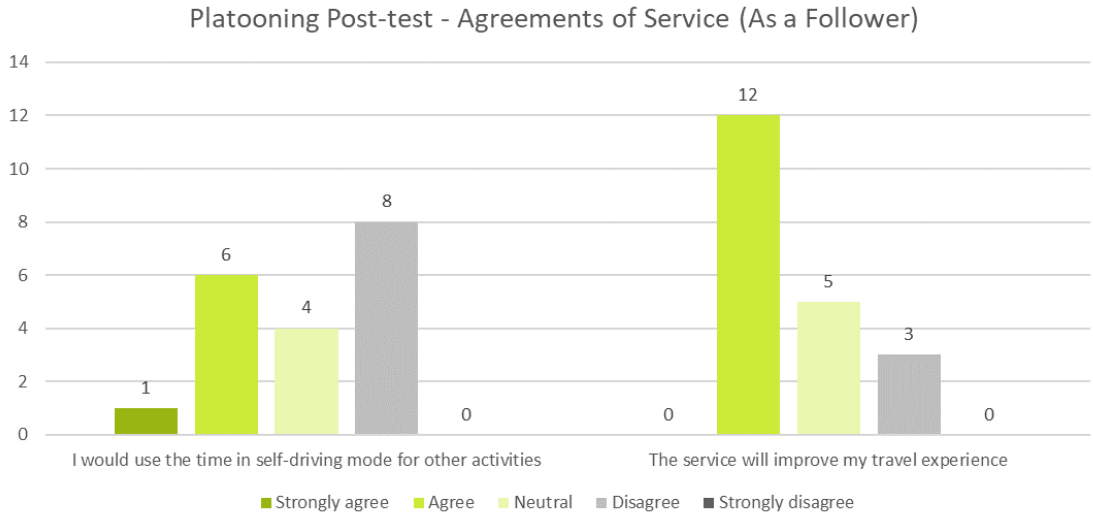
- 16 participants (80%) did not think the service would change their overall number of trips
- All but 4 participants did not think the service would change their private car use
- 6 participants thought that the service would increase the time of trips
- 7 participants thought that the service would make their trips last shorter (in time)
- 13 participants did not think the service would change their distance of trips
- 5 participants thought that the service would increase the distance of trips
- 2 participants thought that the service would make their trips shorter (in distance)
- All but 4 participants thought that the service would increase their safety in traffic
- 12 participants did not think the service would change their travel comfort (as a leader)
- All but 2 participants thought that the service would increase their travel comfort (as a follower)
- 12 participants did not think the service would change their stress while driving (as a leader)
- 13 participants thought that the service would decrease their stress while driving (as a follower)

Further to behavior change, participants were asked how beneficial the service may be to categorised trips as a follower. These were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



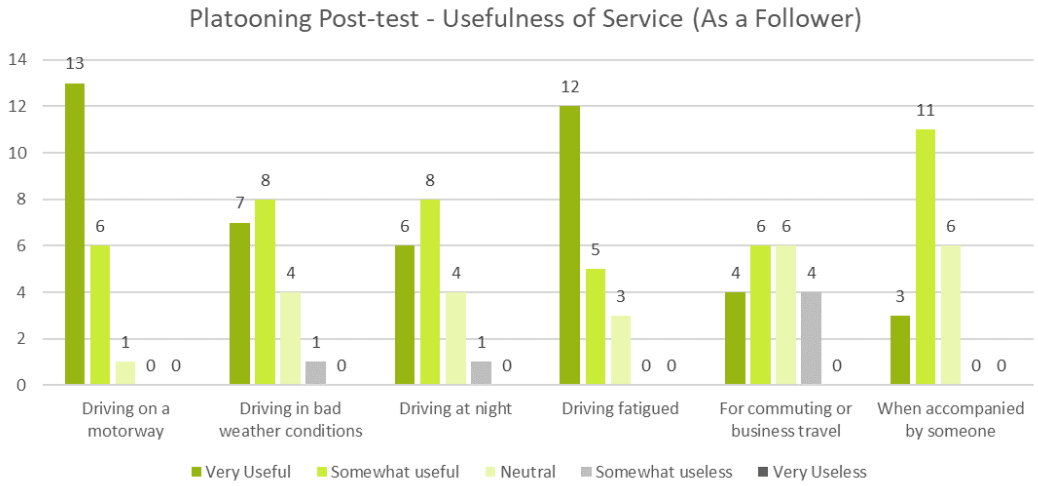
- Almost half of participants (9) felt that this service would be beneficial or very beneficial for commuting trips, though the same number also though they would not be benefical
- The majority of participants felt that the service would be beneficial for non-commuting (75%) and short business (80%) trips
- No participants felt the service would not be beneficial at all for non-commuting trips

Participants were asked if they would use the time in self-driving mode for other activities and if this service would improve their travel experience (as a follower). The answers were ranked from Strongly agree to Strongly disagree, with neutral as a central choice.



- 7 participants agreed or strongly agreed that they would use the time in self-driving mode for other activities, though 8 participants disagreed that they would use the time in self-driving mode for other activities
- 12 participants agreed that this service would improve their travel experience
- 5 participants were neutral about the service would improve their travel experience
- No participants strongly disagreed with either opinion

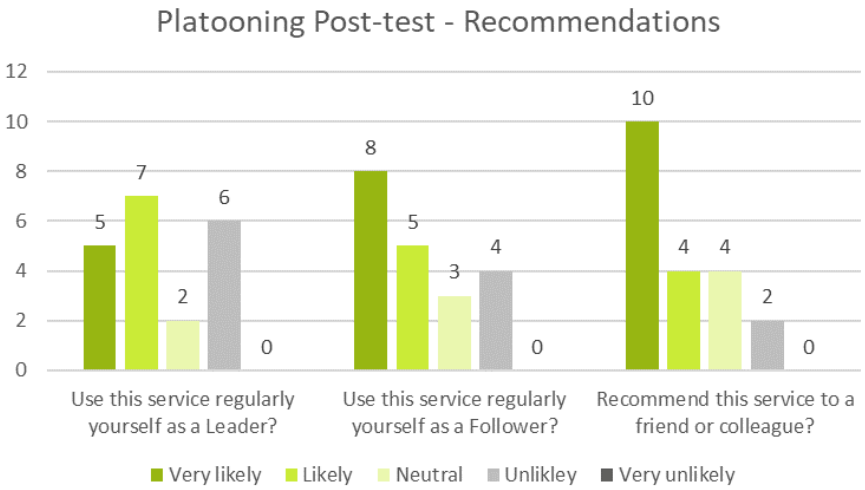
Participants were asked how useful the service would be to them in different circumstances (as a follower). These were ranked from Very useful to Very useless, with neutral as a central choice.



- Over half of participants felt that the service would be useful or very useful for all circumstances
- Almost everyone (95%) felt that the service would be useful or very useful for driving on a motorway
- Six participants felt neutral about the usefulness of this service in circumstance of commuting or business travel
- Six participants felt neutral about the usefulness of this service when accompanied by someone
- No participants felt the service would be very useless for any circumstance
- The least useful circumstance was seen to be for commuting or business travel
- The service was seen as somewhat useless by one participant for driving in bad weather and at night

4.5.2 Interest in service

Participants were asked how likely they would use the service or recommend to a friend as either a leader or a follower. They were ranked from Very likely to Very unlikely, with Neutral as a central choice.

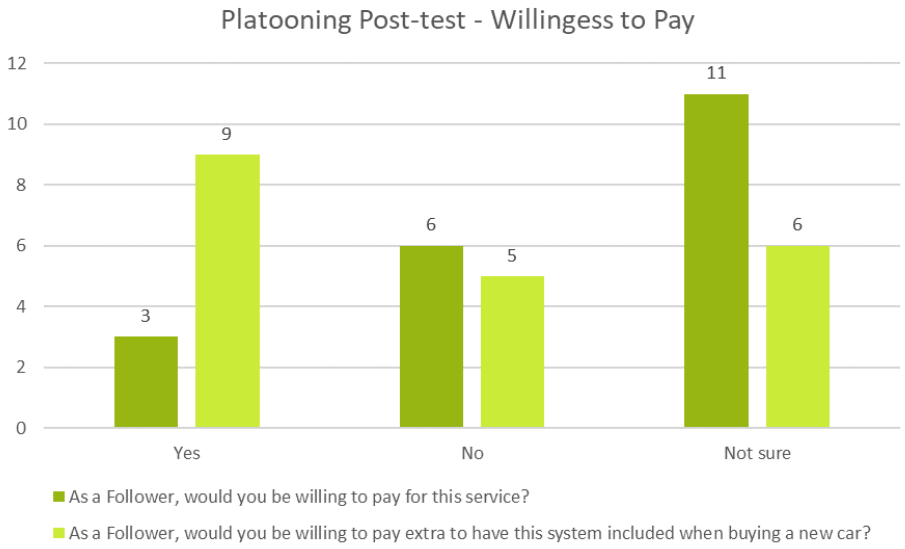


- The majority of participants would use the service regularly and recommend the service to a friend or colleague

- Only 5 participants (25%) were very likely to use this service regularly as a leader and 6 were unlikely to do so
- 8 participants (40%) were very likely to use this service regularly as a follower
- Half of participants were very likely to recommend the service to a friend or colleague
- No participants were very unlikely to use the service or recommend the service to a friend or colleague
- The following explanations were provided by the participants:

Pleasant service, can help with smoother traffic flow
It is nice if you can use this when it suits you. I can imagine that it will be useful in the future.
Has benefits for older drivers at a later age
Is not working optimally yet
I think that as a leader and as a follower you drive more relaxed, as a leader you know that cars behind you respond to you immediately, as a follower you know that your car will respond immediately.
If reliable really is reliable: why not ...
Usually use cruise control, and with this system the variability of the traffic flow is taken into account.
It contributes to more effective road use. Prevents traffic jams.
Some degree of dependence still
I see that it is still rather in its infancy.
Because this can greatly improve the flow.
If it works well in the future, I think it would be a nice way to drive long distances
Most car drivers are not able to follow well, which results in uneven distances between them, resulting in congestion.
The service is currently unnecessary
I don't see many benefits of platooning
Added value I think, only for long distances or in daily traffic jams (car sharing)
Highly recommended, will in future save on traffic jams, fuel etc.

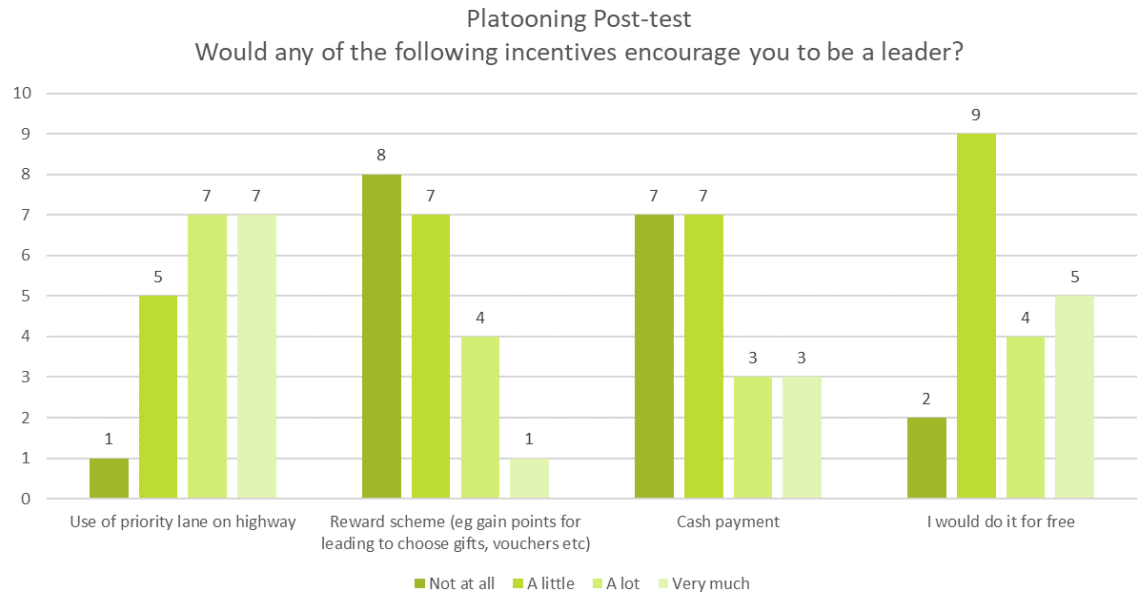
The participants were asked if they would be willing to pay for this service or pay extra to have this system included when buying a new car as a follower.



- Just three participants would be willing to pay for this service as a follower
- Six participants would not pay to use this service as a follower
- Over half of participants were not sure if they would pay for this service as a follower

- About half of participants would be willing to pay extra to have this system included when buying a new car as a follower
- Five participants (25%) would not pay extra to have this system included when buying a new car
- Six participants were not sure if they would pay extra to have this system included when buying a new car

The participants were asked if any of the following incentives would encourage them to be a leader. The answers were ranked from Very much to Not at all.

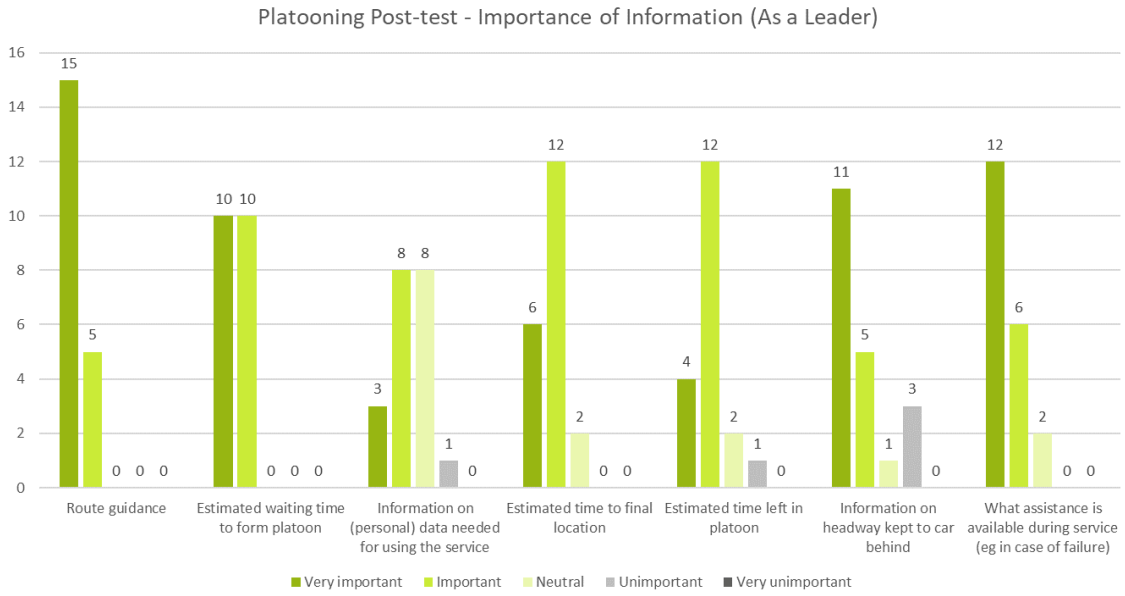


- The reward scheme would seem least effective, as eight participants thought it would not encourage them at all, and only 5 would encourage them a lot or very much.
- Nearly half of participants thought that "I would do it for free" would encourage them a little to be a leader
- Over half (14) of participants thought that the "use of priority lane on highway" would encourage them very much or a lot to be a leader
- Other incentives that encourage participants to be a leader are:

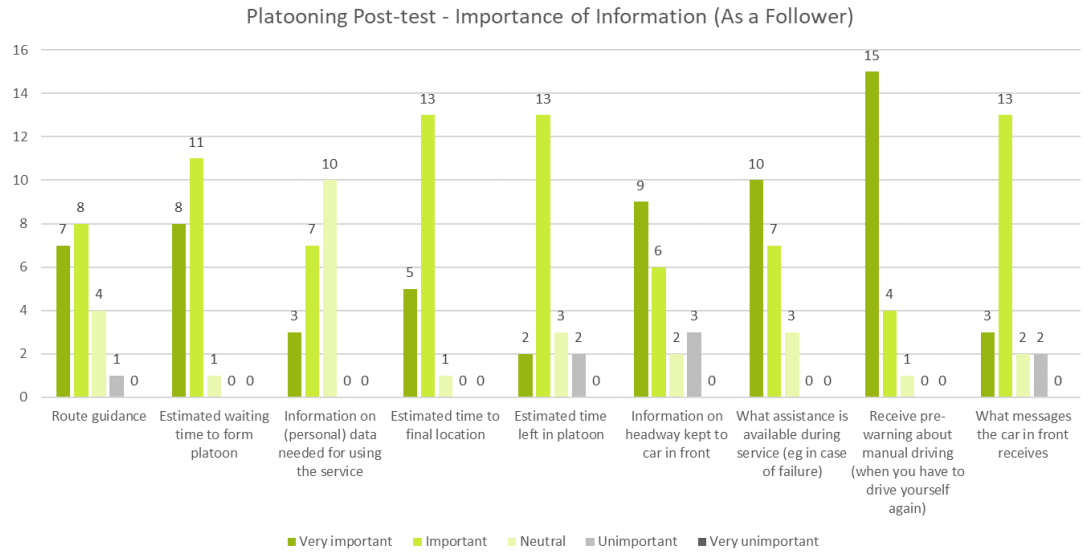
Bonus: to be able to follow you must have driven as a leader a number of times
Safety
Would like to see it its development and help with it, so keep going and I would love to participate
Gain experience
Help acquaintances get on the right track
Environmental aspects
Discount in road pricing

4.5.3 Importance of Information during Service

Participants were asked about the importance of various aspects of information that could be provided through the service as both a follower and a leader. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- No participants thought that the information in all aspects were very unimportant as a leader
- No participants thought that the information in aspects of route guidance, estimated waiting time to form platoon, estimated time to final location, and what assistance is available during service were unimportant
- All participants thought that the information about estimated waiting time to form platoon was important or very important
- 8 participants were neutral about the information on (personal) data needed for using the service



- No participants thought that the information in all aspects were very unimportant as a follower
- No participants thought that the information in aspects of estimated waiting time to form platoon, (personal) data needed for using the service, estimated time to final location, what assistance is available during service, and receive pre-warning about manual driving were unimportant

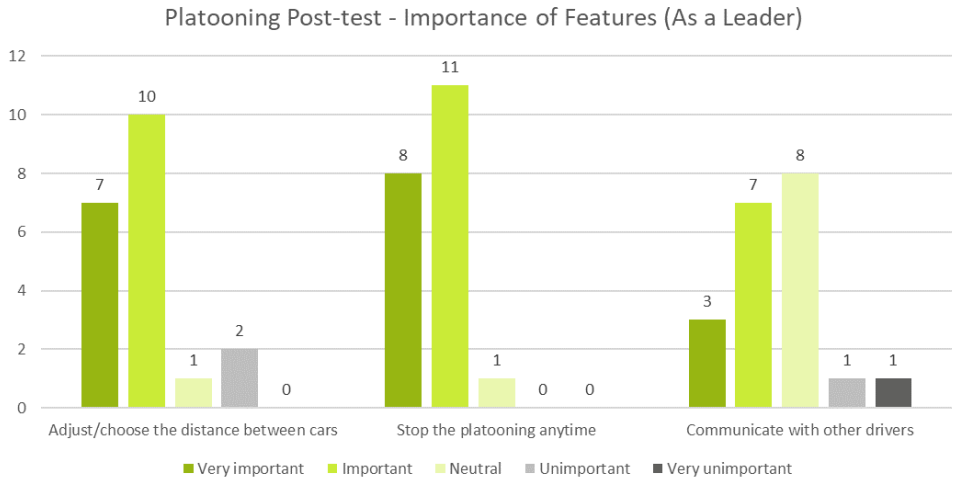
- Half of participants were neutral about the information on (personal) data needed for using the service
- The majority of participants (over 50%) thought that the information in all aspects were important or very important as a follower
- Nearly everyone (95%) thought that the information about estimated waiting time to form platoon and receive pre-warning about manual driving were important or very important

Participants were also asked if there is any other information that they would like to have as either a leader or a follower. The answers of other information that participants would like to have are [3]:

Info about traffic and info about the chances of platooning not working out
How many followers you have behind you. And a notification when someone quits on their own initiative
Certain matters will undoubtedly be adjusted during the remaining time.
Information on the screens should take into account the colour-blind.
As a follower, be warned in time for unexpected events on the road which the leader can see.
General info regarding traffic, weather etc.
To which bait item can I follow *[NB this is incomprehensible]*. For a follower it is also important that there must be coordination with fellow passengers, if you are not driving alone.

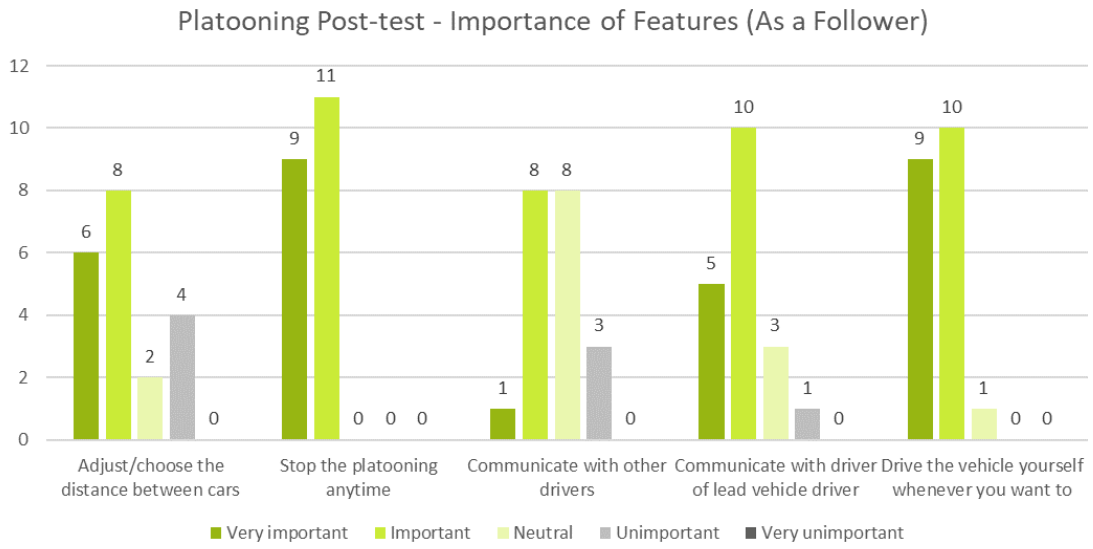
4.5.4 Importance of Features of the Service

Participants were asked about the importance of various features during service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- No participants thought that the features of adjust/choose the distance between cars and stop the platooning anytime were very unimportant as a leader
- 2 participants thought that communicate with other drivers were unimportant or very unimportant
- 8 participants were neutral about feature of communicate with other drivers as a leader during service
- Nearly everyone (95%) thought that the feature of stop the platooning anytime was important or very important, and no one thought it was unimportant.

[3] Translated from dutch



- No participants thought that the features in all aspects were very unimportant as a follower
- 4 participants thought that adjust/choose the distance between cars was unimportant
- 8 participants were neutral about feature of communicate with other drivers as a follower during service
- All participants thought that the feature of stop the platooning anytime was important or very important
- Nearly everyone (95%) thought that the feature of drive the vehicle yourself whenever you want to was important or very important and no one thought it was unimportant.

4.5.5 Additional feedback

Participants were given the opportunity to give further feedback to designers of the system on anything else that might be used to them:

Information about other users and information about the chance that platooning will succeed
Fixed [? Fast?] vehicle detection, following traffic.
Giving people confidence in the system

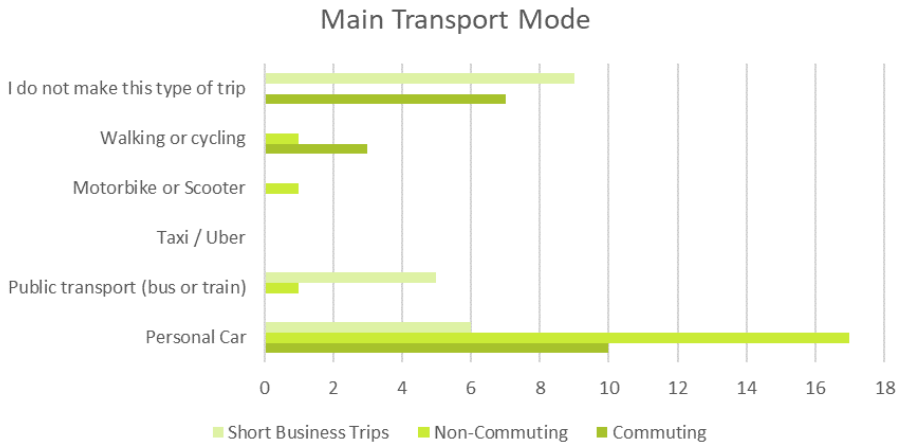
Inform non-users well about how the "trains" work, and what reactions in the picture this can give.
I assume that you also have starting places where locations / distances are indicated.
Indeed a special app

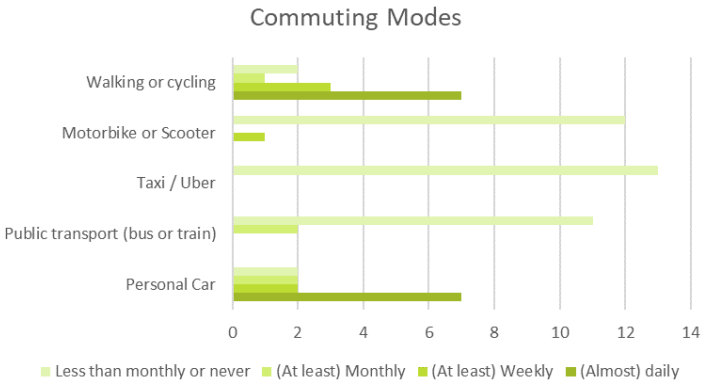
5 Background

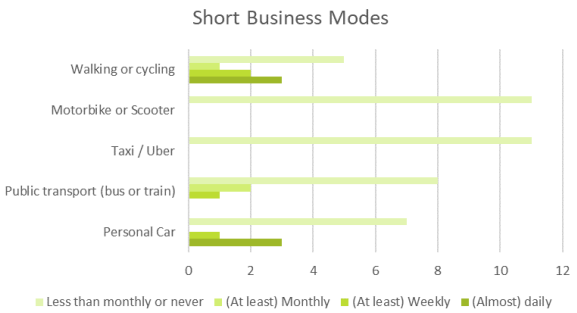
Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

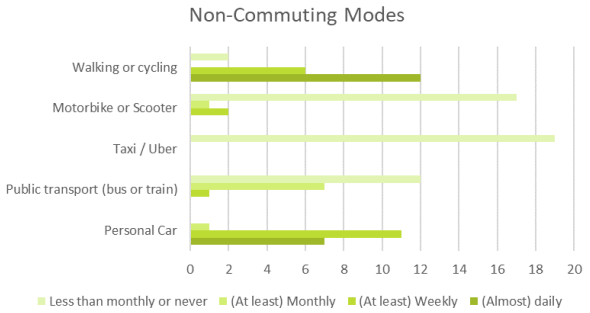
5.1 Travel Habits

Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.



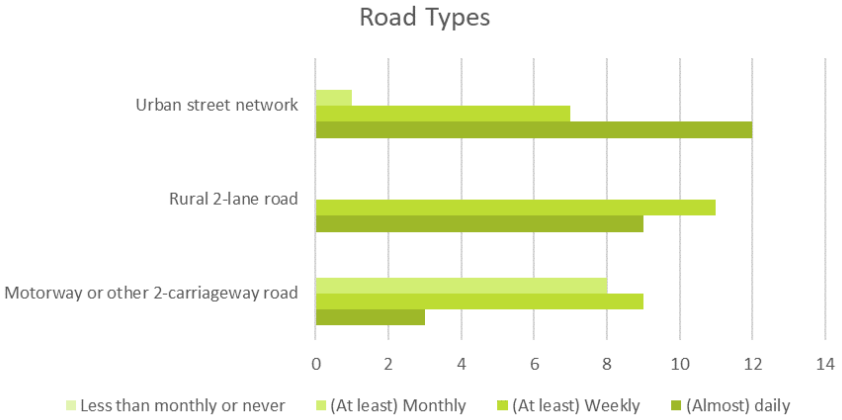






- 35% and 45% participants do not make commuting or short business trips, respectively
- Over 54% participants use personal car as their main transport mode for all trips types
- The majority of participants (85%) use personal car as their main mode for non-commuting trips
- No participants use taxi/uber as their main mode for any trip types.
- Small numbers of participants use public transport as their main mode for non-commuting and short business trips
- No participants use public transport as their main mode for commuting trips
- Just one participant use scooter/ motorbike as their main mode for non-commuting trips
- Small numbers of participants use waking or cycling as their main mode, but not for short business trips

Participants were asked how often they drove on different road types.

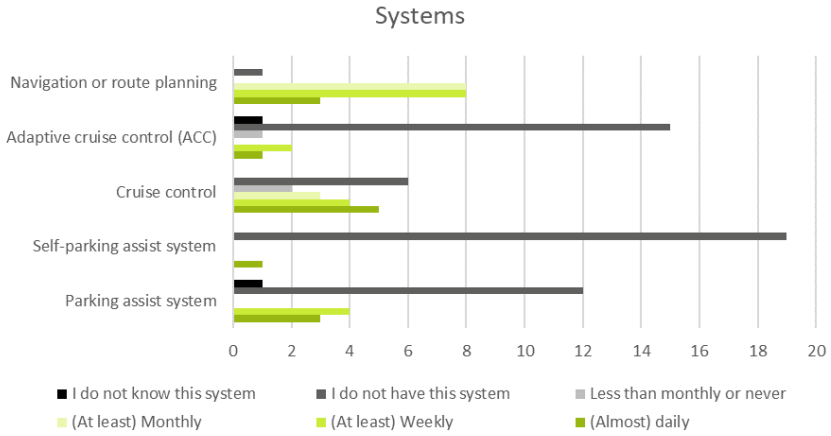


- Over half of participants (60%) drive on urban network almost daily
- Over half of participants (55%) drive on rural network at least weekly
- Eight participants drive on motorways at least monthly
- No participants drive on rural network at least monthly
- No participants drive on different road types less than monthly or never

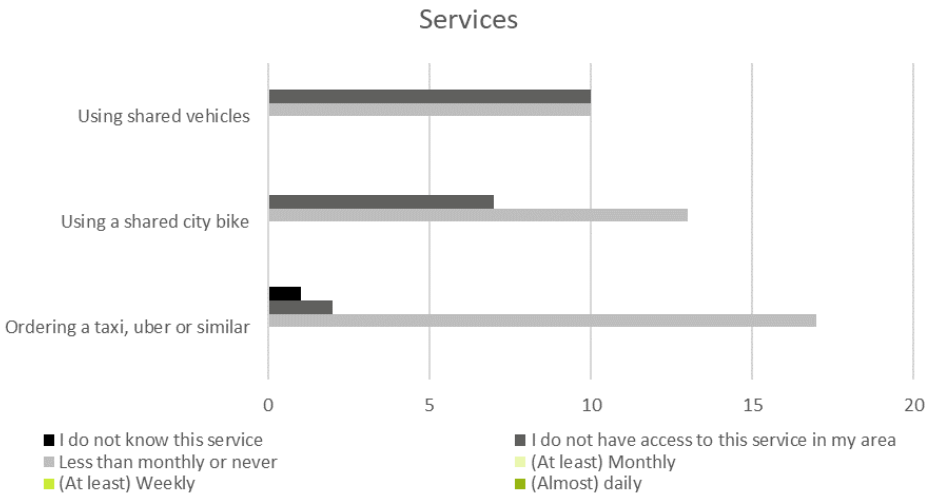
5.2 System and Service Acceptance

System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



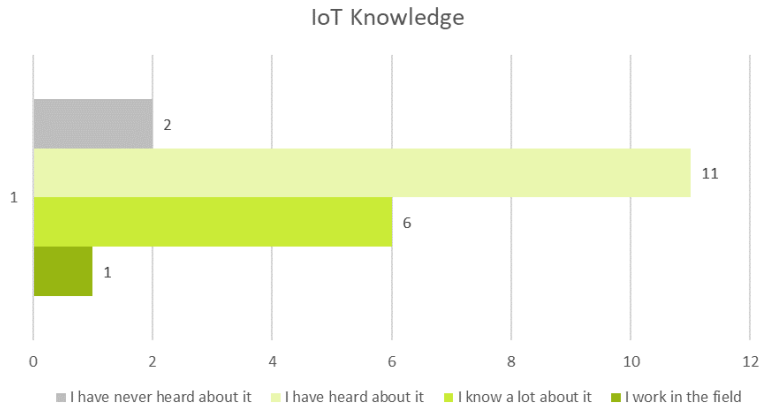
- All but two participants have heard of all system types
- The majority of participants do not have self-parking (95%), ACC (75%) or parking assist systems (60%)
- 14 participants (70%) have cruise control
- Only 1 participant does not have a navigation system
- Seven participants with parking assist system use it almost daily or at least weekly
- Just one participant has self-parking assist system and uses it almost daily
- The majority of participants with a navigation system use it at least weekly or at least monthly



- Just one participant do not know how to order a taxi, uber or similar
- Half of participants do not have access shared vehicles
- All participants who do have access and knowledge of these services use them less than monthly or never.

5.3 IoT Knowledge

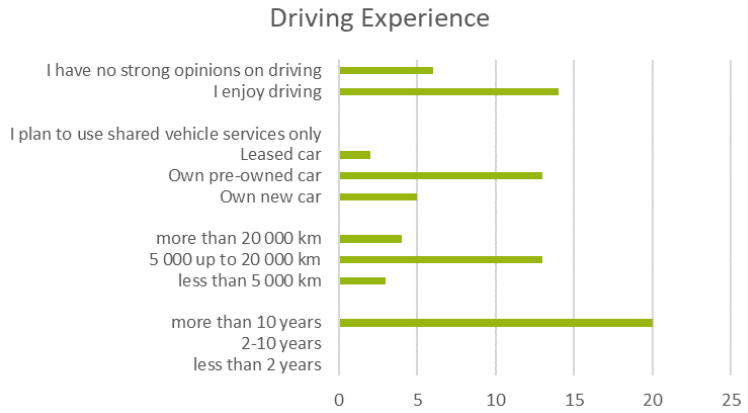
Participants were asked how aware they were of Internet of Things.



- Over half of participants (65%) have either not heard or know little about IoT

5.4 Driving Experience

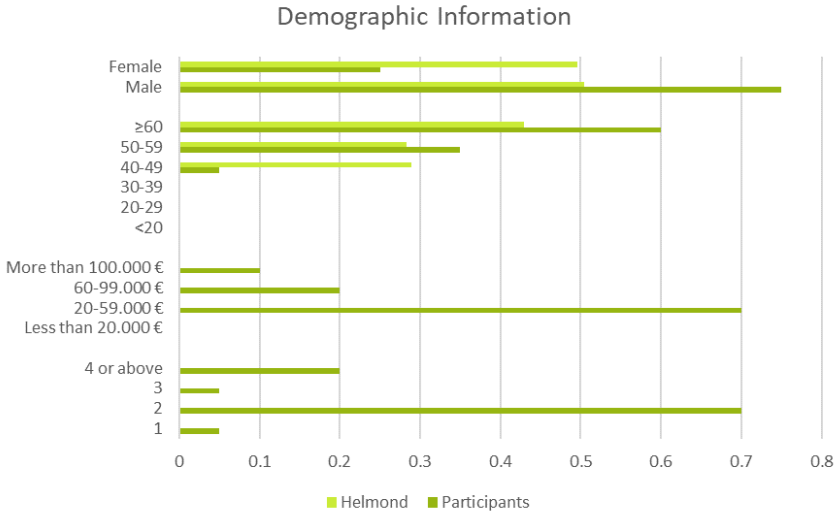
Participants were asked about their attitude and experience towards driving.



- The majority of participants (70%) enjoy driving
- Over half of participants (65%) plan to owe a pre-owned car
- Over half of participants (65%) drive between 5 and 20 km a year
- All participants have been driving for more than 10 years

5.5 Demographic Information

Participants were asked about their background to establish representation of the test group.[4]



- The percentage of female participants was about half of Helmond region
- The ≥60 age group was over-represented
- The 40-49 and 50-59 age groups were under-represented
- No participants were in the groups of <20, 20-29 or 30-39

[4] https://www.citypopulation.de/php/netherlands-admin.php?adm2id=0794

AUTOPILOT

Brainport Urban Driving

1 Background

The Brainport Urban Driving user testing took place the 13th – 14th April 2019 at the Campus of Eindhoven University, NL. Forty Four (44) participants took part, recruited through online and social media advertisements. These took place across ten sessions over the two days in groups of between 2 and 6 participants.

2 Test Protocol

Introductory presentations were given in Dutch, as were most discussions. Description of the technology and test conditions were also carried out in Dutch. Questionnaires were in Dutch and carried out on an ipad by the participants, through the online survey tool, 'Limesurvey'. The questionnaire had been refined following the December pilot tests, in both content and userbility.

3 Technical problems

There were some minor issues with the technologies during the testing. In four test runs the IoT connection failed or the app was not detected at the start of the test, requiring an immediate restart. These were not considered significant enough to effect the user experience. One participant (13041917) experienced significant issues across the test run due to multiple connection failures. The results for this participant were therefore removed from the analysis.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 5 point scale. This was rated 2 to -2 (eg Positive = 2, Negative = -2).

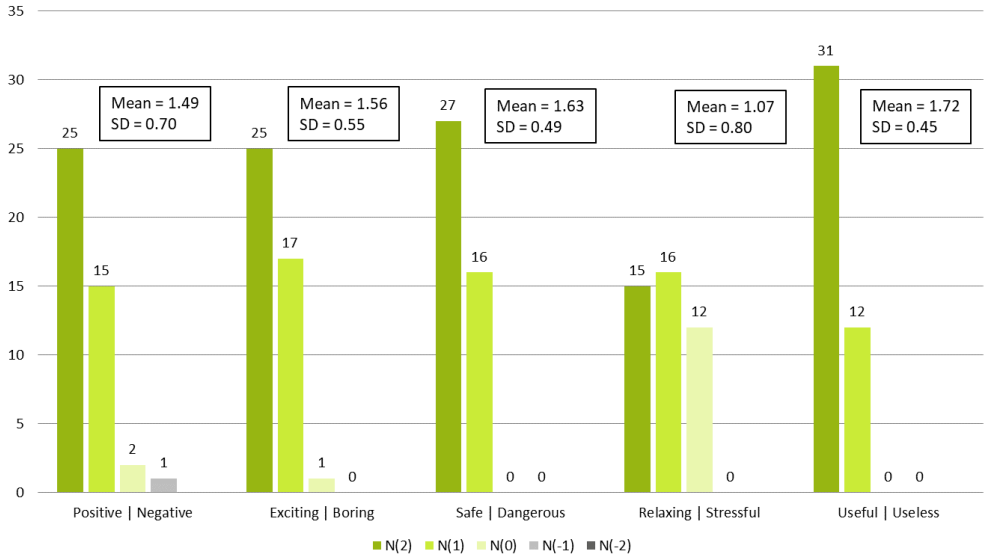


Figure 1: Participants expectations on the test and usefulness of the service

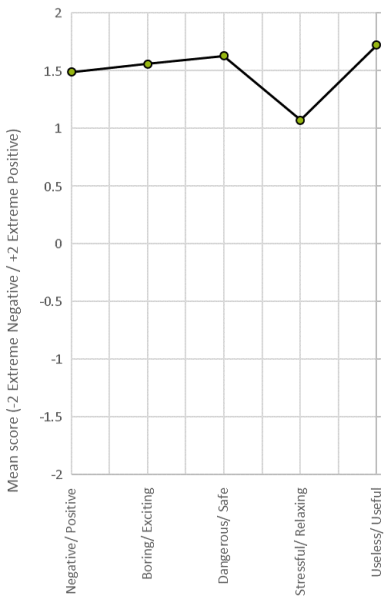


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service

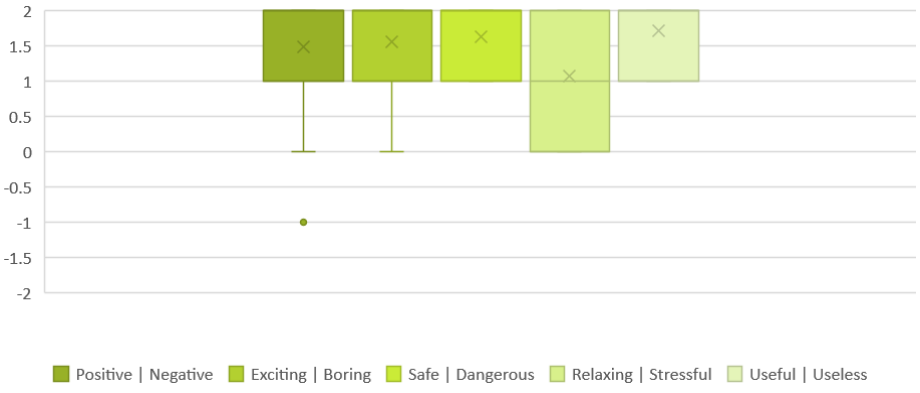


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Table 1: Standard Deviation between average score of test run groups

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless
0.25	0.30	0.19	0.37	0.23

- No participants thought that the experience would be boring, dangerous, stressful or useless
- Only one participant thought that the experience would be negative
- Twelve participants were neutral about how relaxing or stressful the experience would be
- The greatest variation, both across all participants and between test run groups, was about how relaxing or stressful the experience would be

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -2 to 2(eg Positive = 2, Negative = -2), in five areas. The same categories were used as in the Pre-Test.

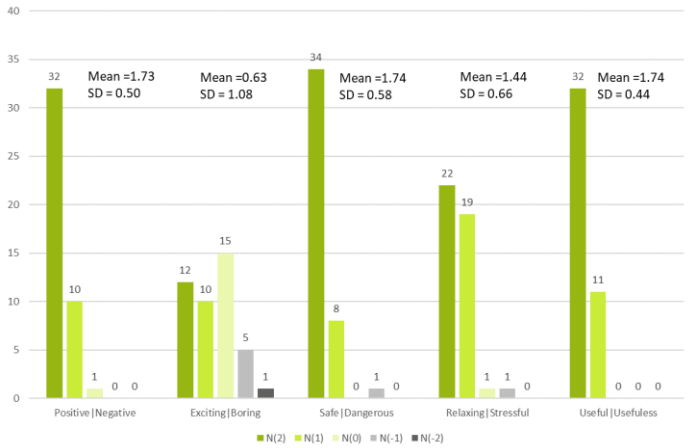


Figure 4: How participants felt about the test and usefulness of the service

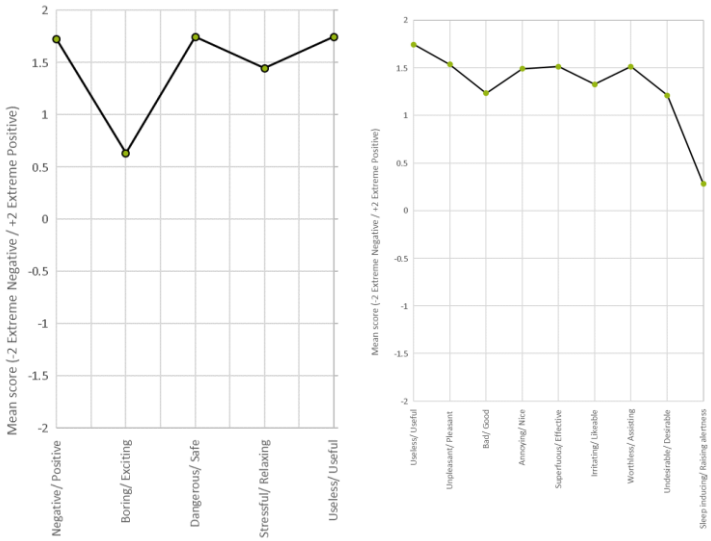


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

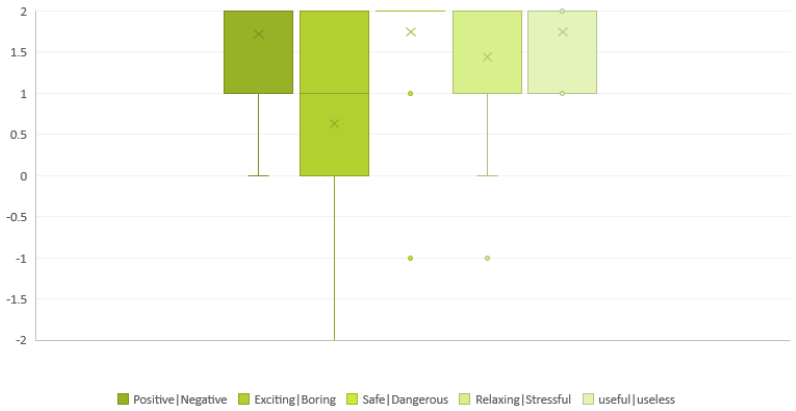
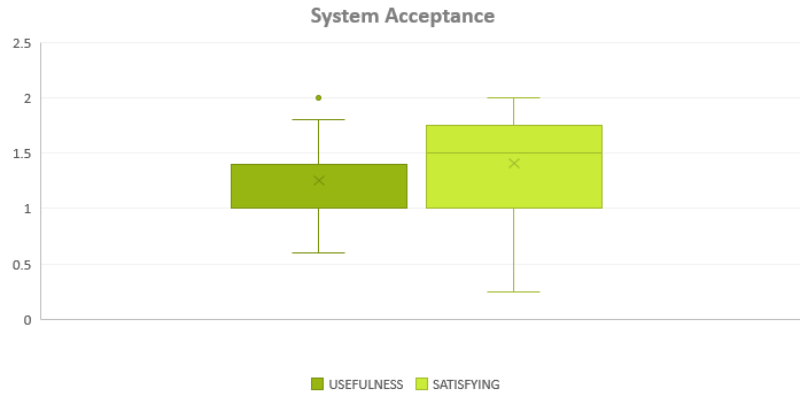


Table 2: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

Positive/Negative	Exciting/Boring	Safe/Dangerous	Relaxing/Stressful	Useful/Useless	
0.24	0.58	0.24	0.32	0.28	

- No participants thought that the experience was negative or useless
- Only one participant thought that the experience would be dangerous or stressful
- Six participants found the experience boring
- Fifteen participants were neutral about how exciting or boring the experience was
- The greatest variation, both across all participants and between test run groups, was about how exciting or boring the experience was

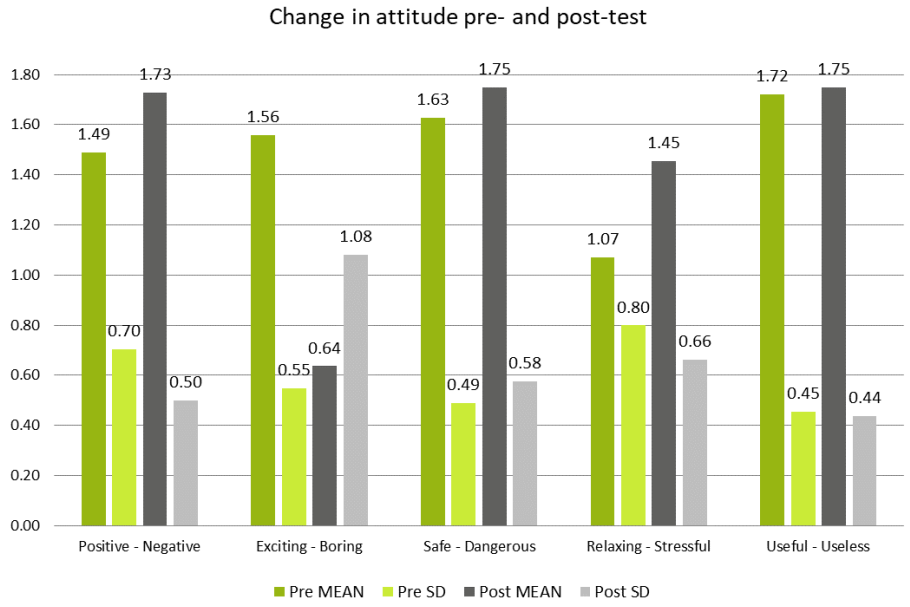
Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[1] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more useful than satisfying.



[1]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.



Positivity of Experience

- The post-test reactions were more positive and with a smaller deviation than the pre-test expectations

Excitement of Experience

- The pre-test expectation was much more exciting than the post-test reaction
- This was the biggest change from pre-test to post-test
- Post-test reactions had the biggest deviation in responses

Safety of Experience

- There was little change between the pre-test expectations and post-test reactions
- It was one of the most positive areas

Stress of Experience

- This area had the largest positive change from pre-test to post-test

Usefulness of Service

- There was little change from the pre-test expectations to post-test reactions
- It was one of the most positive areas

AUTOPILOT

Initial Post-Test Reactions[2]

Although the majority of the participants made a positive comment (marked green), six of the participants expressed some form of disappointment (marked red).

Very clever, am impressed
Interesting development
Interesting to see the technology in action
Striking how much information is registered during the ride
Short and sweet but interesting
Interesting
Very interesting but still needs a lot of research.
Interesting
Nice, interesting
The service operates fairly smoothly, however, there is no feedback on actions
Useful system, potential of growing big
Pleasant ride, feeling of safety, however, the speed was low, which eliminates some problems
The technology appears to have progressed quite far already
Positive, singular experience
Excitement and surprise
Cool. Special to have car start just like that without a prompt.
It was a lot of fun
Very interesting to participate in, to see where we are now
Special, relaxed and quiet trip
Very nice to experience. Still experimental stage.
Interesting, instructive
Playful
Very interesting to be able to ride in an autonomous car. The possibility of calling the car as a taxi service seems very useful to me.
A very good and interesting experience
It was neat and exactly as expected, just like a normal taxi service.
I would like to continue to follow this development
Interesting experience.
Incredible. I was very impressed with how the car can drive itself, especially registering the surroundings, like pedestrians.
Neutral
Nice experience
Nice
Good to be able to participate in this. This is the future
Nice but still a strange experience
Positive! A good initiative to make shared cars smarter in this way
The car recognized its surroundings better than I expected and drove cautiously.
Nicely organized experiment, and the driving seems safe. Further the app and servers needs some improvements
The experience was nice and smooth. I enjoyed seeing the use of the car from different perspectives. The one raising most questions was being a passenger.
Nice to see
Nice
It was very pleasant, reassuring, comfortable.
The future is nearer than I realized

[2] Translated from Dutch

The car drives very defensive and cautiously.

The test was fun, the service appears useful to me and is functioning ok already.

No innovative

6 participants reported feeling unsafe or uncomfortable during the test:

No. It was just going uncomfortably slow now and then.

The classification algorithm was quite liberal in seeing cars where there were none. That was slightly concerning

The initial jerk of the car was uncomfortable and made me concerned.

The car seemed to hit the curb in one of the corners.

When waiting for the request signal in the car, the driver was in the back with me with the door open and said he was ready to drive without closing the door. At first I did not realize he first had to turn on the car/turn off th parking breaks before the car would move, so I was a bit confused. Other wise everything seemed very safe and well prepared.

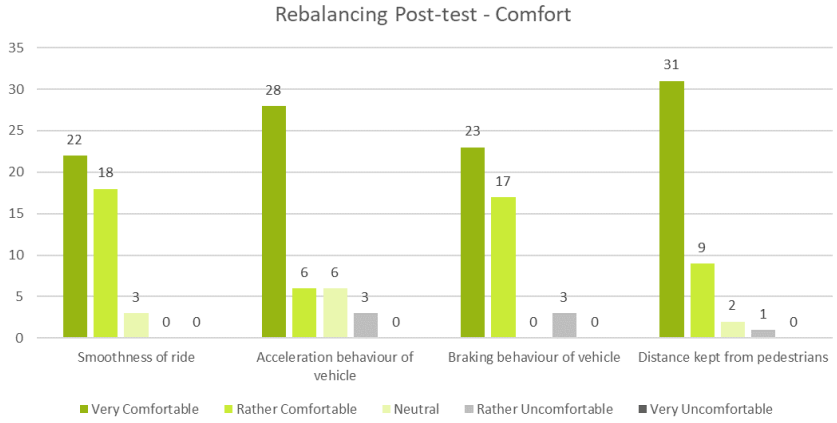
I did not felt unsafe or uncomfortable but I had a few seconds of uncertainty and doubt as the car braked in front of the pedestrian. The camera screen made it clear that they had been seen by the car but I was thinking about situations were the obstacles is less obvious (kids or animals, branches on the road) and was missing a signal from the car to make sure the obstacle has been perceived.

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 Comfort whilst experiencing service

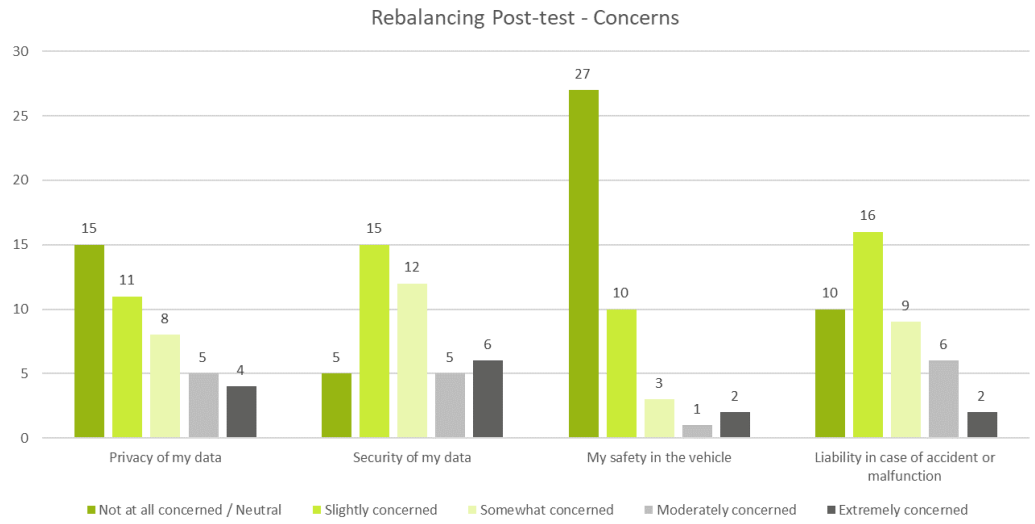
Participants were asked to comment on the perceived comfort of various aspects of the service. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice.



- At least one participant reports discomfort for all aspects except smoothness
- No participants found that any aspect was very uncomfortable
- For each aspect, over three quarters of participants found it comfortable
- Six participants thought neutral about acceleration behavior of vehicle
- The greatest number of participants who felt discomfort was regarding acceleration and braking behaviours of vehicle

4.4.2 Concerns whilst using service

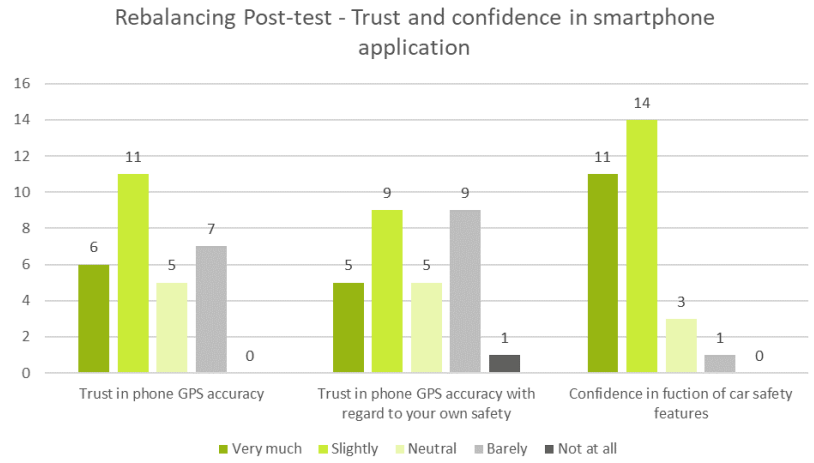
Participants were asked to comment on their concerns regarding various aspects of the service. They were ranked from Not at all concerned / Neutral to Extremely concerned.



- Over half of participants where either not concerned or only slightly concerned for privacy (60%), safety (86%) and liability (60%), except for data security (47%)
- The aspect that had the greatest number of people without concerns was regarding the safety of the vehicle (63%)
- The aspect that had the smallest number of people without concerns and the greatest number of participants with extreme concerns was data security.

4.5 Post-Test Thoughts on Using smartphone application

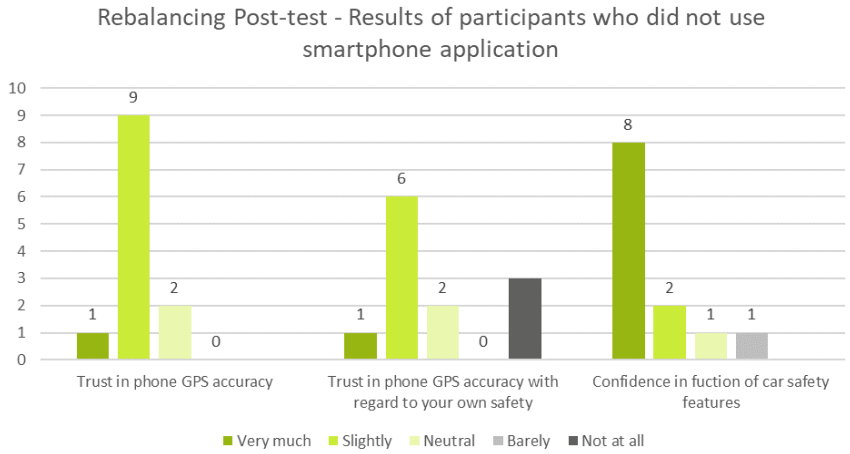
In order to know about the feelings of safety and comfort while using this service with respect to smartphone detection, the participants who used the smartphone application (67%) were asked about their trust and confidence in the application and related car features.



- Over half of participants thought that they would feel slightly or very trustful/ confident

- Participants were most confident about the car safety features.
- 5 participants thought neutral about trust on phone GPS
- No participants thought they would not feel trustful/ confident at all for general GPS trust or confidence in car features.

The participants who did not use smartphone application were also asked these questions. Due to a technical error, the result of one participant who did not use smartphone application was not recorded.



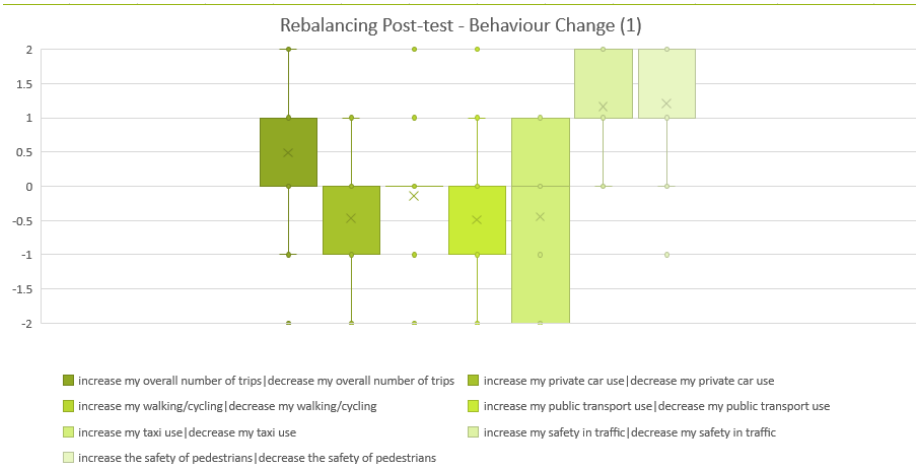
- 10 participants thought that they would feel slightly or very trustful/ confident in phone GPS generally and in car safety features.
- No participants did not trust general phone SPS accuracy
- No participants thought they would not feel trustful/ confident at all in the car features
- The least trust was in the phone GPS accuracy regarding ones own safety.
- In general there was more trust in both phone GPS and car features confidence from those who did not experience the smartphone application

4.6 Post-Test Thoughts on Future Use

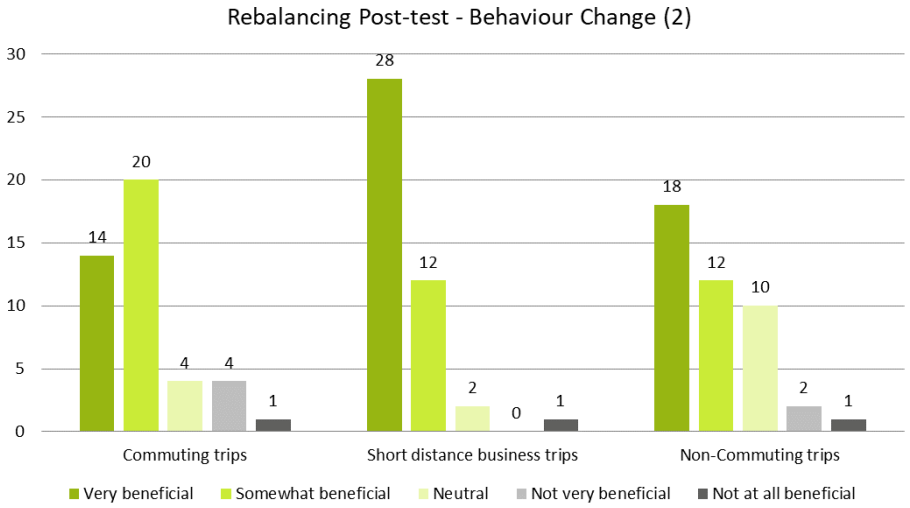
Participants were asked to comment on how they might use the service if it was available.

4.6.1 Behaviour Change

Participants were asked how the service might affect their usual travels. This included how overall number of trips, private car use, walking/cycling, public transport use, taxi use, traffic safety and pedestrians' safety would change (ranked between -2 and 2) and how beneficial it may be to categorised trips. They were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



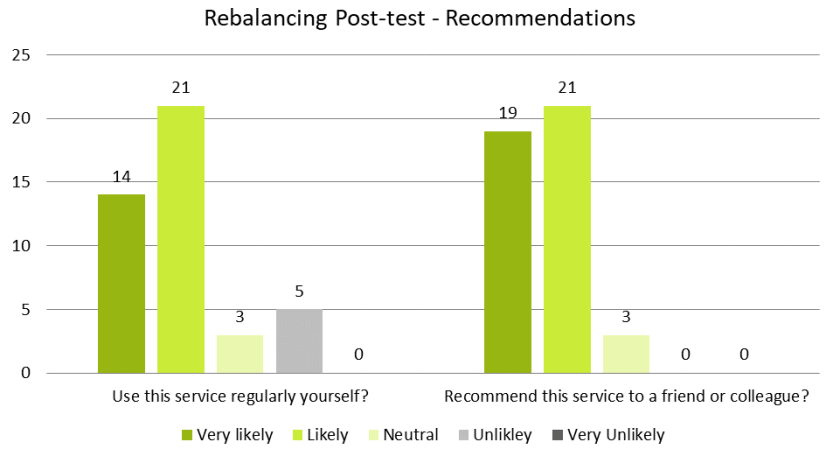
- Only 3 participants thought that the service would decrease their overall number of trips
- 7 participants thought that the service would increase their private car use
- Over half of participants did not think the service would change their walking/ cycling
- Only 4 participants thought that the service would increase their public transport use
- 12 participants thought that the service would increase their taxi use
- 18 participants thought this service would decrease their taxi use
- 14 participants did not think the service would change their taxi use
- No participants thought that the service would decrease their traffic safety
- Only 1 participant thought that the service would decrease safety of pedestrians



- The majority of participants felt that the system would be beneficial for all trip types
- The greatest number of participants who felt this system would be very beneficial was for short distance trips
- Only one participant felt that this service would not be at all beneficial for all trip types
- The highest number of neutral participants was regarding non-commuting trips

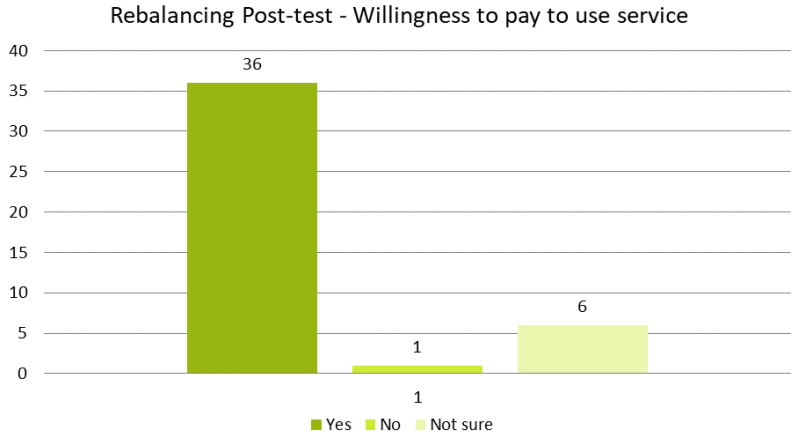
4.6.2 Interest in service

Participants were asked how likely they would use the service or recommend to a friend. This was ranked from Very likely to Very unlikely, with Neutral as a central choice.



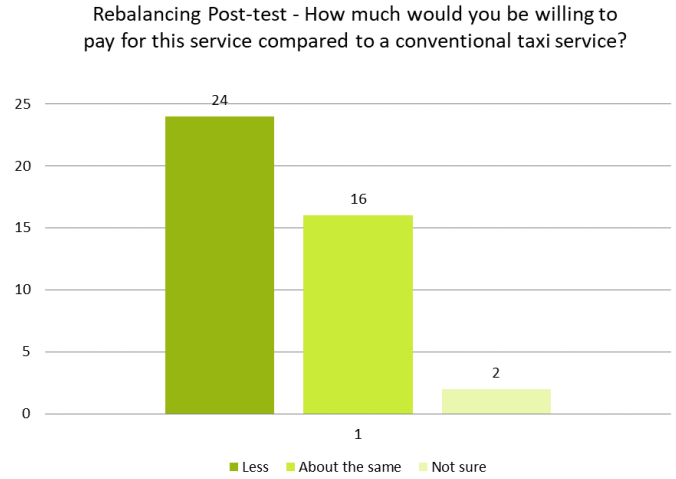
- The majority of participants would use the service regularly and recommend this service
- 32% and 45% of participants were very likely to use this service and recommend it to friends or colleague, respectively
- About half of participants were likely to use this service and recommend it to others
- No participants were very unlikely to use this service and recommend it

The participants were asked if they would be willing to pay for the service.



- 84% of participants would be willing to pay for this service
- Only one participant would not pay to use this service
- Six participants were not sure if they would pay for this service

The participants were asked how much they would be willing to pay for this service compared to a conventional taxi service.



- Two participants were not sure if they would pay for this service
- The majority of participants (58%) would pay for this service when the price was less than the conventional taxi service
- About half of participants would pay for this service when the price was about the same with the conventional taxi service

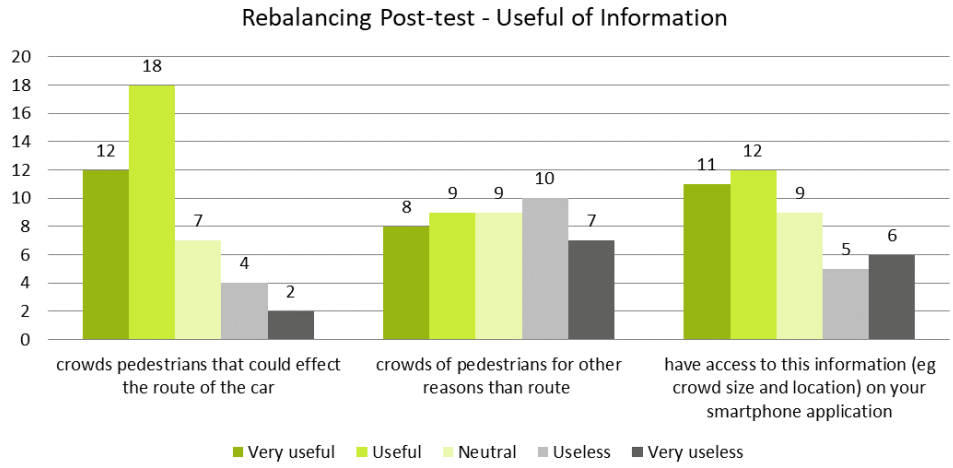
Reasons for using/recommending service:

No need for own car, just at specific times. I could get rid of my car. It makes you consider better whether it's rreaally necessary to go somewhere by car. Positive forr the environment.
I'd certainly use this service if it's near faultless and I don't loose any time driving myself.
When one gets older this service will be good as an alternative for taxis.
Resp. (?) Lease car – convenient, safe, environmentally friendly service
Safe and relatively relaxed way of travelling
I'm convinced of the usefulness of these systems. Their reliability remains to be proven.
It seems inevitable in the future
Go on a trip relaxedly and use the time in the car for important business.
In certain cases it's a comfortable way of getting from a to b.
I enjoy driving myself and am a sporting-style driver. Driving is no burden for me.
I think the service will be expensive, and as a student I'll not be a standard user, although it might be convenient to use the car as designated sober driver.
I am a student in a small city where mostly a bike works well for transportation
It's been well thought out and simple to come into use
Experience, and you can use travelling time well because you don't have to pay attention
Personally rather drive my bicycle than another transport. if I had to make short trips through busy cities , I'd consider it more
I expect in the beginning to really enjoy travelling in a self-driving car because it's a novelty. For short distances I'm happy with a bicycle. I enjoy driving myself so not all my trips would be with a self-driving car. On longer drives it would be extra good to be able to focus your attention on other things than traffic. In the case of commuting it would be good to be able to indicate what time you want a car in advance in stead of only when you're really already wanting to leave.
Mainly a financial question of how expensive it would be as well as the environmental concern of reducing car usage (even electric cars use more energy and create more micro particles than biking)
If there'd be one on campus it would probably be occupied all the time, and I'd sooner take the bicycle or walk. Otherwise I'd certainly use this now and then.
As extra for commuting or after a night on the town. If I'm going on a nice weekend drive I prefer my sports car.
Parking is becoming ever harder and more expensive. Better than public transport. More privacy when

you're alone in the car.
It's a safe and especially relaxed way of driving. The 'stress' of having to pay attention to traffic largely disappears.
Since automatic driving is a revolutionary concept and has associated risks, i would like everyone to question and learn About its background before trying it rather than me recommending it.
It has the advatages of a shared car, and still the convenience of your own car before your door.
Het is makkelijk
I like to drive myself. Thus said, for leisure I would prefer to be the driver and have AI assistance rather than have the car do most of the work. That said, for anything but leisure, the service is relaxing, safe and seems that if it is, adopted at a grand level, very efficient as the slow human communication services (horns, light etc) won't slow down traffic. As a taxi service, it seems to be cheaper overall and provide a safer and relaxing experience.
We own only one car but feel the need for more now and then.
Convenient if you don't have a car yourself and travelling by public transport is not always possible timewise.
It's ideal for relatively short trips that are yet a bit too long for cycling. Public transport is always a bit of a nuisance.
Cheaper and more convenient than a taxi. Better for the number of cars on the market as well.
If I start using the system I'm convinced I will let others know and recommend it if I like it.
No more busses or taxi to go to the town centre. Parking problems largely solved this way as well.
If the system is safe and reliable I'll certainly use and recommend it. Because it will in general be cheeaper, safer and more environmentally friendly.
We own two cars but one could well go if there'd be a good sharing service. That would have to be quickly available and very reliable
This service would allow me to work during the ride as on a train, but it's faster and brings me nearer to my destination.
Very much depending on the costs, as I am a student that lives by the center and have a bike. In case that my bike breaks down like this morning, if cheap I would very much like to use this service, but I would not use it regularly.
I often need to maximize my time to work, especially when going to a meeting or conference. When taking a taxi, I feel kind of forced to interact with the taxi driver and not to focus on preparing my meeting. I would therefore benefit of an autonomous vehicle. I am also commuting once a month and the road is basically a long boring highway for 300km. That could definitely be done with an autonomous vehicle, even though I would not necessarily trust the car at a high speed
Practical, accessible
Gaining time
Especially for elderly people I'll recommend this system when it's driving. Concerning hiring a car to drive yourself it's very conveenient when you don't have one yourself but do want to go places thaat arre not well served by public transport, e.g. when I'd visit someone abroad or the other way arround.
Travelling safely at times of own cchoice. Easier transporting of luggage and shopping
I use car-sharing a lot, and then I always have to collect the car myself first. No need for that anymore.
It would be an alternative for my own car, but not for the bicycle or public transport. I prefer the bicycle for exercise.
Makes me feel safe

4.6.3 Usefulness of Information during Service

Participants were asked about the usefulness of various aspects of information that could be provided through the service. These were ranked from Very useful to Very useless, with Neutral as a central choice.



- 70% of participants thought that the information on crowds of pedestrians that could affect the route of the car was useful or very useful
- Around half of participants thought that the information on crowds of pedestrians for other reasons and having access to the information would be useful
- Nearly half of participants did not think that crowd information for other reasons was useful.

Other information that participants would like to see are[3]:

For the app Weather conditions influencing the road. Time indication: time the ride will take, delay for the arrival of the car once you order it.
One depends on the waiting time in question 3. If you're not in a hurry waiting is not a problem.
Feedback in app about arrival times of the shared car
To be able to give in, e.g., a week planning with dates, times and locations. Makes a difference in waiting times. More efficient. Expected times of arrival.
Possibly expected time of arrival on reservation
Maybe in the future an account of the cost of a call
The app give more clear images of e.g. persons, dogs, etc.
Supply feedback on the cras actions. Why does it brake/speed up
Possibility to take into account students who might want to use the service as a replacement of the designated sober driver. Be aware then of possible vandalism and other damage by drunk users
Indicate what time the car will be readdy forr you
Combination of rides with others
Have settings to care about such functionality and ability to change the route in real time
The meaning of the rectangle in front of the car was not clear, nor was the change of colour
Have a good look at how Uber and Zeenly are doing this. Make it nicely coloured.
A sign on the car indicating it's for me.
I'd like better feedback on having requested a ride and the way the app is dealing with that.
The application can be more user friendly.
Expected time of arrival may be more useful information than expected route of travel
Probably too early at this stage, but providing some sort of social interaction in the car would be a great way to improve the user experience. An assistant such as Alexa could converse with the user, provide information during and about the ride. Options to manually modify the route if possible could extend the service to better fit tourists or car pooling.
If all traffic should be shown smartphone screens will be too small. Look into Google glasses or other

[3] Translated from dutch

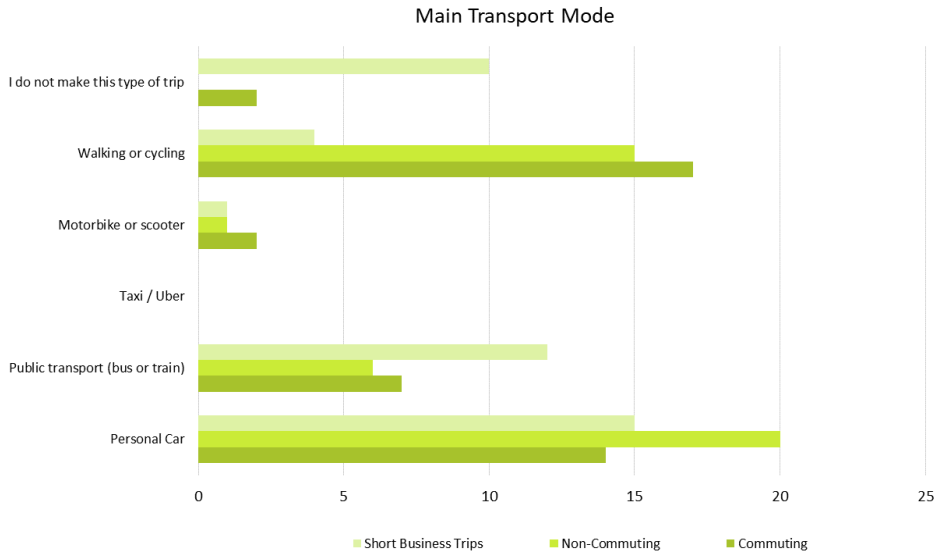
options?
I get why it's useful for the car to know where the traffic is congested, but for a user like me that infromation isn't directly relevant.
Time of travel when the car comes to collect you. I'd focus on the pracctical safety aspects, and not so much on the feeling people get from the app.
Arrival time, walking back, so relevant.
Indicate why a certain route is chosen automartically. At the moment one can, using navigation, decide wich route to choose.
Maybe it's still to be implemented in the system, but the car should really not start before driver and passengers have fastened their safety belt. Indication of direction should be incorporated in the system as well.
I'd like to know which route the vehicle is taking and why. But especially I'd wantt to know about the ETA
Show the route of the car in te app when the car is on its way and expected time of arrival in case of a delay.
Visible on the app: time until car arrives. If the car is empty and the potential route it needs to drop off other passengers first. The square in front of the car is not useful for the final app. Please do something about the photos on the map... use icons or smtn instead if you really want it. For the sale strategy you can add two ‘classes’ like through the security on the airport, where the first priority is more expensive?
Crowd is something I never thought about and don’t necessarily consider useful because I have been driving daily for 14 years now and almost never encounter the case of a crowd slowing me down or having any consequences
Indicate waiting time an a price indication, and that pedestrians have been detected while driving, and the route being driven.
ETA information, information to enable recognizing the vehicle, battery or fuel supply of the vehicle
Indicate time of arrival
I don't need all this information, as long as the car has it

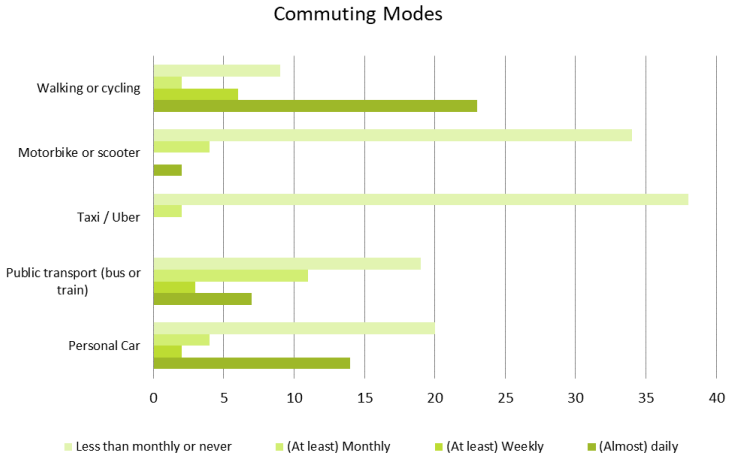
5 Background

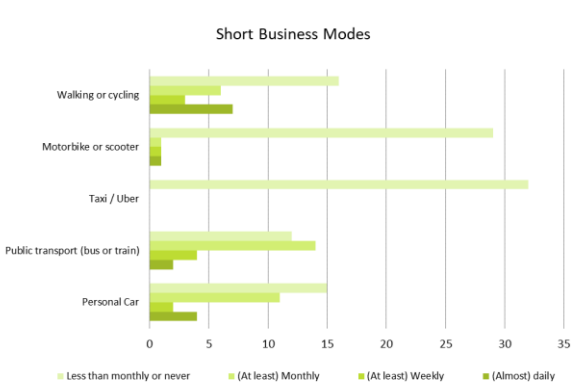
Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

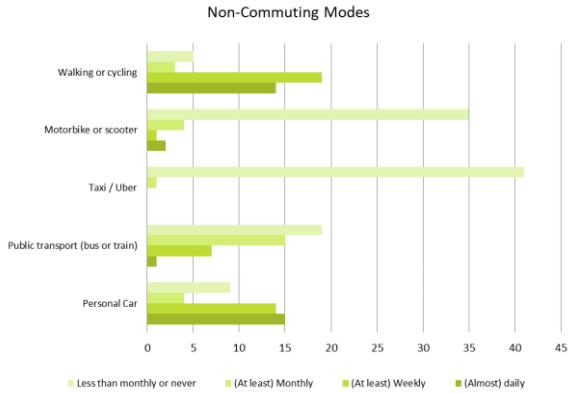
5.1 Travel Habits

Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.





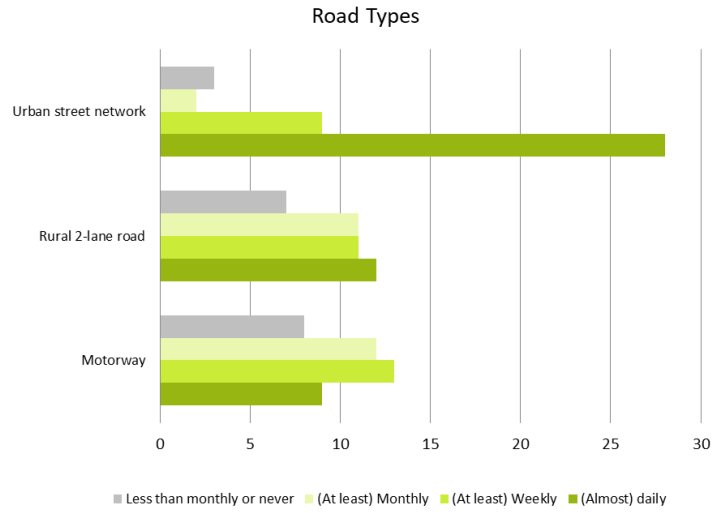




- A small number of participants do not make commuting or short business trips
- Over one-third of participants use personal car as their main transport mode for all trip types
- About half of participants use personal car as their main mode for non-commuting trips
- No participants use taxi/uber as their main mode for any trip type
- Small numbers of participants use public transport as their main mode, most commonly for short business trips
- Two participants use scooter/motorbike as their main mode for commuting

- Only one participant uses scooter/motorbike as their main mode for short business and non-commuting trips
- Over one-third of participants use waking or cycling as their main mode for commuting and non-commuting trips

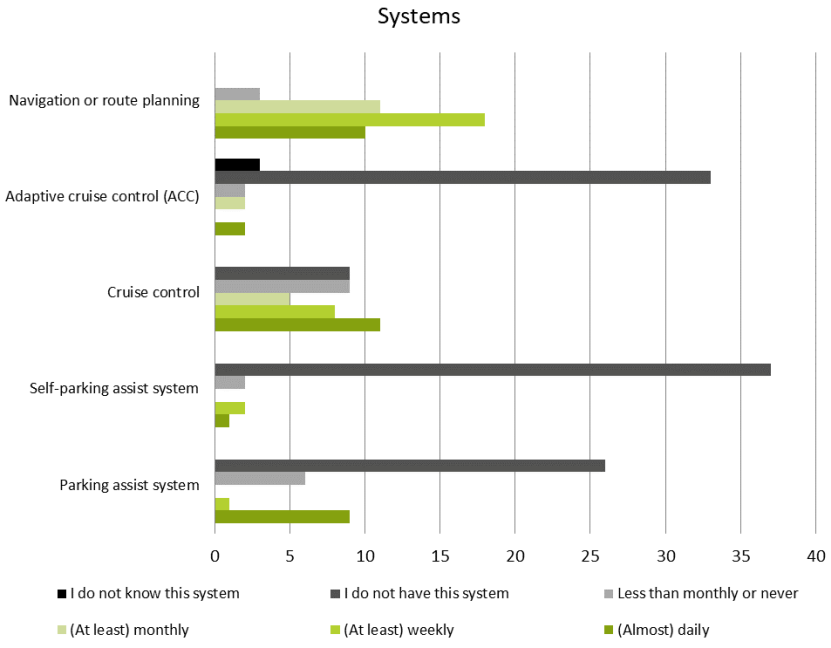
Participants were asked how often they drove on different road types.



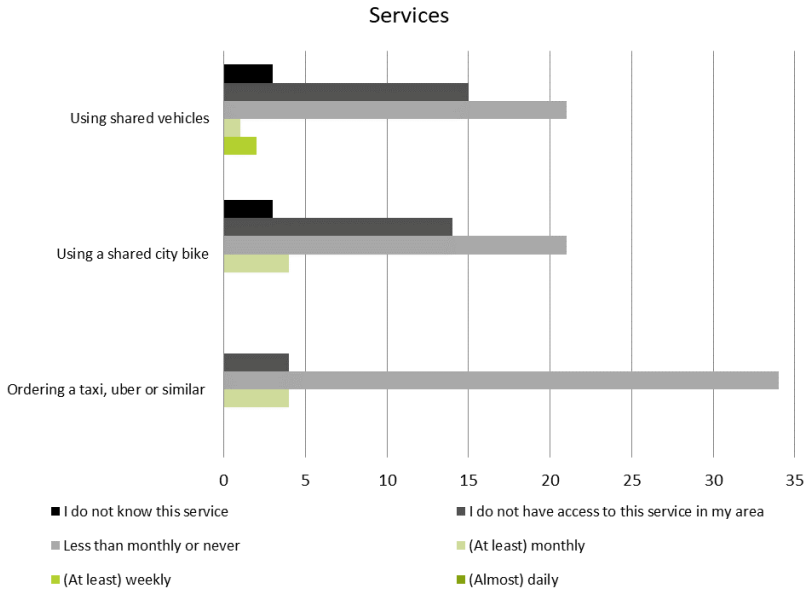
- Over two-thirds of participants drive on urban network almost daily
- Only a small number of participants drive on urban network at least monthly and less than monthly
- The same number of participants drive on rural networks at least weekly and at least monthly
- The majority of participants drive on motorways at least weekly

5.2 System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



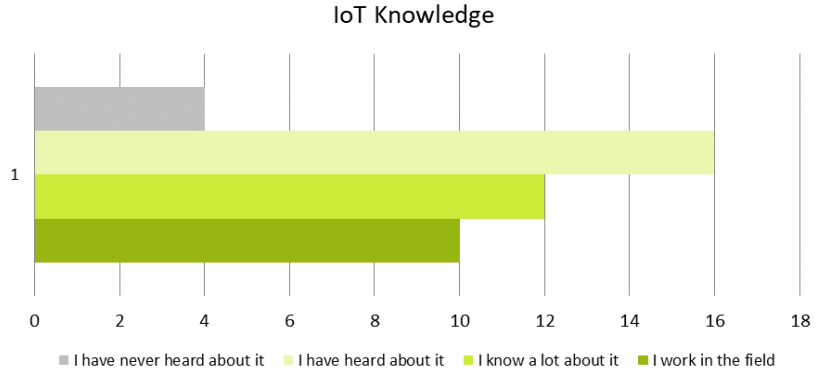
- All participants have heard of all system types except from one who does not know ACC.
- Over half of participants do not have ACC (79%), self-parking (88%)or parking assist systems (60%)
- Over two-thirds of participants (79%) have cruise control
- All participants have a navigation system
- Over half of participants with parking assist use it almost daily whereas the rest use it rarely
- The majority of participants with cruise control use it at least monthly with many of those using it daily
- Only a few of participants with navigation system use it less than monthly



- Almost half of participants do not have access (or know of) shared bikes or cars
- The majority of those who do have access and knowledge of these services use them less than monthly or never.

5.3 IoT Knowledge

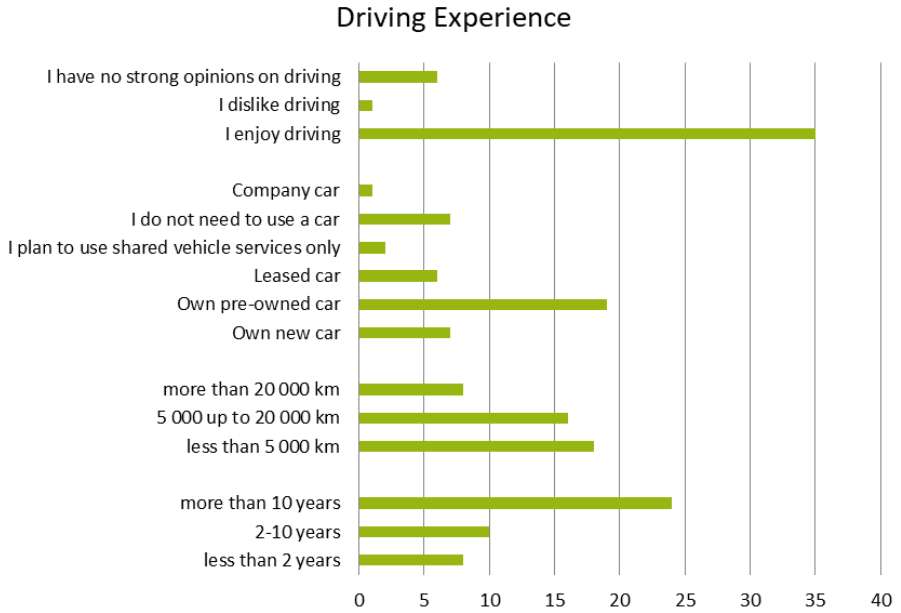
Participants were asked how aware they were of Internet of Things.



- Nearly half of participants (47%) have either not heard or know little about IoT
-

5.4 Driving Experience

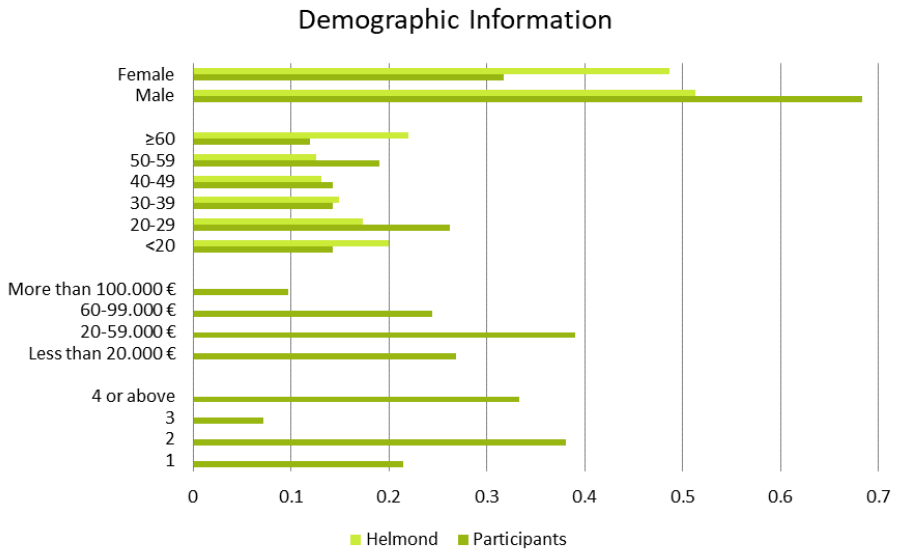
Participants were asked about their attitude and experience towards driving.



- The majority of participants (84%) enjoy driving, and only one participant dislikes driving
- Nearly half of participants (44%) plan to buy a pre-owned car
- About the same number of participants drive between 5 and 20 km and less than 5 km a year
- More than half of participants(58%) have been driving for more than 10 years

5.5 Demographic Information

Participants were asked about their background to establish representation of the test group.[4]



- The percentage of female participants was lower than the Eindhoven region
- The 20-29 and 50-59 age groups were over-represented
- The ≤60 age group was under-represented

[4] https://www.citypopulation.de/php/netherlands-admin.php?adm2id=0772

Livorno Highway Pilot

1 Background

The Highway Pilot Public Multimedia Demonstration took place the 19th October 2018 at the Port of Livorno, Italy. It was a part of a public event organized by the pilot site project partners to demonstrate the use cases Urban Driving and Highway Pilot to experts and general public.
Twelve (12) participants filled out the questionnaire after they have received a Multimedia (Video) Demonstration of the Highway Pilot use case in Livorno. The small number of participants is due to the fact that the public event was originally planned to be only first test of the questionnaire and other materials for user evaluation. As due to technical and organizational issues, the user acceptance evaluation activities had to be postponed, this report is based only on the user evaluation activities from the public event.

2 Test Protocol

Introductory presentations were given in Italian beside the video demonstration also in Italian. Questionnaires were available in English and Italian, the preferred language was, however, Italian. Most of the questionnaires were filled out on paper; three were carried out on an ipad by the participants, through the online survey tool, 'LamaPoll'.

3 Results

3.1 Pre-Test Expectations

Since the demonstration was only using Multimedia and the survey was originally planned to be only carried out as a pre-test, no Pre-Test Questionnaire were used.

3.2 Post-Test Reactions

First, the participants were asked about their motivation to take part of the public event.

Motivation:
Curiosity
Interest
Collect information about automated driving / tests
A possible future
...

After that, participants were asked to rate how they found the demonstration and the usefulness of the service between two extremes rated 1 to 5 (e.g., Positive = 1, Negative = 5; 6 = Don´t know), in five areas. *Note that the scale is different than other pilot sites (1 to 5 instead of -2 to 2); if needed, the data can be recoded. Also: due to the small number of participants (n=12), no mean and SD are provided.*

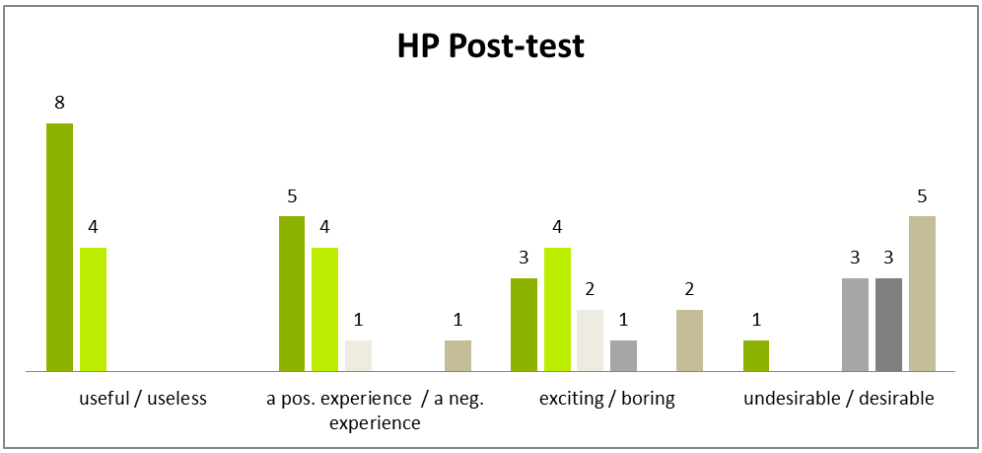


Figure 1: How participants felt about the test and usefulness of the service

- All participants evaluated the system as useful
- The anticipated (potential) experience of using the service was positive
- The answers regarding the evaluation of the system in terms of exciting or boring were heterogeneous with a trend that more participants evaluated it as rather exciting
- Regarding the desirability of the system, six out of the twelve participants evaluated it as rather desirable; five didn´t or couldn´t evaluate it (="don´t know")

At the other pilot sites, the systems were evaluated in terms of 'usefulness' and 'satisfaction' using the Van der Laan scale.[1] Again, due to the low number of participants in Livorno and as only selected items were used, the evaluation along these two aspects was not possible.

Initial Post-Test Reactions[2]

After the demonstration, the participants were asked to state their first impressions about the demonstrated system.

First impressions:
Good
Complex, but fascinating at the same time
Intelligent and well-coordinated
...

3.3 Post-Test Thoughs on Future Use

Participants were asked to comment on how they might use the service if it was available.

3.3.1 Interest in service

The participants were asked if they would be willing to use for the system if available.

[1]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

[2] Translated from Italian

Asked about whether they would use the demonstrated system, ten out of the twelve participants stated that they would use it; two reported that they don´t know whether they would use it.

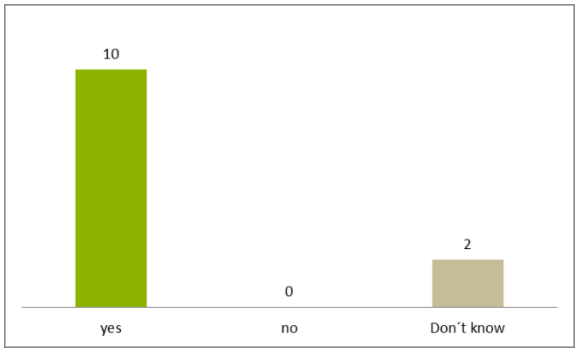


Figure 2: Interest of the participants for using the system

- Ten out of the twelve participants stated that they would use the system
- Two of the participants reported that they don´t know whether they would use it or not

The participants were asked if they would be willing to pay extra for the system when buying a new car.

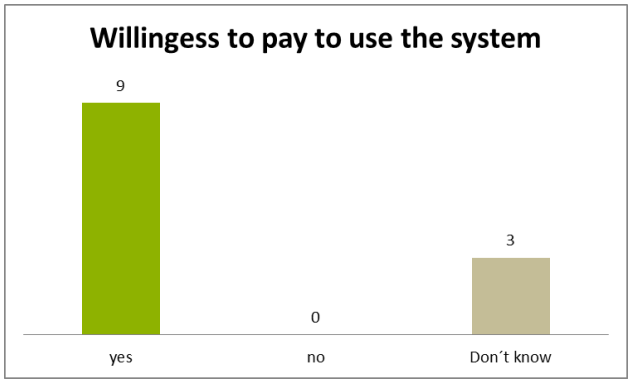


Figure 3: Willingness to pay extra for the system

- 9 out of the 12 participants stated that they would be willing to pay extra for the system when buying a new car
- 3 participants were not sure whether they would like to pay or not for the system

3.3.2 Behaviour Change

Participants were asked how the service might affect their usual travels. This included (i) how car use and traffic safety would change (ranked between 1 and 5; *note that evaluation on other pilot sites is between -2 and 2; scale can be recoded if needed*), (ii) whether they would change their mode choices, and (iii) how beneficial it may be to categorized trips. The latter ones were ranked from 1 = Very beneficial to 5 = Not at all beneficial, with neutral as a central choice.

The anticipated changes in (i) car use and perceived traffic safety were evaluated, as mentioned above, on a 9-Point-Scale. Figure 3 presents the average values, although we recommend using the

descriptive reporting below the Figure when interpreting the results as the small number of participants (n=12) makes it difficult interpreting average values in a meaningful way. The evaluation was, however, overall in a positive direction.

- Regarding the number of trips and car use, 4 out of the 12 participants have chosen the middle of the scale which indicated that this one third of the participants do not expect any changes regarding the mentioned aspects; 6 out of the 12 participants stated to expect increase in number of trips, and only 3 to 4 expect changing their car use
- Most of the participants (8 to 10) expect improvements in overall safety in traffic and for pedestrians and cyclists; 1-2 stated expecting rather decrease in safety and 3 were not sure about the impact of the system on traffic safety
- 10 out of 12 expect an increase in comfort while 1 stated that comfort will potentially decrease and 1 were not sure about the effect of the system on comfort
- Regarding effect of stress while driving due to the system, the half of the participants expect that stress will decrease when using the system; two stated it will increase, two were in middle and another 2 were not sure about the effect

After that, the participants were asked whether they would change their (ii) travel mode usage if the system was available.

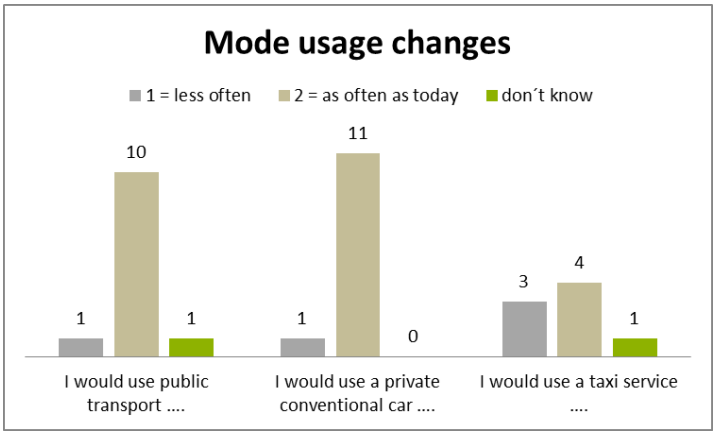


Figure 5: Anticipated changes in mode usage

- All but 1 to 2 participants stated that they don´t expect any changes in the use of public transport or private car use; this is somehow contradicted to the statements on the previous question where the number of people who stated that the system will increase their car use was higher; one possible explanations is that this question refers to the use of conventional car while the previous one was about a car use in general with availability of the system
- Regarding potential use of taxi services, the answers were more heterogeneous – here four answers were missing; 3 out of the rest 8 can imagine using taxi less often and 4 as often as today

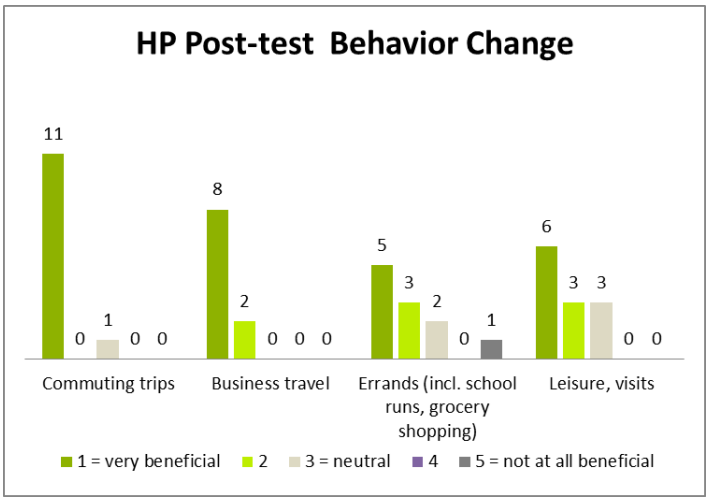


Figure 6: Anticipated benefits for certain trip purposes

- The majority of participants felt that the system would be beneficial for all trip types, especially for commuting and business trips

3.3.3 Importance of Information and features during usage of the System

Participants were asked about the importance of various aspects of information that could be provided through the system. These were ranked from 1 = Very Important to 5 = Very Unimportant, with 3 = Neutral as a central choice.

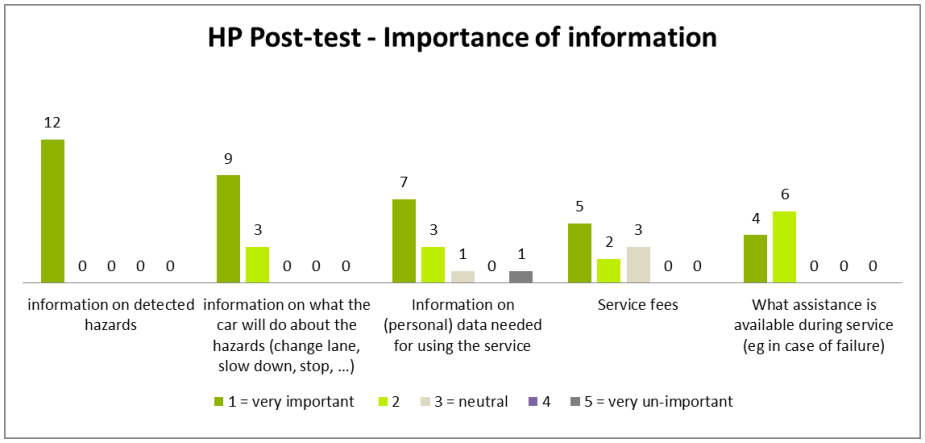


Figure 7: Importance of types of information

- No participants thought that any type of information were unimportant, except of one person who stated that information on personal data would be very unimportant
- All 12 participants found one of the main feature of the system – providing information on detected hazards – as very important
- 7 to 9 participants found also information about what the car will do about the hazards as well as personal data needed for using the service as very important
- Information about service fees and what assistance is available during service use were both rated only by 4 to 5 participants as very important one

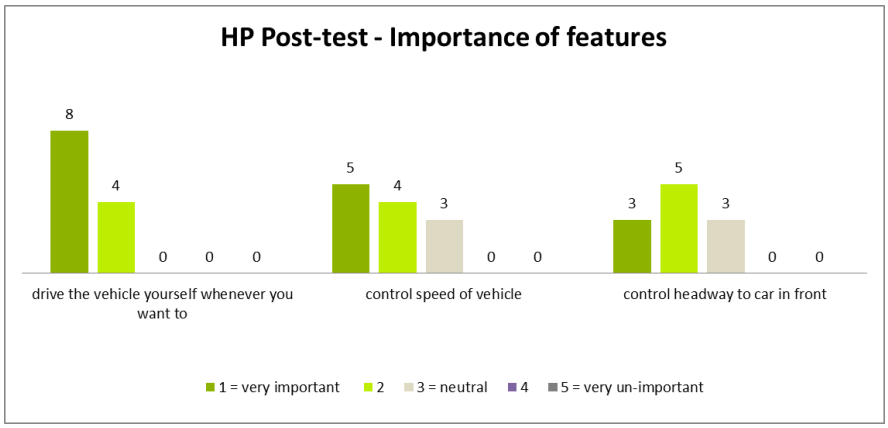


Figure 8: Importance of features of the system

- All participants rated the option to drive the vehicle by oneself whenever one want to as (very) important
- The option to control speed of the vehicle was found to be (very) important by 9 out of the 12 participants; 3 were neutral about it
- The option to control headway to car in front was rated only by 3 participants as very important; 5 found it (somehow) important, and 3 chose "neutral"

3.3.4 Concerns whilst using service

Participants were asked to comment on their concerns regarding various aspects of the service. They were ranked from 1 = Not at all concerned / 3 = Neutral to 5 = Very concerned.

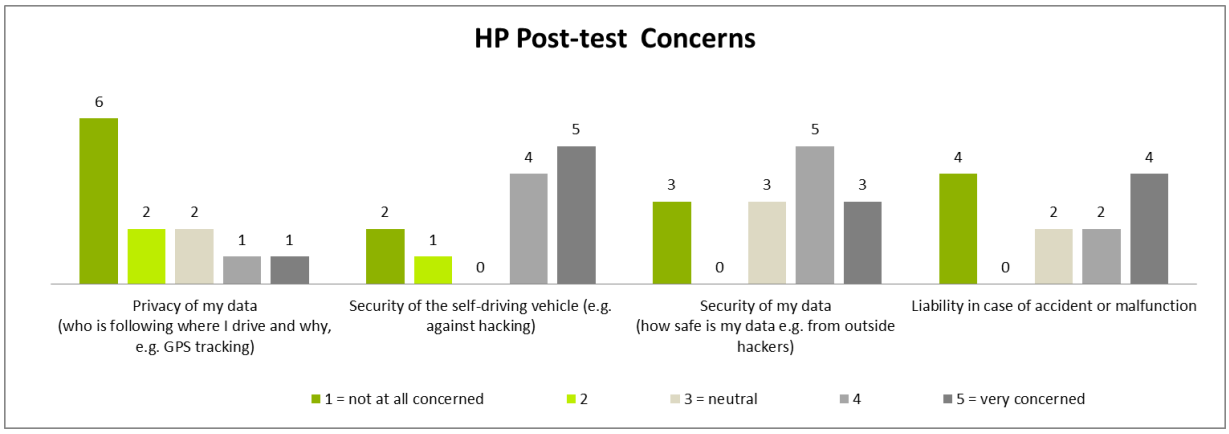


Figure 9: Concerns related to usage of the system

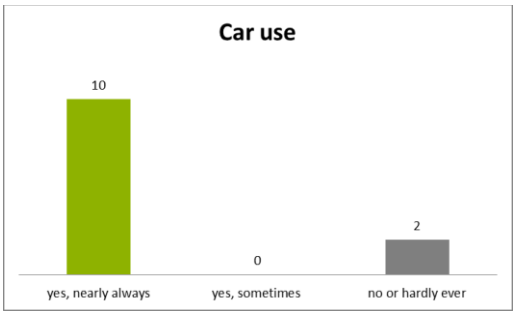
- There were concerns about security of the self-driving vehicle, security of the own data, and liability in case of accident or malfunction; regarding the liability, however, also 4 out of the 12 participants stated not to be concerned regarding this aspect at all
- Less concerns (or not concerned at all) are 10 out of 12 participants regarding privacy of their data in terms of who is following where they drive and why, e.g. GPS tracking

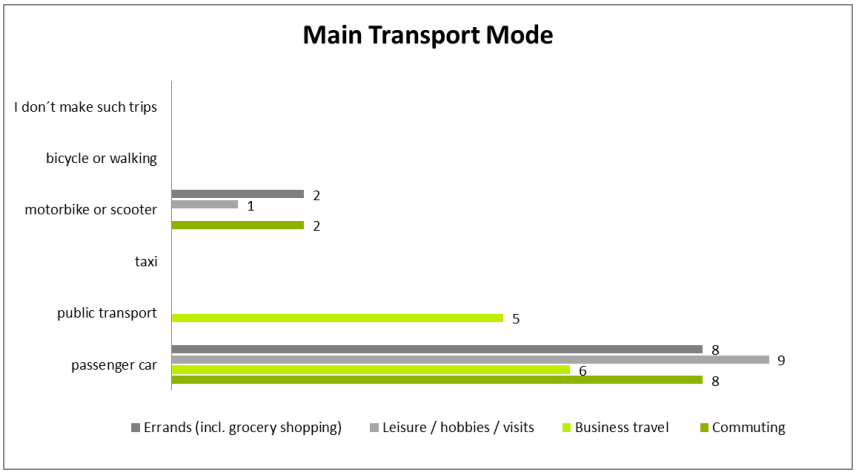
4 Background

Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

4.1 Travel Habits

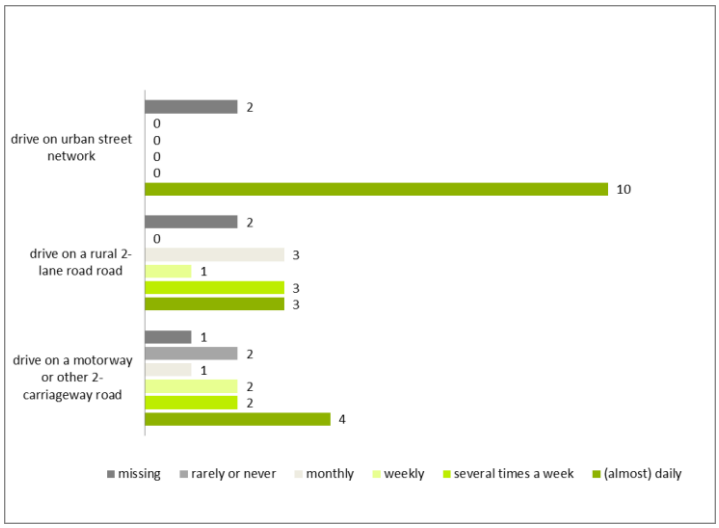
Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.





- All participants but 2 uses a car nearly always
- The high share of car users is reflected also in the distribution of main transport modes used for different trip purposes – here, the car is used by most of the participants for all trip purposes
- Public transport is used by 5 participants for business trips
- Motorbike or a scooter is the preferred mode by 2 participants for commuting or running errands; one participant stated to use one of these modes on leisure trips

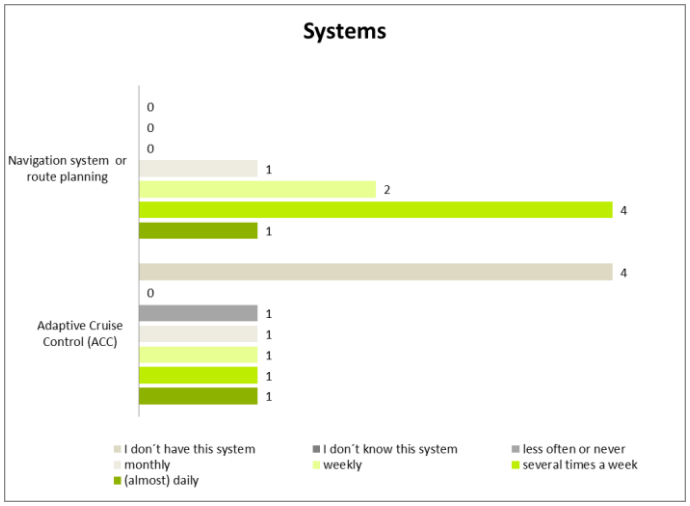
Participants were asked how often they drove on different road types.



- All but 2 of the participants drive on urban and rural networks (almost) daily
- Half of the participants stated to drive on rural 2-lane roads (almost) daily or several times a week
- Also, half of the participants drive at least weekly on motorways; 4 of them even (almost) everyday while 3 stated to use a motorways monthly or nearly never

4.2 System and Service Acceptance

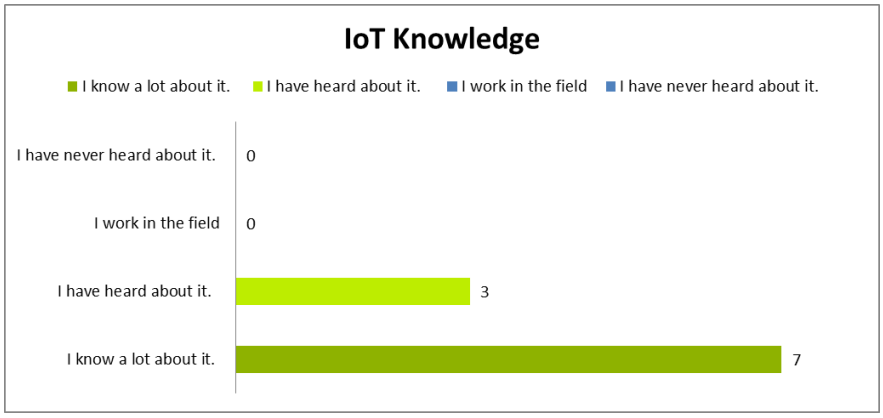
Participants were asked how often they used advanced driving systems and shared mobility services.



- All participants have heard of all system types
- Navigation system or route planning is used at least weekly by 7 out of the 12 participants; 4 use it several time a week and 1 even daily
- Regarding ACC, the usage seems to all over the frequency scale – here, 4 participants stated that they don´t have this system in their cars and 5 reported to use it very differently ranging from never to daily (1 person per frequency category)

4.3 IoT Knowledge

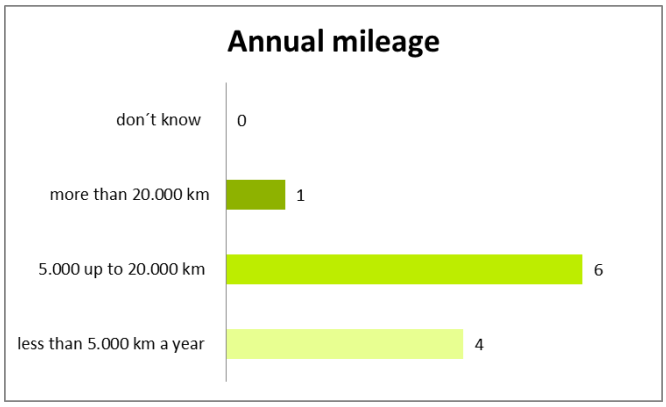
Participants were asked how aware they were of Internet of Things.



- All participants were familiar with the concept of IoT – 7 stated to know a lot about it and 3 to have at least heard about IoT

4.4 Driving Experience

Participants were asked about their attitude and experience towards driving.



- As indicated above, all participants are car drivers – the half of them drive 5.000 to 20.000 km a year and 4 stated to drive less than 5.000 km a year

4.5 Demographic Information

Participants were asked about their background to establish representation of the test group.

- 7 of the participants were Men, 2 Women and for 3 the data is missing
- The age range from 29 to 64 with an average age of 48 years old (although, again, the small sample does not allow interpreting average values in a meaningful way)
- The half of the participants were over 50 years old; only 2 were under 35

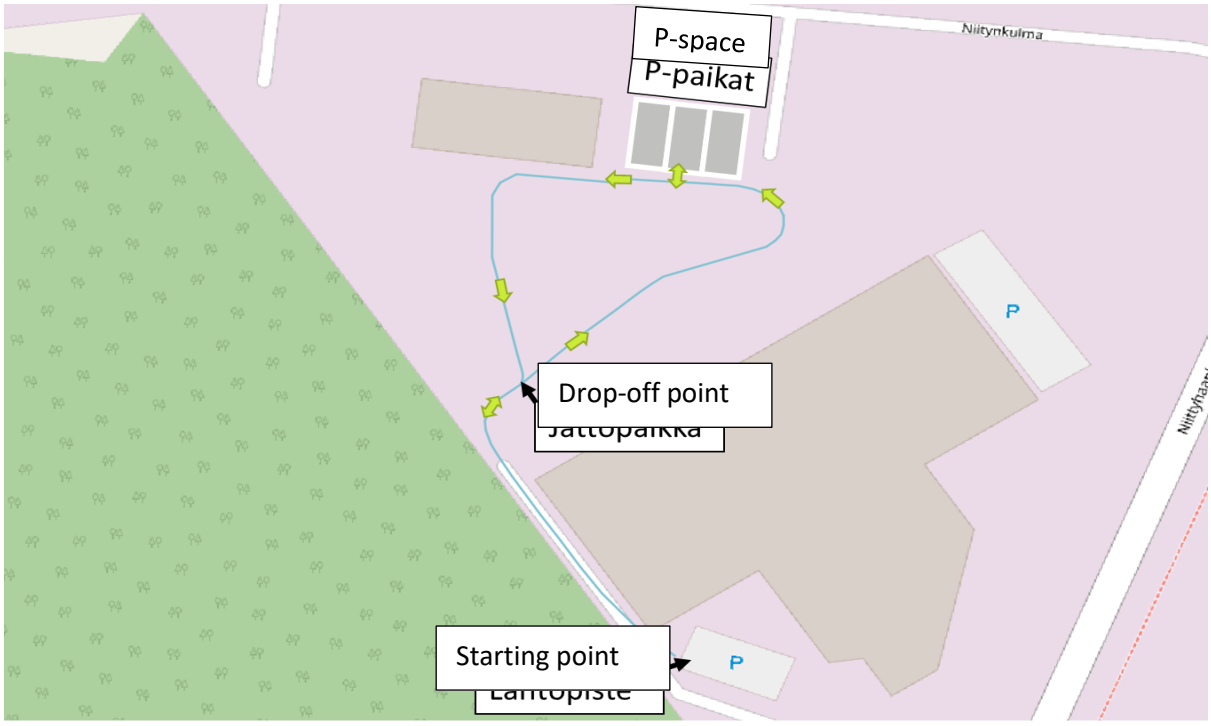
Tampere AVP

1 Background

The Tampere AVP user testing took place in October 2019 (8th, 10th, 12th, 18th, 22nd and 26th) at VTT's facilities in Tampere, FI. Twentynine (29) participants took part, recruited through an external company (Testaamo). The tests took place in groups of 2 to 3 participants.

2 Test Protocol

Introductory presentations were given in Finnish. Description of the technology and test were also carried out in Finnish. After the briefing the participants filled out the pre-test questionnaire. Then the actual test was carried out on the parking place outside. The test route was driven three times to allow each participant to sit in the front seat.



After the test the participants filled out the post-test and background questionnaires. Questionnaires were in Finnish and carried out on portable computers by the participants, through the online survey tool, 'Limesurvey'.

3 Technical problems

There was some minor technical problems (positioning) but at least one of the three test rounds were successful for all test groups.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 5 point scale. This was rated 2 to -2 (eg Positive = 2, Negative = -2).

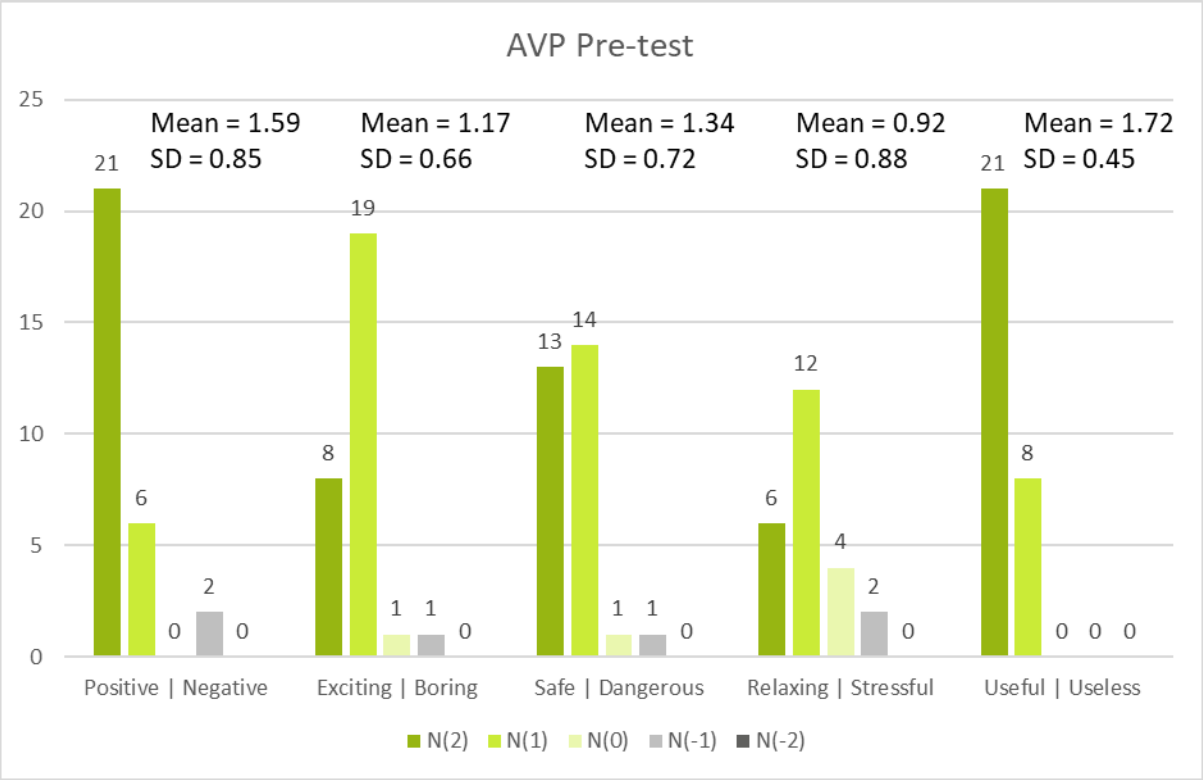


Figure 1: Participants expectations on the test and usefulness of the service

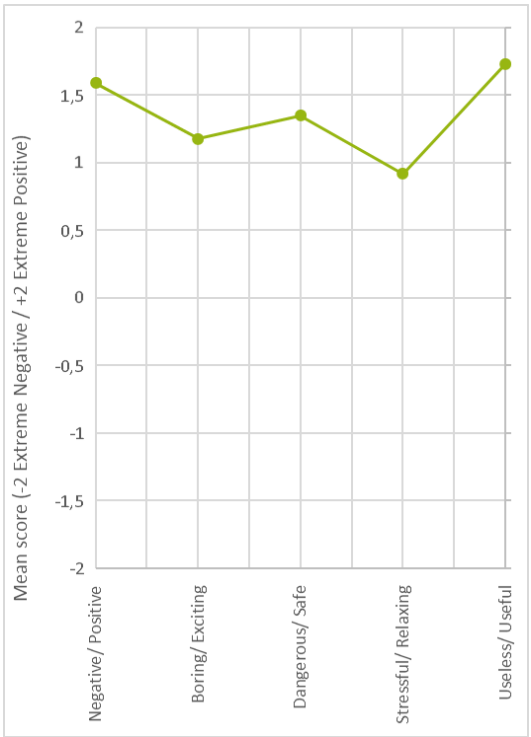


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service.

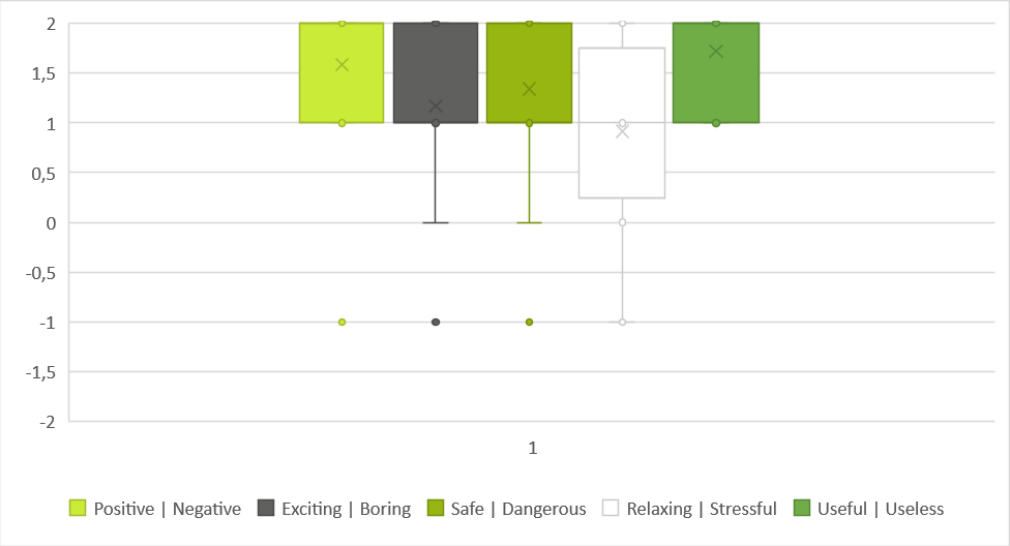


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- One to two participants thought that the experience would be negative, boring, dangerous or stressful
- Four participants were neutral about how stressful the experience would be and one were neutral about how boring and dangerous it would be
- The least positive expectation was around how relaxing the experience would be
- The most positive expectation was around how useful the system would be
- The greatest variation across all participants was about how relaxing or stressful the experience would be

Motivation for taking part in the study[1]

- I am interested in new things and services. I also like to try new services and technologies before other people. It is great to see the development of products and services before they are ready.
- Really interesting to get to try and see the function of an automated vehicle.
- Interesting topic that I don't have personal experience of. Useful addition to driving.
- Interested in new technology
- Opportunity to follow the development and be aware of the future
- Interesting test. Time is available.
- It is great after all to participate in this kind of pioneer test. Experience new and fascinating things.
- New experiences and understanding of new technology
- Interesting, I like Testaamo's tests
- Curious about the test results, glad to be involved with future outlooks
- Technological developments interests me. I want to see how the world develops.
- Automotive technology and especially the new technologies in autonomous driving

[1] Translated from Finnish

- I am interested in IoT and automated driving. I also studying a field that touches the subject.
- The topic sounds really interesting and the future outlook seems good in my opinion
- New technology is always of interest and now cruise control functions are on an interesting level.
- I am interested in the development of cars and especially the operating systems of on-board computers. At the moment the on-board computers are quite confusing and as I understand it there are no standardised operating systems. I am interested in the development of electric cars and new innovations in travelling and transport that can reduce the carbon footprint. The use of electric vehicles in freight transport are of special interest to me.
- Automation and robotics are of personal interest to me and car applications are meaningful and important topics from a societal perspective.
- Interest in new technologies
- Technological development are of interest
- I am interested in the automation of driving. In my current car I have lane control and and automatically responsive speed control. I am a user of public transport, motorist and driver.
- I drive a lot and I have to park in many different places
- The topic is of interest and I do not have any experience of it.
- I want to know and see how safe it is to be in the ride while a robot is steering and parking since it is sometimes really hard for myself so nice to see when a robot is handling it
- Future innovations are of interest
- Future vehicle technologies are of interest
- I am interested in driving and new technologies plus the movie ticket compensation
- Out of interest in new technologies and automation in general. The subject is also interesting for my studies.
- Interesting in all new things and as a professional driver you can think a little about the future
- All new things are interesting

Other pre-test comments and expectations[2]

- I am looking forward to the test and I hope to participate also in the future testing.
- It is great that these kind of tests are organised and that I got to be a part of the test team :)
- More like this
- Interesting to see what kind of service has been developed
- Hopefully the service works well and that it will soon be available for public use!
- Interested to see what that car looks like at the moment
- Interesting to see where the research goes compared to the solutions on the market
- Getting new knowledge and experience about the movement of the car and how you can be in the ride while it is moving and parking
- Let's hope that the test and test persons are useful and have an impact on the properties of the final product
- I expect everything to go well

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -2 to 2(eg Positive = 2, Negative = -2), in five areas. The same categories were used as in the Pre-Test.

[2] Translated from Finnish

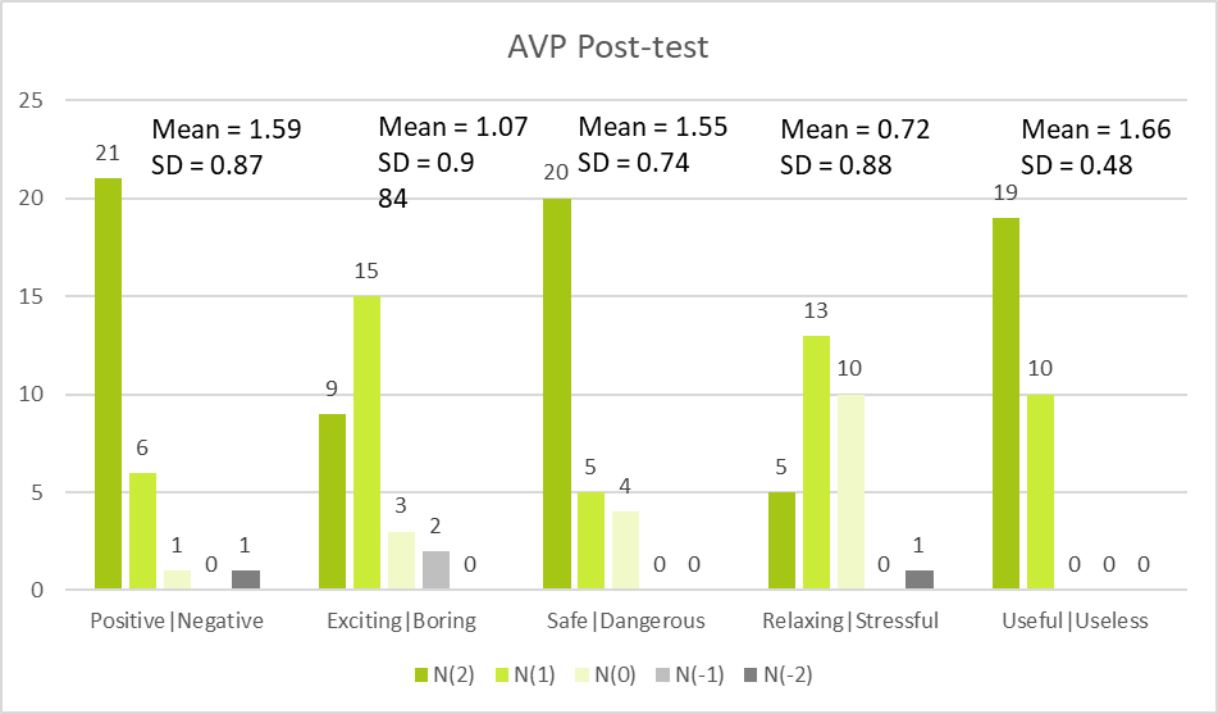


Figure 4: How participants felt about the test and usefulness of the service

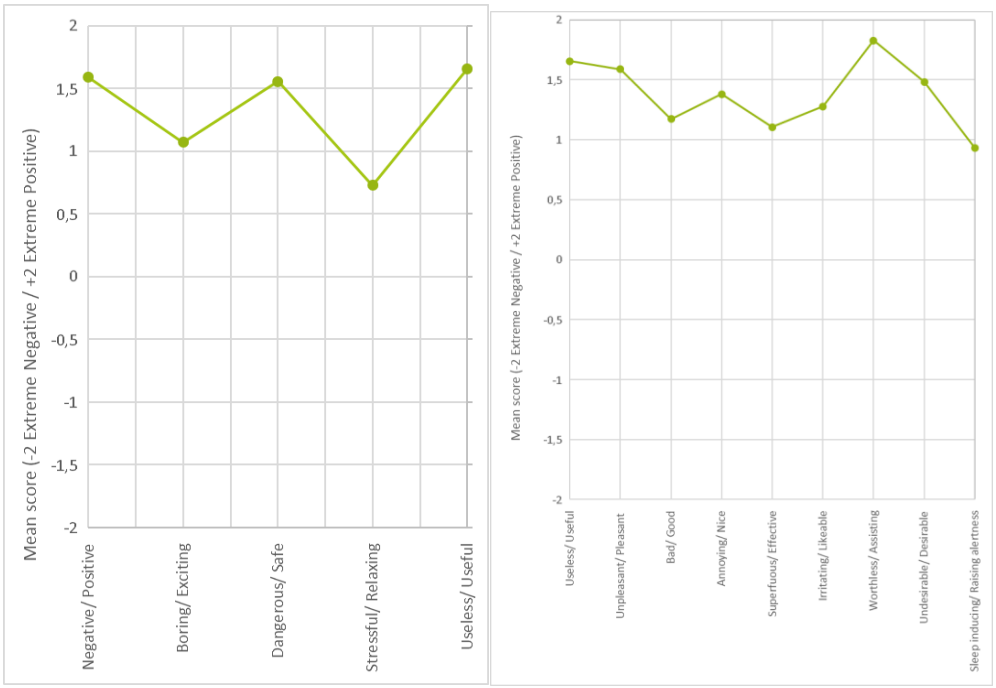


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

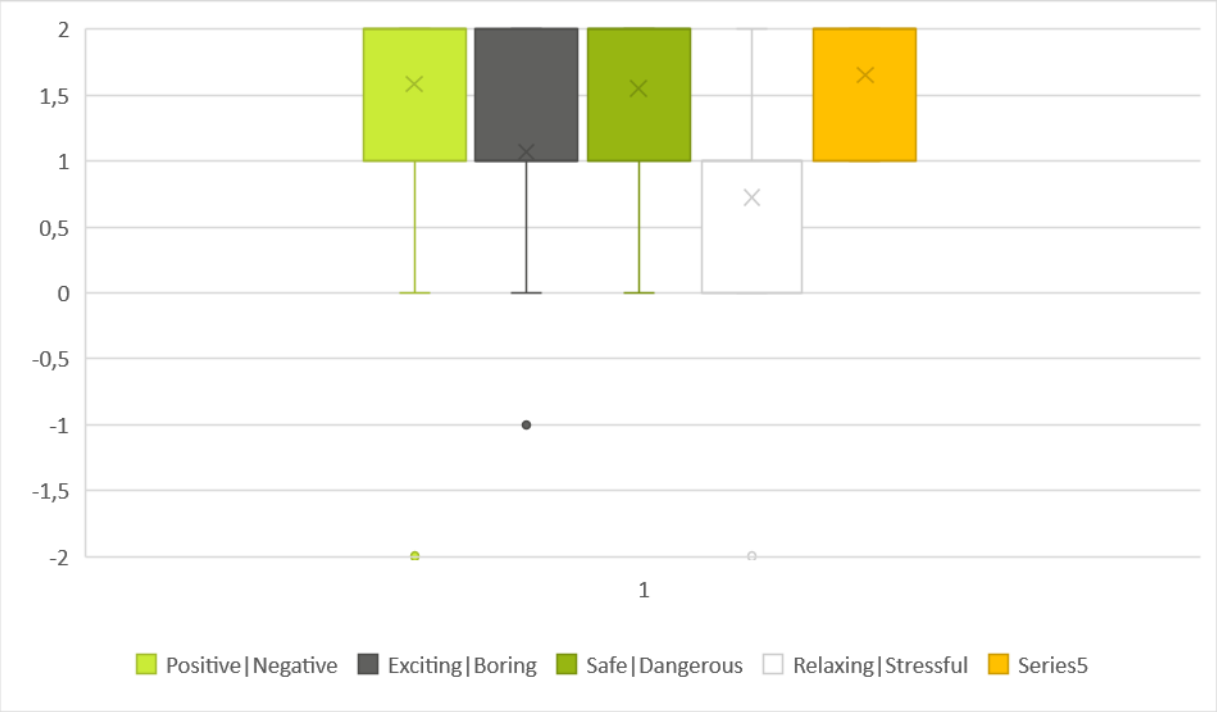


Table 1: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

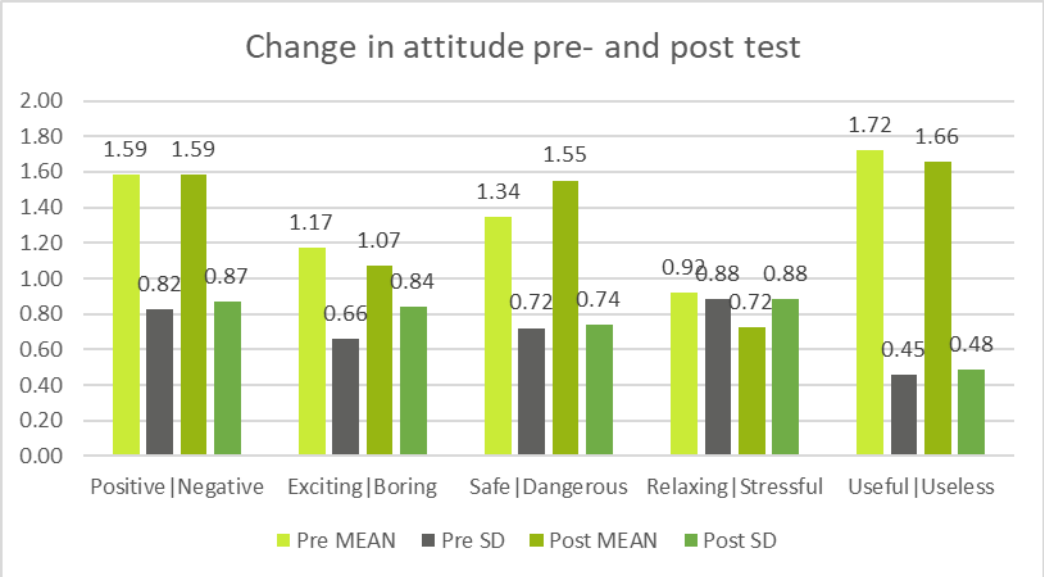
- One participant found the experience negative and one participant found it stressful
- Two participants found the experience boring
- Ten participants were neutral about how relaxing or stressful the experience was
- The least positive reaction was regarding how exciting the experience was
- The most positive reaction was about how useful the experience was
- The greatest variation across all participants was about how exciting or boring the experience was

Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[3] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more satisfying than useful.

[3]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.



Positivity of Experience

- The pre- and post-test expectations were equal but the pre-test expectations had a smaller deviation than the post-test reactions

Excitement of Experience

- The pre-test expectation was more exciting than the post-test reaction
- This was the biggest change in SD from pre-test to post-test

Safety of Experience

- There pre-test expectation was less safe than the post-test reaction
- This was the biggest change in mean from pre-test to post-test

- This was the only area which had a positive change from pre to post test

Stress of Experience

- The pre-test expectation was more relaxing than the post-test reaction
- It was the least positive area both pre and post test
- This was the second biggest change in mean from pre-test expectations to post-test reactions

Usefulness of Service

- The pre-test expectations were more useful than the post-test reactions.
- It was the most positive area both pre and post test

Initial Post-Test Reactions[4]

Although the majority of the participants made a positive comment (marked green), three of the participants expressed some form of disappointment (marked red).

- I like the service a lot. I would be very convenient to park the car automatically for example in large shopping malls so that you could get off at the door and when leaving you would not have to search fo the car and drag your shopping there but instead you could wait at the door for the car.
- The car worked surprisingly well after the first round of confusion and the automated parking seemed to work well and fairly smoothly.
- A versatile, rather useful addition to driving. Big plus for the future of driving!
- Good and positive
- Interesting and informative. I liked my experience.
- This is what's coming. Waiting until this is concretized (positively)
- I was expecting a successul parking. It did not go perfectly between the lines although the reason was revealed. The car drove nicely to the drop-off point and parked drom there to the box. Better than many BMW or Audi driver. I believe a service like this is the future and is useful.
- The feeling of the car was positive
- It was good, interesting service.
- As a service this is really useful. The car arrives to the store's door and goes to park itself and comes back when called upon. One of my first thoughts was that it supports car sharing. Of course it is useful for a private car driver that the car parks itself, but for the big picture it could be more useful that the car would drive on to the next gang after dropping me off. Taxi without a driver etc. But this is not inquired here so that's that.
- Calm drive, no surprises
- The service seemes useful and stable.
- Interesting and convenient service! I believe this to be useful in future cars.
- An exciting future feeling
- The impression was very positive and I think the parking assistance would have a market niche in the future. It was funny that the gear was handled by a "robot hand" that did not always really have the power to push the gearstick
- Interesting and promising system
- Interesting and useful
- Good and necessary continuation for automated parking at "both ends"
- Good idea that is very necessary and liked by the users once it is at that development stage

[4] Translated from Finnish

- Good as a thought and idea (e.g. big parking garages etc.) but I do not perhaps see myself as a future user
- Good idea, still all sorts of uncertainties in the implementation
- The parking looks easy and a bit bumpy in the beginning but you will then get used to it
- Certainly useful for short distance for example in parking garages. For longer distances the service could park/drive the car a bit further away from the center
- Exciting, attractive
- The idea of the service is good and it would safe time and parking space but I am thinking about how reliable it is for safety. If there is some problem in the positioning and the car does not detect an obstacle and drives e.g. on another car or the wall. And how does it detect if a child rushes out or something similar
- Very useful when realized
- Weird, interesting, I think it will be the future soon
- Quite a fun experience.

16 participants reported that they did not feel unsafe or uncomfortable during the test:

- In the beginning suspicious but noticed quickly that the technology works as it should :)
- No
- No, everything went as expected
- No
- Everything went well. No drastic braking or stopping. The car glided calmly forwards
- Feeling was safe. Satellite in the positioning.
- Nothing happened, it was safe the whole time
- No
- No there was not. And I am not on ride in the real situation so for me it is all the same how the car parks itself.
- no
- No
- No
- No, I felt safe. The "driver" explained what is happening all the time
- Not really, since the driver was anyways in control all the time and explained what was happening
- No. The driver was however involved as a backup.
- No

10 participants reported some behavior that made them feel uncomfortable:

- The car slighlty curved on the driving line but otherwise no
- The seatbelts on the backseat were quite miserable. This did not however make me feel unsafe, mostly uncomfortable.
- The robot took control even though there were people without seatbelts inside
- The car reversed into an obstacle. Some malfunction in the navigation system
- In the beginning the direction was towards the wall and in the end towards an obstacle (technical malfunction) thought about the challenges of the project
- Did not but trustworthy and pretty confident ride. Reversing into the box was quite simple but how will it work when the distance is smaller in the boxes. That can not yet be defined.
- Uncertainty if the car stops and turns on time when approaching an obstacle, felt unsafe.
- The car had to be handled manually. It does not work perfectly yet. Although a good start.

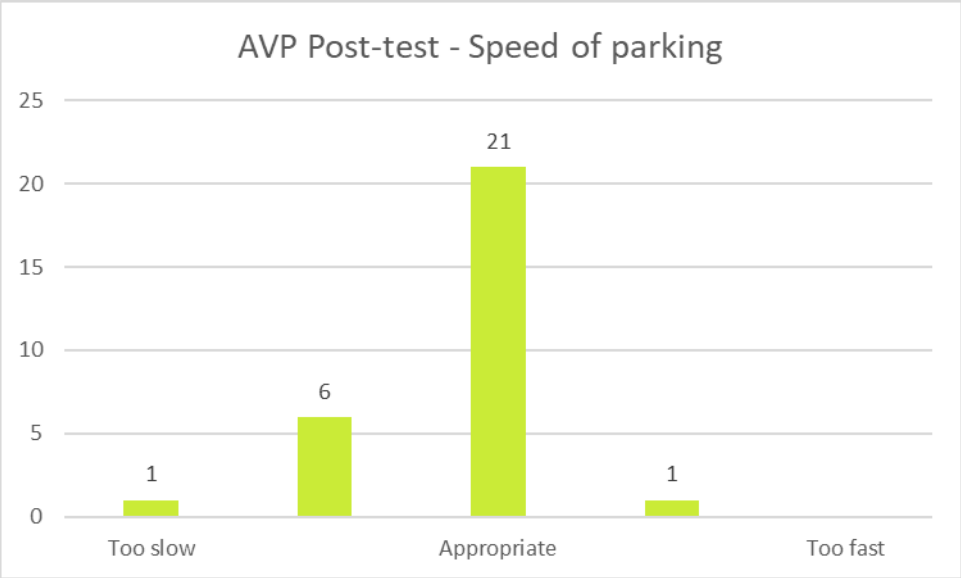
- Nothing that would have made me feel danger to life but I was just thinking about that general safety, that how fast it will detect for example a person rushing out or what if it hits the wall due to a malfunction
- Brake suddenness

4.3 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.3.1 Speed of parking

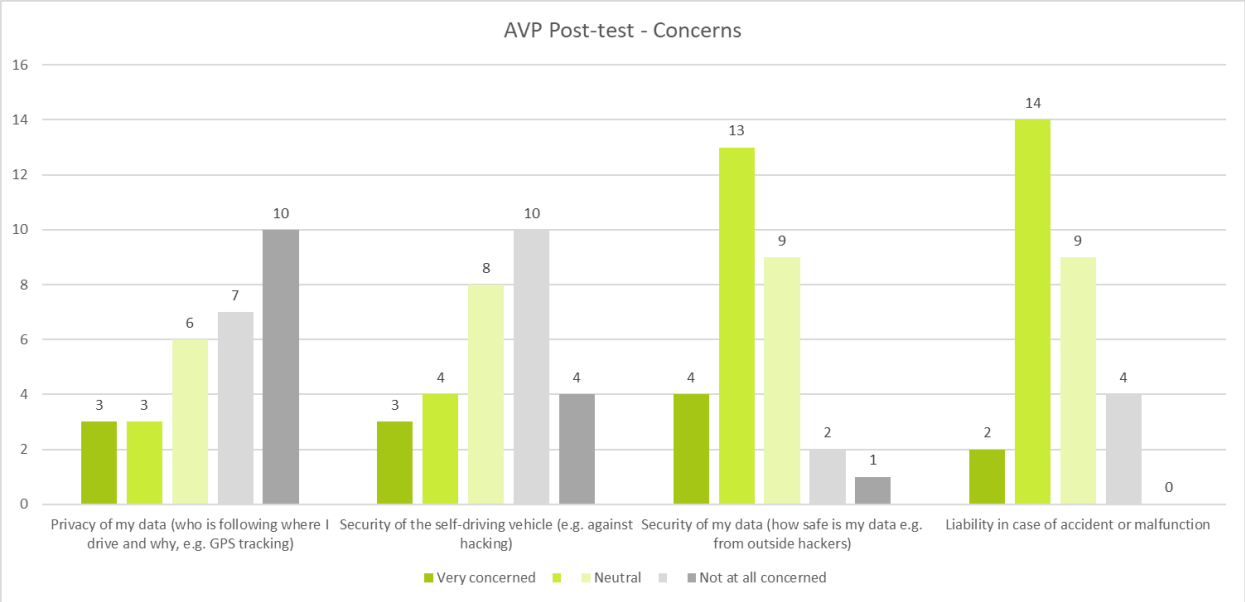
Participants were asked to comment on the perceived speed of the parking on the scale from too slow to too fast, with Appropriate as a central choice.



- Most participants thought that the speed of the parking was appropriate
- Seven participants thought it was slower than appropriate
- One participant thought it was faster than appropriate

4.3.2 Concerns of the tested service

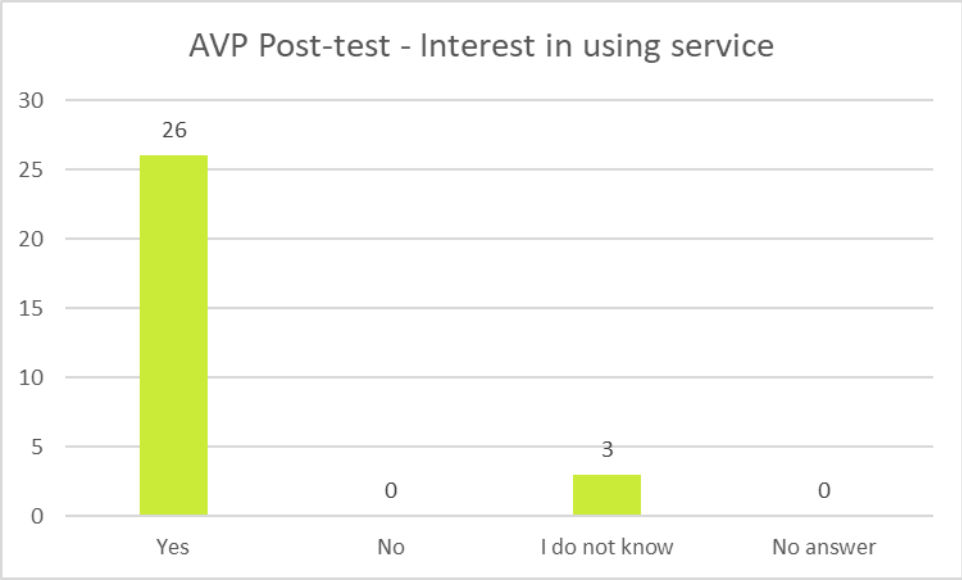
Participants were asked to comment on their concerns of various aspects of the service. They were ranked from Very concerned to Not at all concerned, with Neutral as a central choice.



- Of the participants 55–58%, were concerned of the aspects security of my data and liability in case of accident or malfunction
- Participants were least concerned about the privacy of my data and the security of the self-driving vehicle
- For each of the aspects, two to four participants were very concerned
- For each of the aspects, six to nine participants were neutral
- For the aspect liability in case of accident or malfunction, no participant was not at all concerned

4.3.3 Interest in service

Participants were asked whether they would be interested in using the service regularly if it was available (in full operation, as this was a limited trial). The options were yes, no, I do not know and no answer.



- The majority of participants (90%) would be interested in using the service regularly if it was available in full operation
- 3 participants did not know whether they would be interested

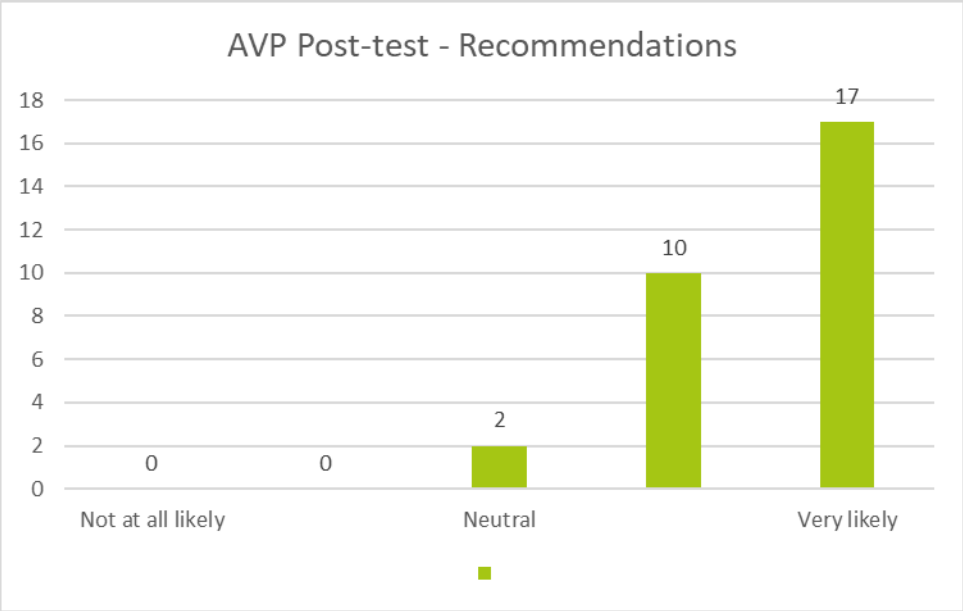
The following explanations were provided by the participants:

- The service would be very useful for example in large parking garages when you could drop-off and pick-up the car without having to wander around the hall looking for the car. The automated parking on the back-/workplace yard would also be convenient
- I would certainly use the service, but it could not cost very much more than normal parking
- I would gladly use the service if there was a chance
- It would make it easier to find a parking place
- Very pleasant service especially in a tight and full parking space
- I believe it would save time, when there might be more parkers in the same space, the parking spaces are narrowed - avoid crashes.
- The service would save time and car damages. Now when I think about the parking speed, the speed was suitable. Often you see too high speeds in parking garages.
- Great tool for parking in shopping malls
- I am only wondering who is responsible and who pays if there is an accident due to a malfunction? I wonder slightly about whether all other cars will always notice it and it the others.
- At big parking lots yes. Very good idea, makes it easier to find your car and carrying shopping bags
- Yes, it would be nice that the car found a parking space itself when going to the store.
- Families with children have for example a lot of shopping trips and the automatic drop-off and pick-up of the car would support that
- I believe that the service would help unload for example shopping malls etc. peak times and accident situations at the parking places
- This would for example speed up searching for a parking place in big parking garages. With big purchases, it would be easier to just summon the car than to walk with all the bags to the car, if you cannot even remember where it was.
- Everything that makes living and being easier interests, I get to sit enough in the car anyway
- I think the service would be useful especially when you have to park in an unknown city or in a situation when there is a hurry
- If I had a car that would have been fitted with the service in the manufacturing stage then I would gladly use it.
- Necessary service in big parking areas where too much time is wasted looking for a parking space
- I would definitely use the service, it would be useful in the vicinity of agencies, shopping malls etc.
- At this moment I do not see myself as a user but in the future, it depends on the other traffic and driving
- Definitely, because you would not have to search for a parking place or remember where you left your car
- Facilitates parking and you can on the other hand trust it since I sometimes have trouble parking. This would give relief in the future once we get more experience
- I would certainly use it to some extent, I cannot say about the regularity. Depends on the parking area where you park whether the service is necessary. Services and reliefs for people do tend to become common.
- If I had the parking service where I park

- In the parking garages of shopping malls or in other big parking garages it would be quite convenient
- Of course I would use, it makes the parking smooth. Eliminates mistakes made by humans in parking garages. Of course the programmer makes mistakes too.
- It would greatly facilitate parking at large parking areas.

4.3.4 Recommendations

The participants were asked how likely they would recommend the service to a friend or colleague. They were ranked from Very likely to Very unlikely, with Neutral as a central choice.



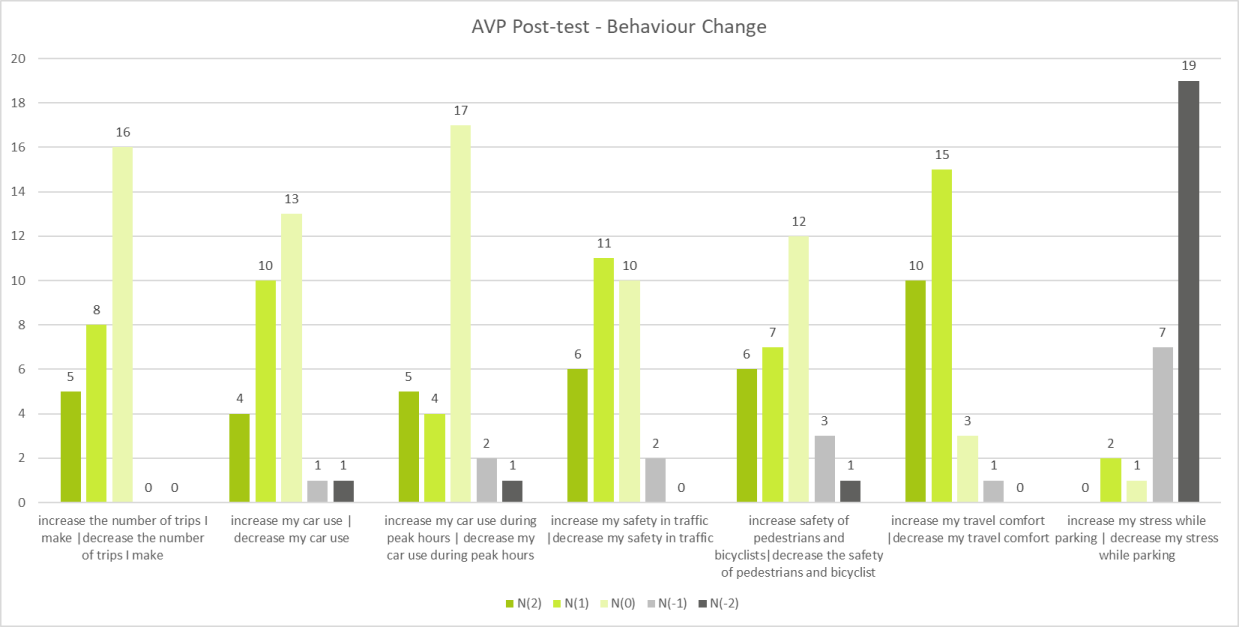
- The majority of participants would recommend the service to a friend or colleague; 17 participants were very likely to recommend
- Two participants were neutral about recommending the service to a friend or colleague

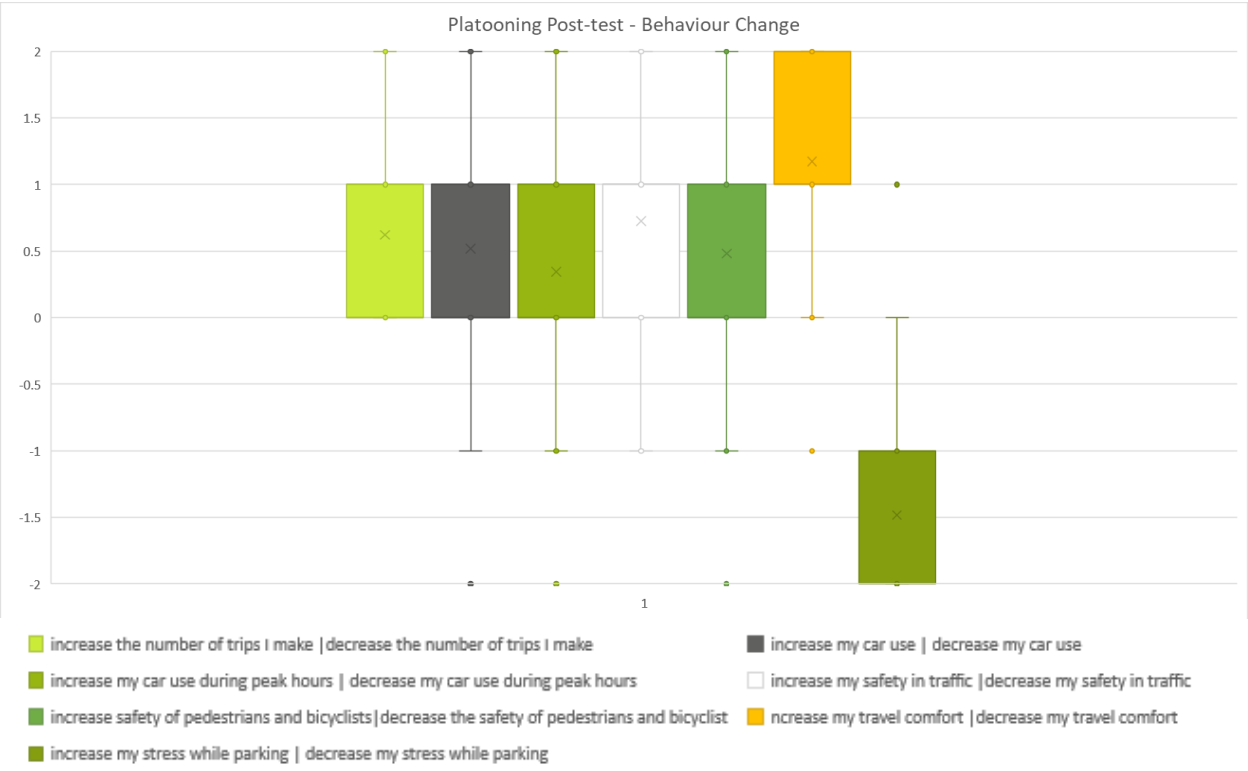
4.4 Post-Test Thoughts on Future Use

Participants were asked to comment on how they might use the service if it was available.

4.4.1 Behaviour Change

Participants were asked how the service might affect their usual travels as both a leader and a follower. This included how trips, private car use, traffic safety, stress and comfort would change (ranked between -2 and 2).

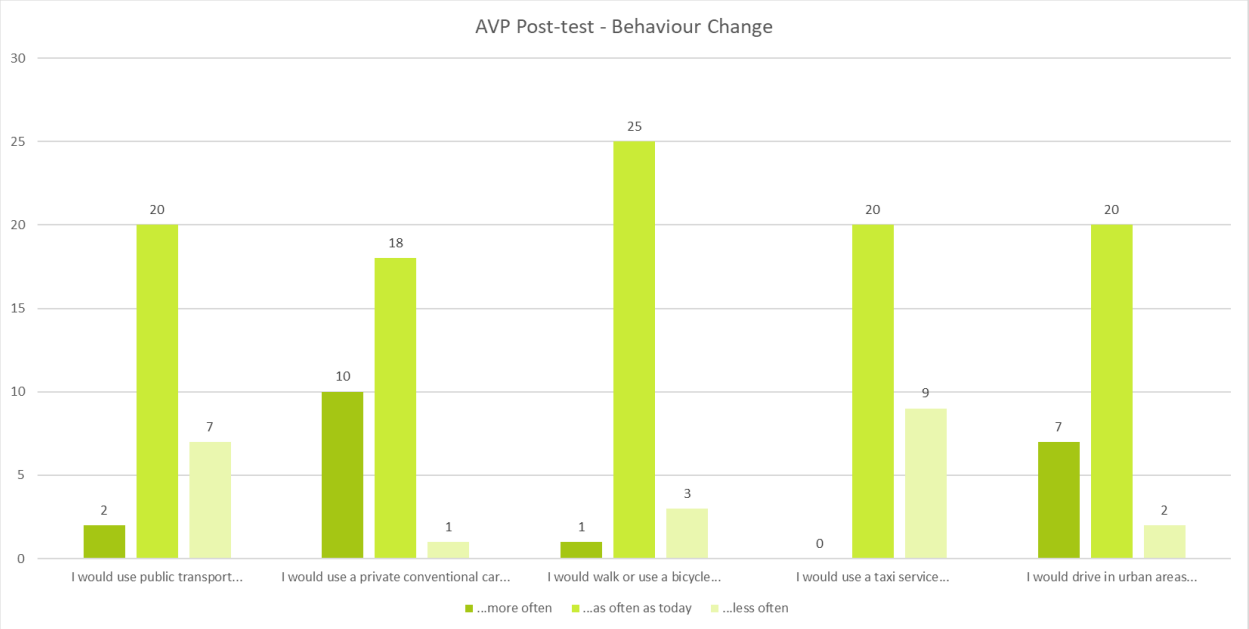




- 13 participants thought the service would increase their overall number of trips and 16 participants thought it would not change their overall number of trips
- 14 participants though it would increase their private car use and 13 thought it would not change
- 9 participants thought that the service would increase their car use during peak hours and 17 thought it would not change
- 17 participants thought that the service would increase their safety in traffic and 10 thought it would not change

- 13 participants thought that the service would increase safety of pedestrians and bicyclists and 12 thought it would not change
- 25 participants thought that the service would increase their travel comfort
- 26 participants thought that the service would decrease their stress while parking

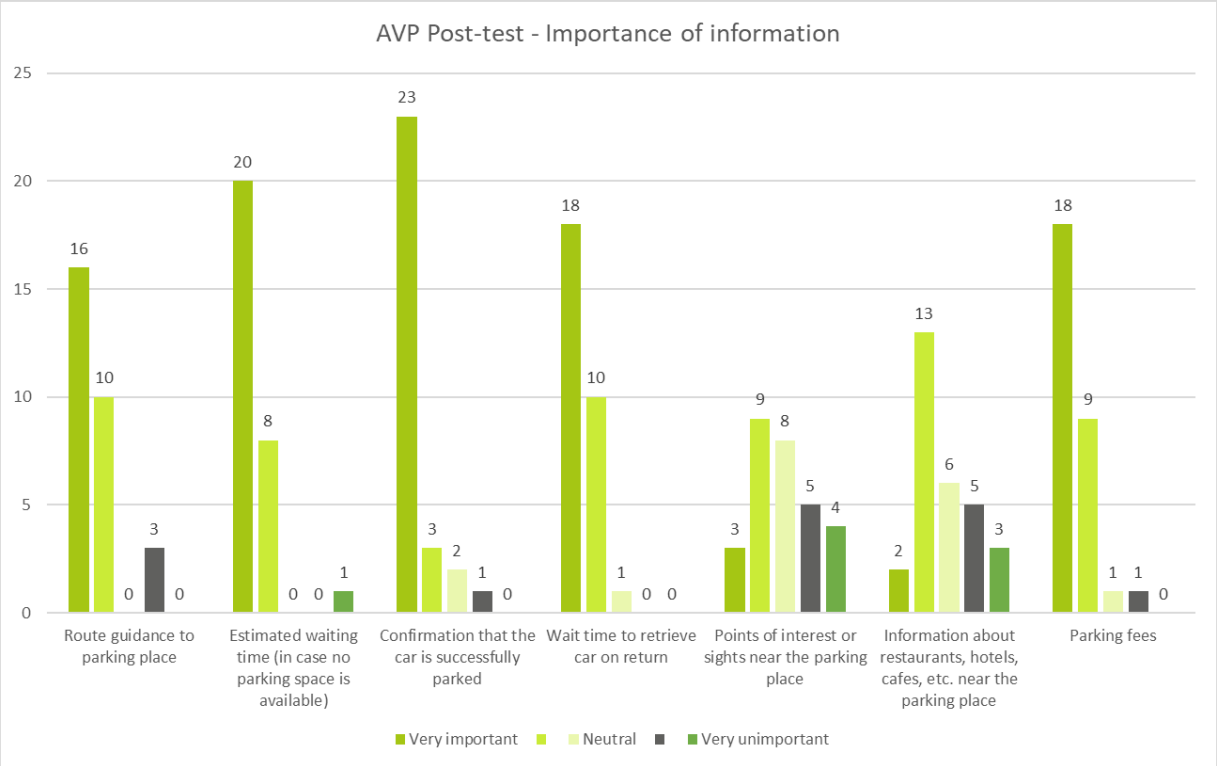
Further to behavior change, participants were asked how the service would affect their choice of travel mode and driving environment. The response alternatives were …more often; …as often as today; …less often.



- A majority of respondents (62–86%) would not change their choice of travel mode or driving environment.
- 7 participants said they would use public transport less often than today
- 10 participants said they would use a private conventional car more often than today
- 3 participants said they would walk or bicycle less often than today
- 9 participants said they would use a taxi service less often than today
- 7 participants would drive more often in urban areas than today

4.4.2 Importance of Information during Service

Participants were asked about the importance of various aspects of information that could be provided through the service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- A majority (25 to 28) of participants found it important to get the following information: route guidance to parking place, estimated waiting time, confirmation that the car is successfully parked, wait time to retrieve car on return and parking fees
- 12 to 15 participants found it important to get information on points of interest or sights near the parking place and information about restaurants, hotels, cafes etc. near the parking place
- 8 to 9 participants found it unimportant to get information on points of interest or sights near the parking place and information about restaurants, hotels, cafes etc. near the parking place

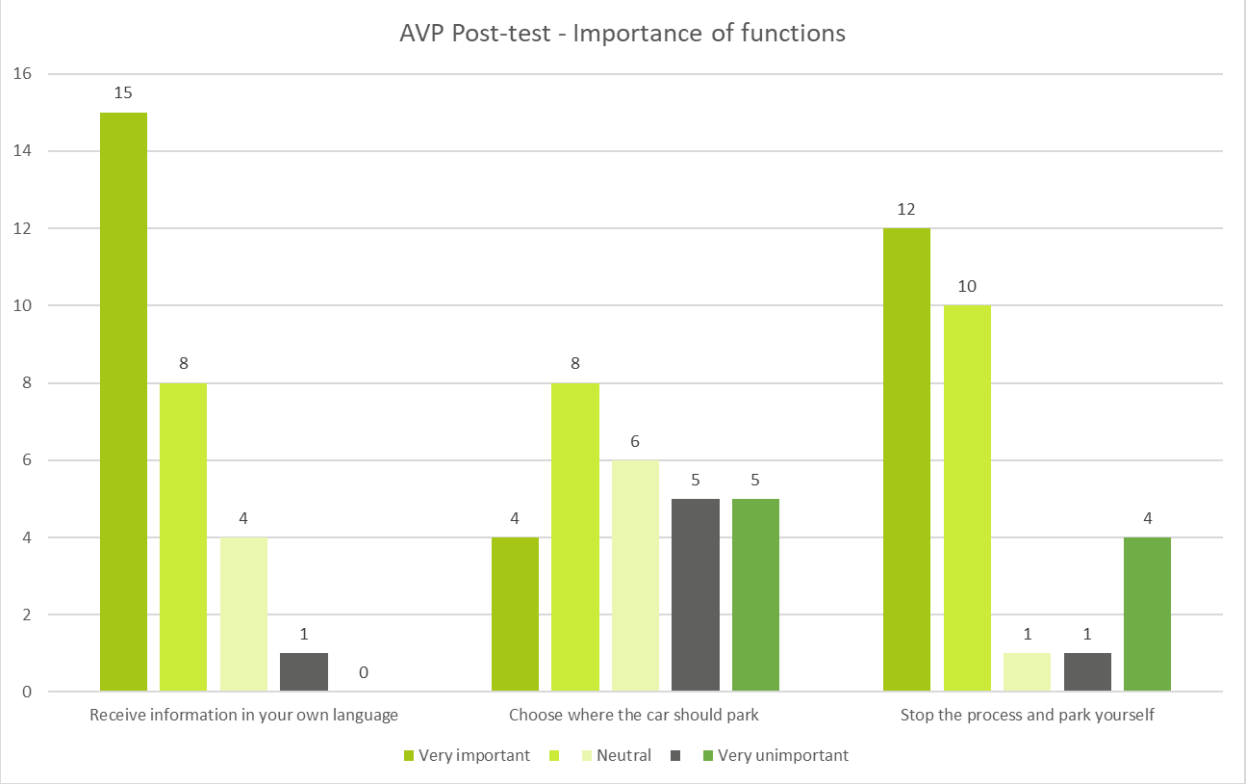
Participants were also asked if there is any other information that they would like to have. The answers of other information that participants would like to have are [5]:

- I would like to get information on the parking situation, e.g. how much free space, price and nearby shopping places
- Waiting time for car to return from parking
- Record of vehicle movement when I am not in the car. Possibly also video footage either around or inside the car.
- I would like to get information on the parking space in potential malfunctions, e.g. car is in hall D5 on place 34.
- Loggdata on what network my car has joined and for how long. It would also be interesting to maybe know why the car has parked in a certain spot - I would assume that the spot that the computer has optimized might be amusing in some way
- Pictures or videos on where the car drives

[5] Translated from Finnish

4.4.3 Importance of Functions of the Service

Participants were asked about the importance of various functions during the service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- 23 participants found it important to get information in their own language
- For the aspect "choose where the car should park", 12 participants found it important and 10 participants found it unimportant
- 22 participants found it important to be able to stop the process and park themselves

Participants were also asked if there is any other function that they would like to have. The answers of other functions that participants would like to have are [6]:

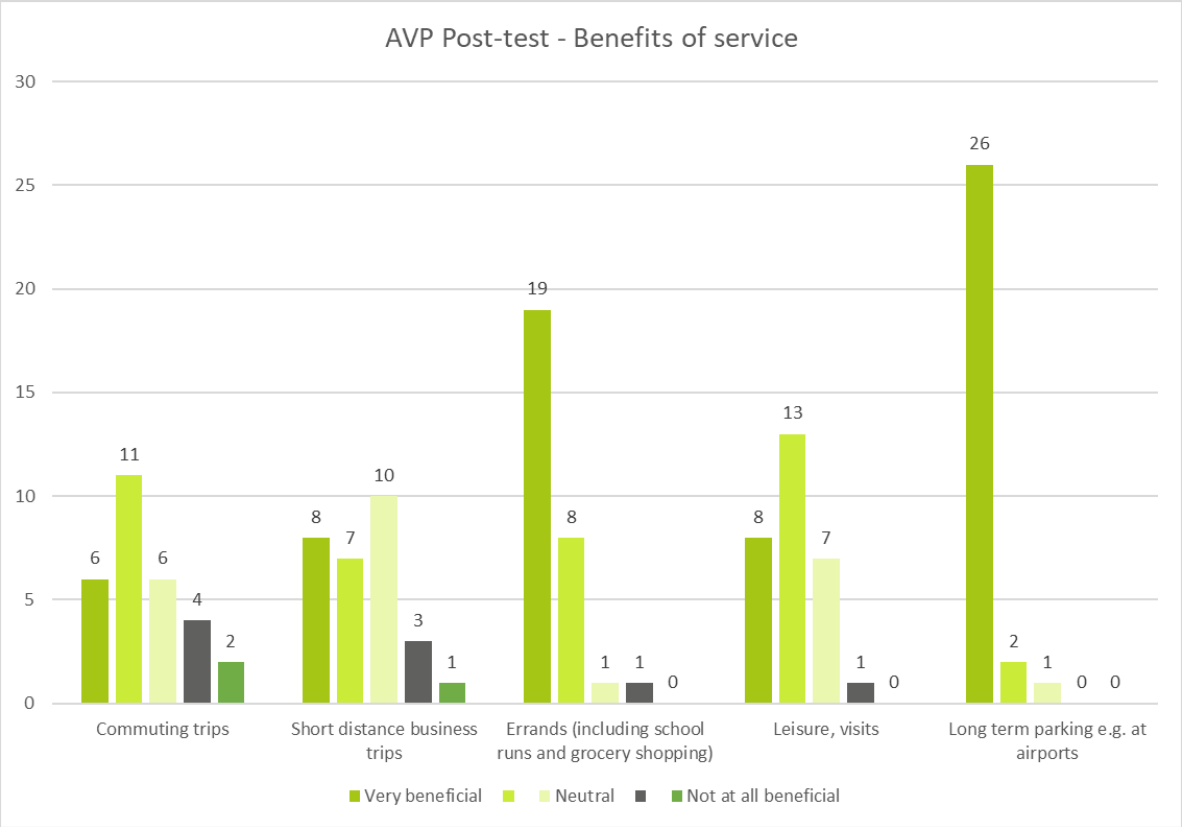
- A functioning customer service in case of malfunction
- Specifically to have the service in your own mother tongue because not everyone speaks English fluently let alone understands it (e.g. older people). A clear speech voice could also be included.
- Give information on the weather outside, to be prepared for rain…
- Payment in the same application.
- Choose from multiple drop-off/pick-up points, even if it would differ from the original drop-off point
- I think it would be nice if the car had voice commands. I am not a big fan of tablets or phone applications, especially when it comes to car technology. Therefore, I would find other ways than touch screen to manage the parking as desirable.

[6] Translated from Finnish

- Acceptance that the parking system takes control of the car and the opportunity to select manual parking.
- It would be good to have complete trip planning e.g. train/subway/plane trip
- Remote control of heating etc. during parking

4.4.4 Benefits of Service

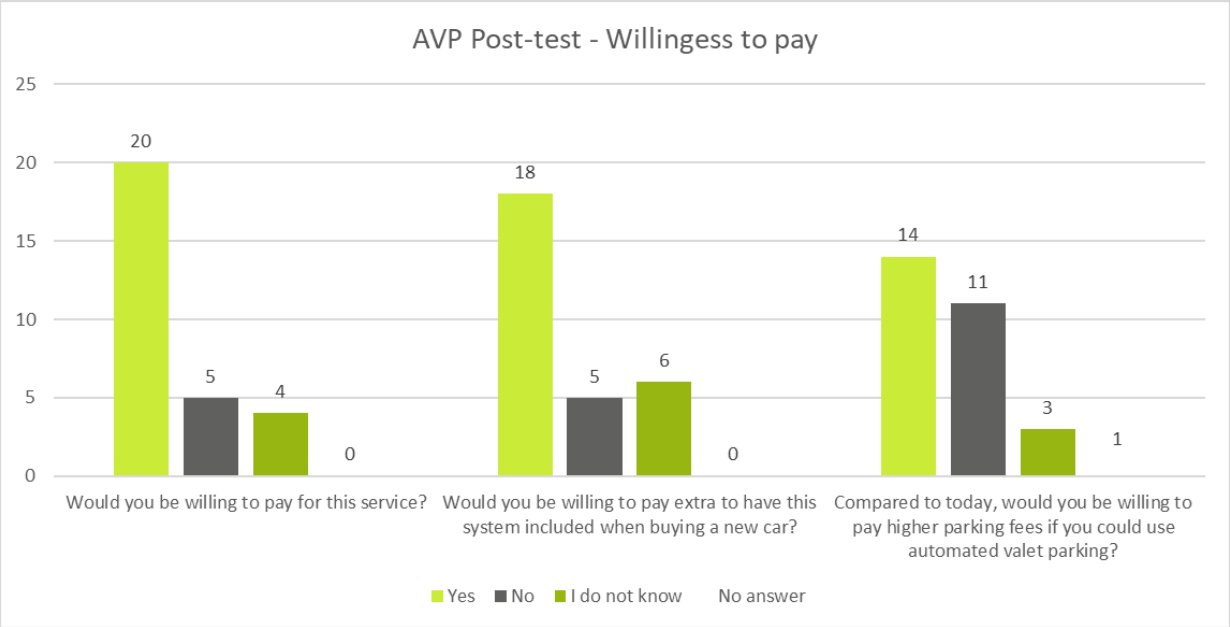
Participants were asked how beneficial the service would be to them on their regular or daily trips. These were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



- The majority of participants thought that the service would be beneficial on all types of trips
- For commuting trips; 17 participants thought the service would be beneficial and 6 thought that it would not be beneficial
- For short distance business trips; 15 participants thought the service would be beneficial and 4 thought that it would not be beneficial
- 27 participants thought the service would be beneficial on errands
- 21 participants thought the service would be beneficial on leisure visits
- 28 participants thought the service would be beneficial on long term parking
- The service was seen as most beneficial for long term parking and least beneficial for commuting trips and short business trips

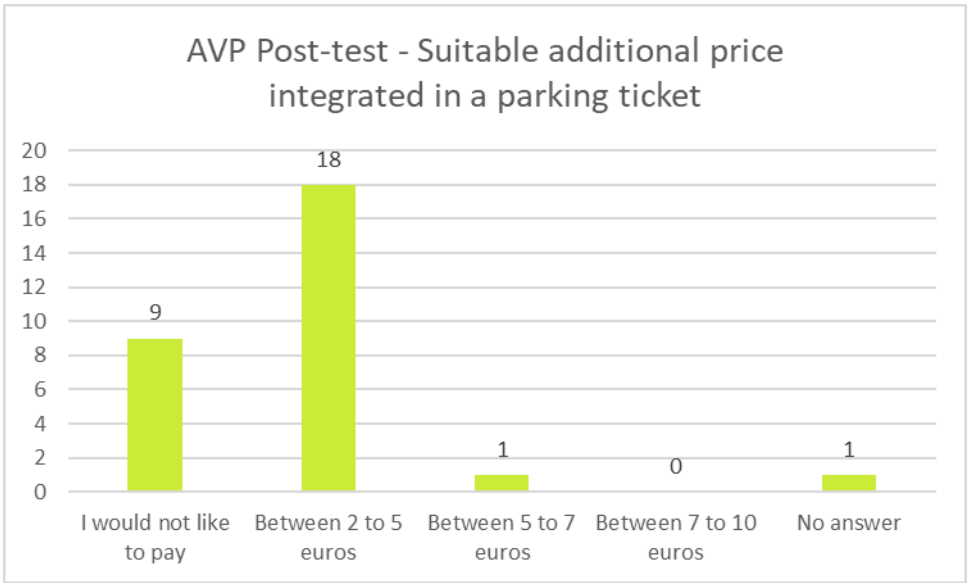
4.4.5 Willingness to pay

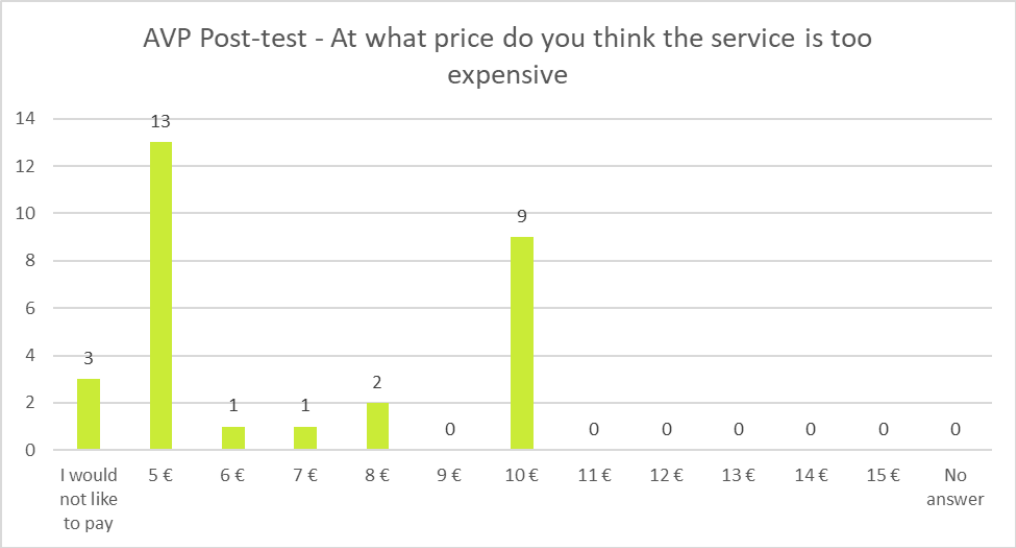
The participants were asked if they would be willing to pay for this service, pay extra to have this system included when buying a new car or pay higher parking fees if they could use automated valet parking.



- 20 participants would be willing to pay for the service
- 18 participants would be willing to pay extra to have the system included when buying a new car
- 14 participants would be willing to pay higher parking fees if they could use automated valet parking

The participants were asked what would be a suitable price for the service (additional price integrated in a parking ticket) and at what price the service would be too expensive.

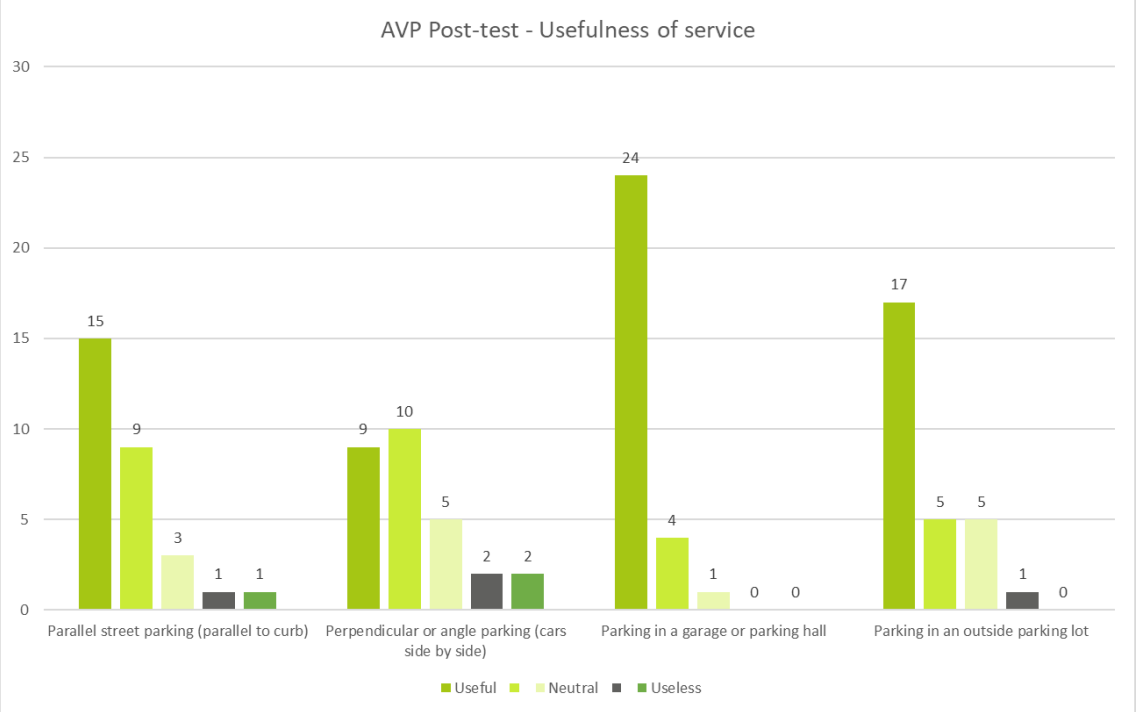




- 18 participants were willing to pay between 2 to 5 euros as additional price integrated in the parking ticket
- 13 participants thought the service was too expensive at 5 euros and 9 participants thought it was at 10 euros

4.4.6 Usefulness of Service

Participants were asked how useful the service would be to them for different types of parking. These were ranked from Useful to Useless, with neutral as a central choice.



- 24 participants found the service useful for parallel street parking
- 19 participants found the service useful for perpendicular parking
- 28 participants found the service useful for parking in a garage or parking hall
- 22 participants found the service useful for parking in an outside parking lot

- The service was seen as most useful for parking in a garage or parking hall and least useful for perpendicular parking

4.4.7 Additional feedback

Participants were given the opportunity to give further feedback to designers of the system on anything else that might make it more useful to them:

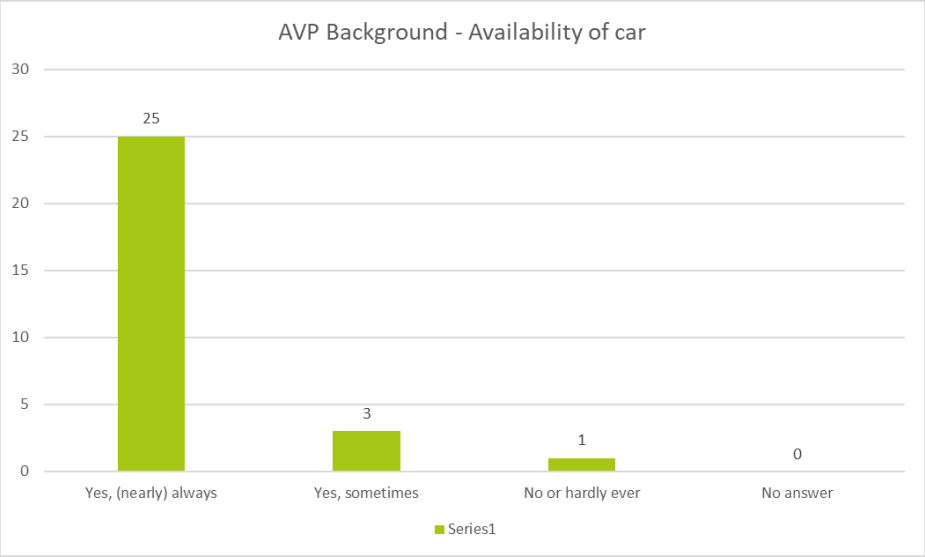
- Parking in the backyard (if the yard is tight)
- Is useful. Saves parking space.
- I think the technology should be fitted in the car then it has been taken into account in the price of the car and the users would not need to pay for the service separately. For example the shopping malls could order the service and it would cost for them.
- The parking system would be excellent especially in tight parking garages.
- I would preferably pay for the service as a relative addition to the parking time than as a fixed amount.
- Simple and clear symbols throughout the chain
- Driving and reversing into and out of narrow parking boxes
- Increasing the distance so that the cars could be parked in separate parking places further away from the center, but that would already require more autonomous driving.

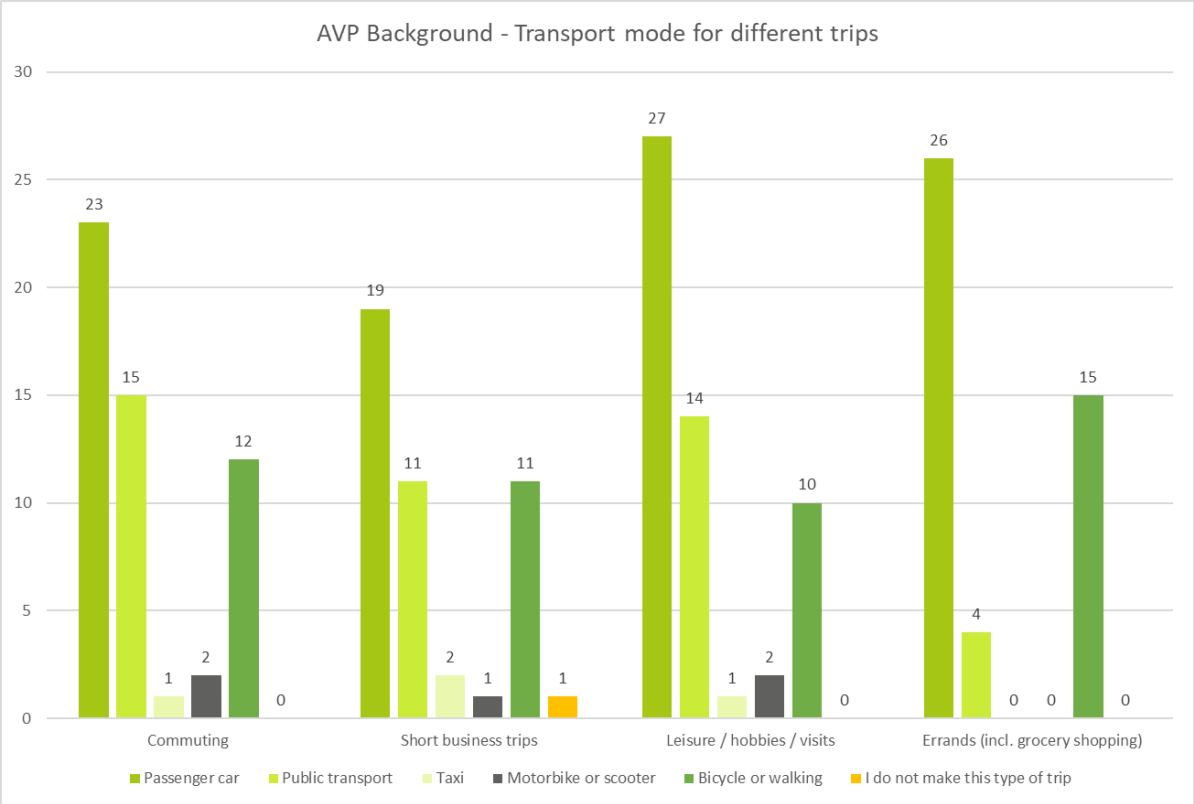
5 Background

Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

5.1 Travel Habits

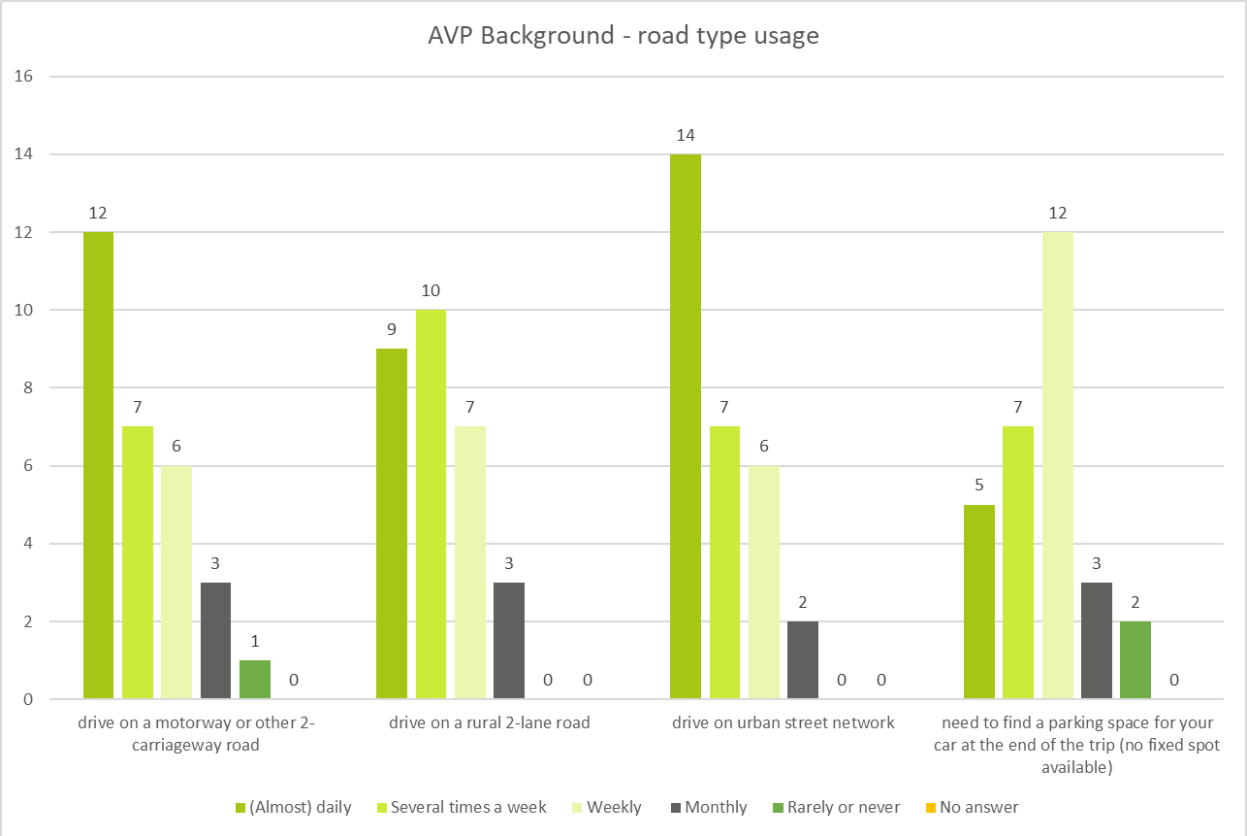
Participants were asked whether they had a car available and what transport modes (1-3 options) they used for various trip types.



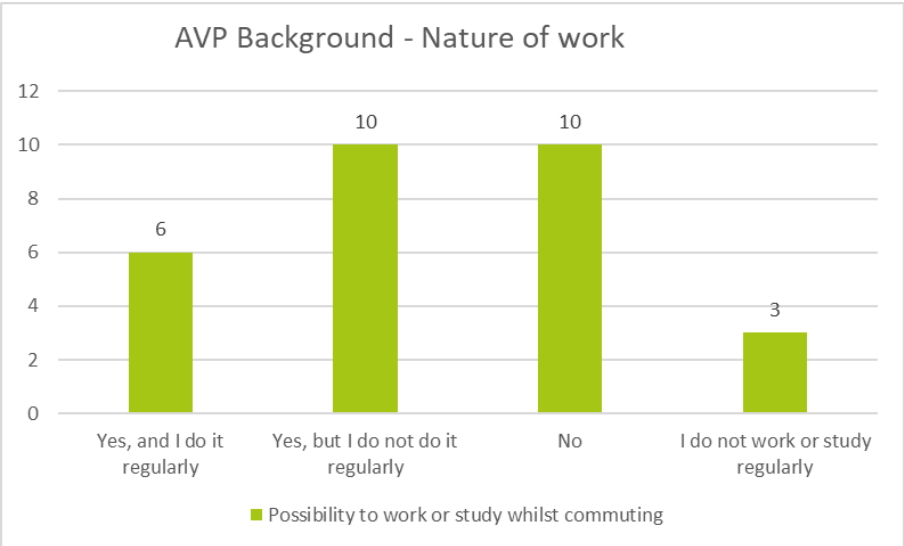


- 25 participants had a car available nearly always
- For commuting trips 23 participants used passenger car, 15 participants used public transport and 12 participants bicycled or walked
- For short business trips 19 participants used passenger car, 11 participants used public transport or bicycled or walked
- For leisure, hobbies and visits 27 participants used passenger car, 14 participants used public transport and 10 bicycled or walked
- For errands 26 participants used passenger car, 4 participants used public transport and 15 bicycled or walked
- Passenger car was the most used transport mode for all trip types
- Public transport was the second most used transport mode for commuting and leisure, hobbies and visits
- Bicycle or walking was the second most used transport mode for errands
- Taxi and motorbike or scooter was used by one to two participants for all trip types except errands
- One participant did not make short business trips

Participants were asked how often they drove on different road types and how often they had to find a parking spot at the end of the trip.



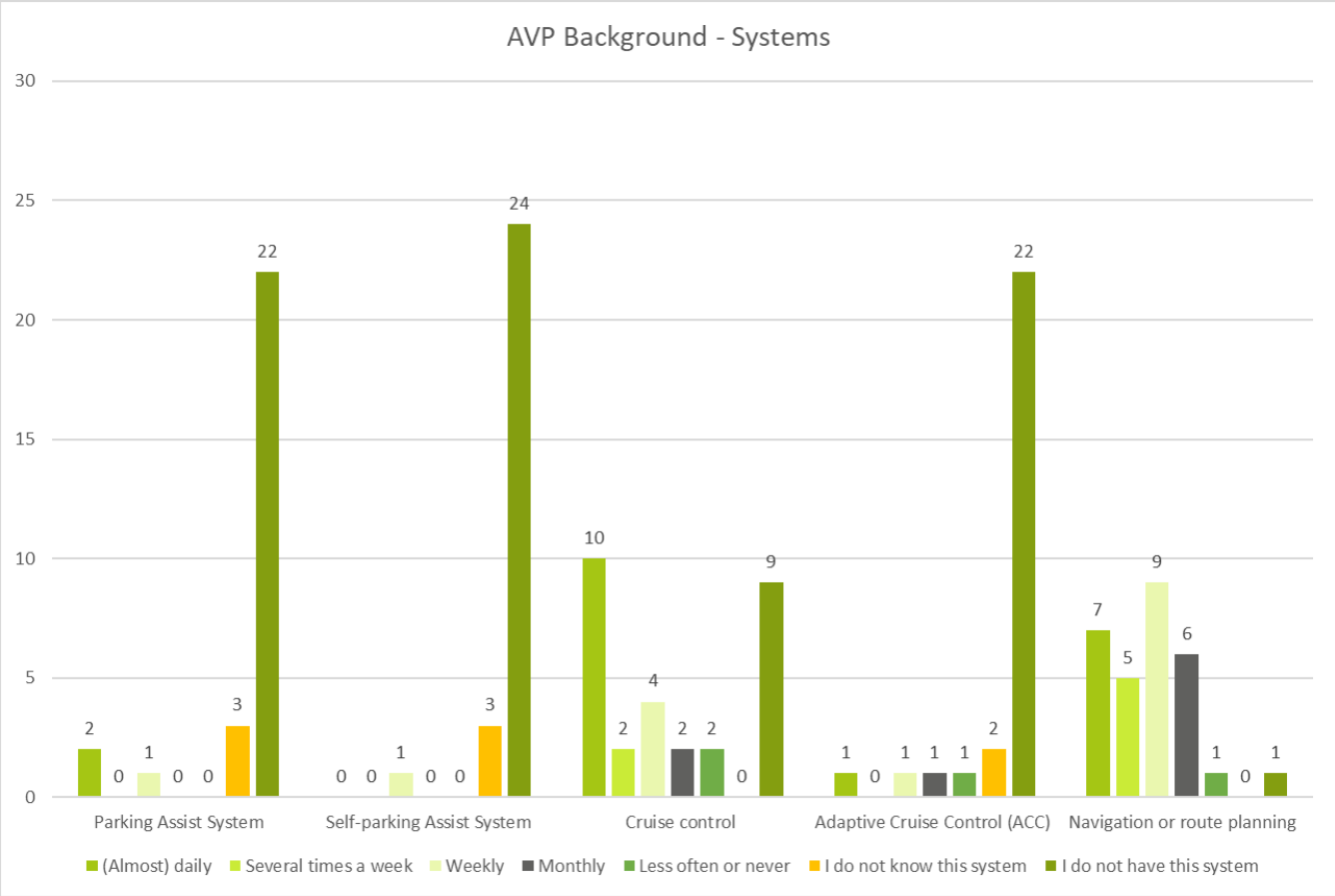
- Over half of participants (19 to 21) drive on all road types at least several times a week
- Two to four participants drive monthly or less often on all road types
- 12 participants have to find a parking space at the end of the trip at least several times a week or weekly respectively
- 5 participants have to find a parking space at the end of the trip monthly or less often



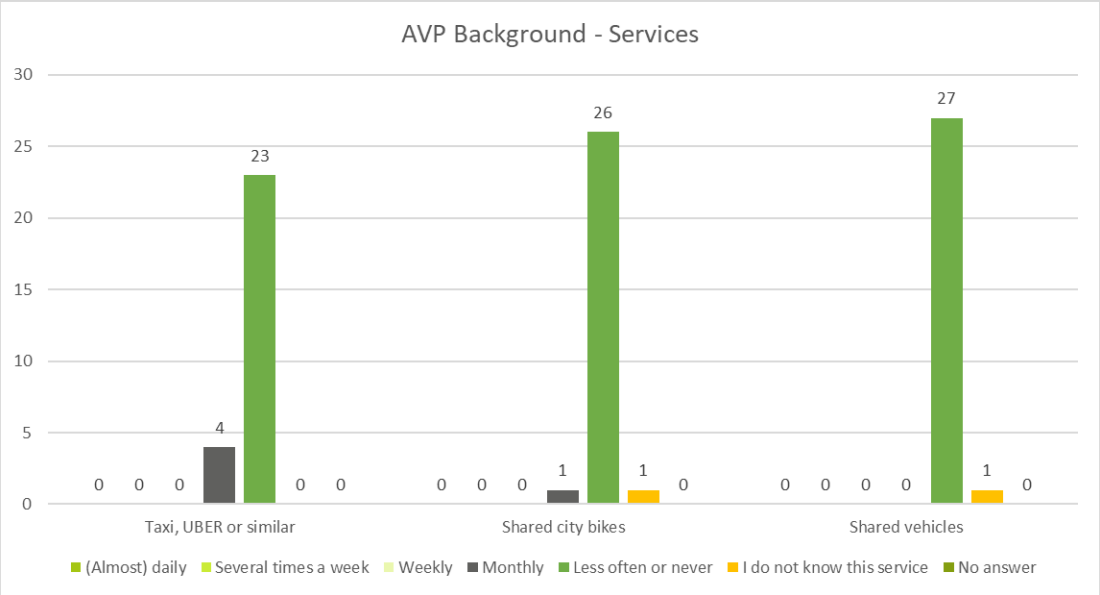
- 6 participants regularly work or study whilst commuting
- 10 participants could work or study whilst commuting but they do not do it regularly
- 10 participants do not have possibility to work or study whilst commuting and 3 participant

5.2 System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



- 12 participants used cruise control and navigation or route planning (almost) daily or several times week
- 22 to 24 participants did not have parking assist system, self-parking assist system or adaptive cruise control
- Two to three participants did not know parking assist system, self-parking assist system and Adaptive cruise control
- Two participants has parking assist system and uses it (almost) daily
- One participant had parking assist system and self-parking assist system and uses it weekly
- The majority of participants used cruise control and navigation or route planning at least monthly

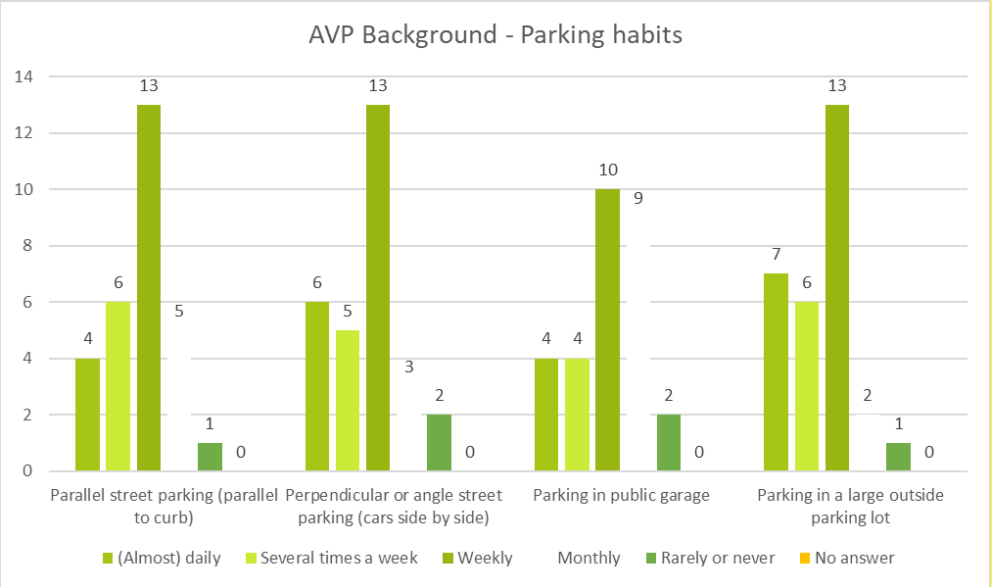


- Taxi, UBER or similar was used monthly by 4 participants and less often or never by 23 participants
- Shared city bikes was used monthly by 1 participants and less often or never by 26 participants
- Shared vehicles was used less often or never by 27 participants

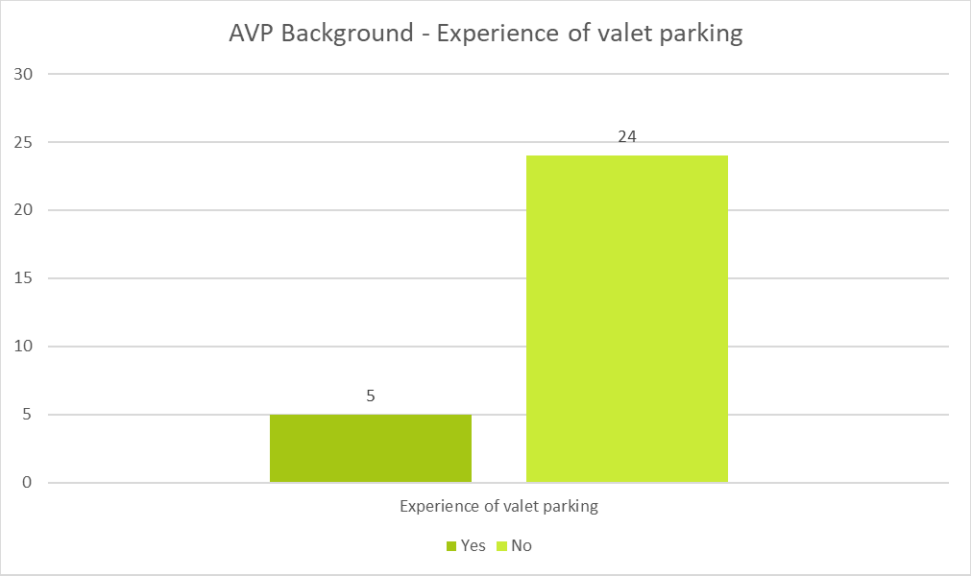
5.3 Parking habits

Participants were asked where they have a personal parking space available and how often they used advanced driving systems and shared mobility services.

- 26 participants had a personal parking space at home
- 5 had a personal parking space at work
- 3 had a personal parking space somewhere else
- 3 had a personal parking space nowhere



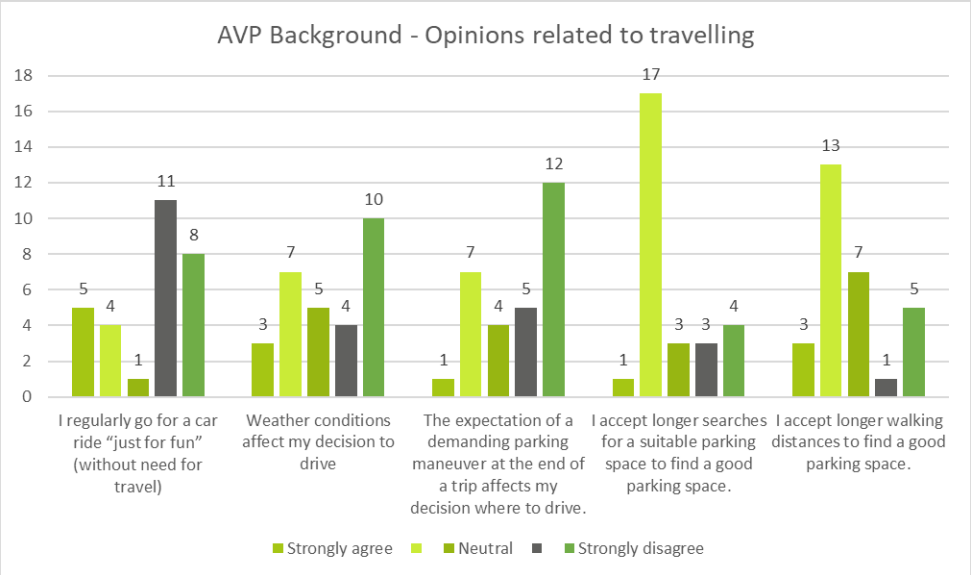
- 8 to 13 participants parked several times a week or (almost) daily in all described ways
- 10 to 13 participants parked weekly in all described ways
- 1 to 2 participants parked rarely or never in all described ways



- 5 participants had tried traditional valet parking

5.4 Opinions related to travelling

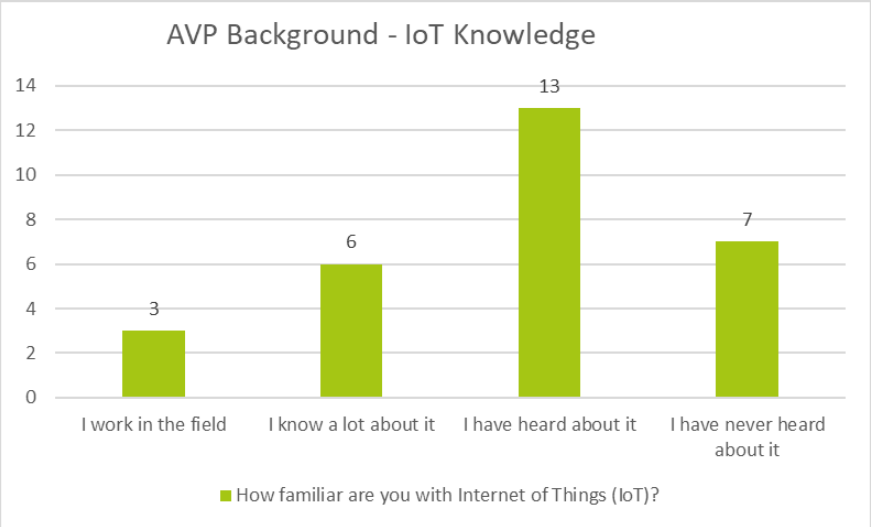
Participants were asked about their attitude and experience towards driving and travelling. These were ranked from Strongly agree to Strongly disagree, with Neutral as a central choice.



- 19 participants do not regularly go for a car ride "just for fun"
- 14 participants driving decisions are not affected by weather conditions
- 17 participants driving decisions are not affected by the expectation of a demanding parking maneuver at the end of a trip
- 18 participants accept longer searches for a suitable parking space to find a good parking space
- 16 participants accept longer walking distances to find a good parking space

5.5 IoT Knowledge

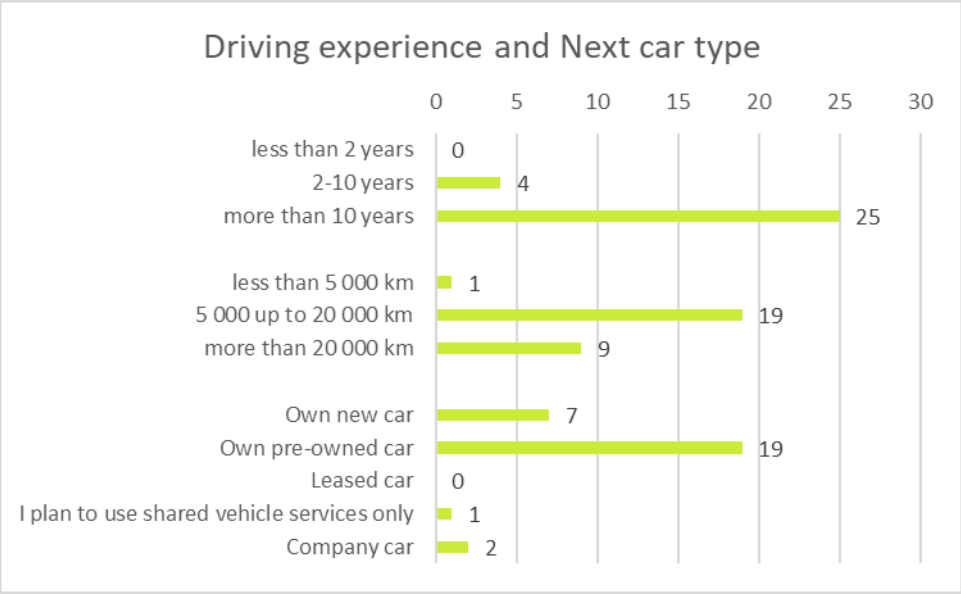
Participants were asked how aware they were of Internet of Things.



- 9 participants either work in the field or know a lot about IoT
- 13 participants have heard about IoT
- 8 participants have never heard about IoT

5.6 Driving experience and next car

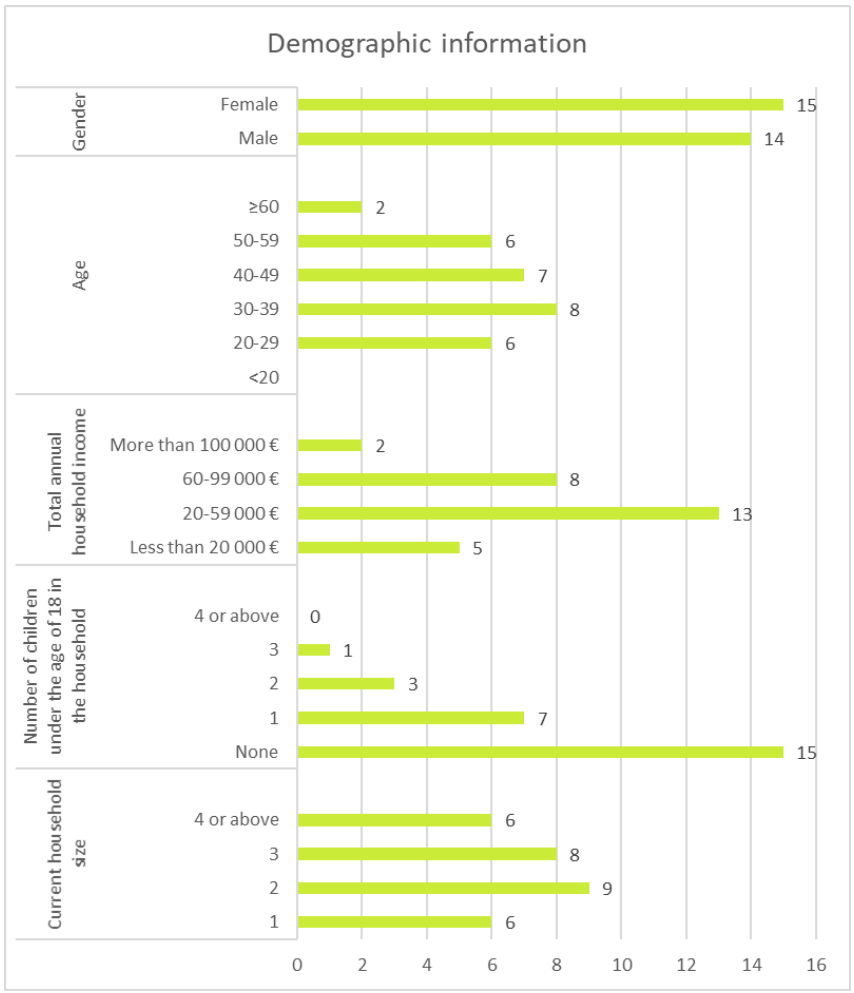
Participants were asked about their driving experience and their next (most probably) car type.



- The majority of participants (86%) have been driving for more than 10 years
- Over half of participants (65%) drive between 5 and 20 km a year
- Over half of participants (65%) plan to own a pre-owned car

5.7 Demographic Information

Participants were asked about their background to establish representation of the test group.



- 15 participants were female and 14 male
- 6 to 8 participants were aged 20–29; 30-39; 40-49 and 50-59. There were 2 participants over 60
- 13 participants had a household income of 20–59.000 € and 8 participants had a household income of 60-99.000€
- 9 participants had a household size of 2, 8 participants had a household size of three and 6 participants had a household size of 1 or 4 or above respectively
- 15 participants had no children under 18 in their household

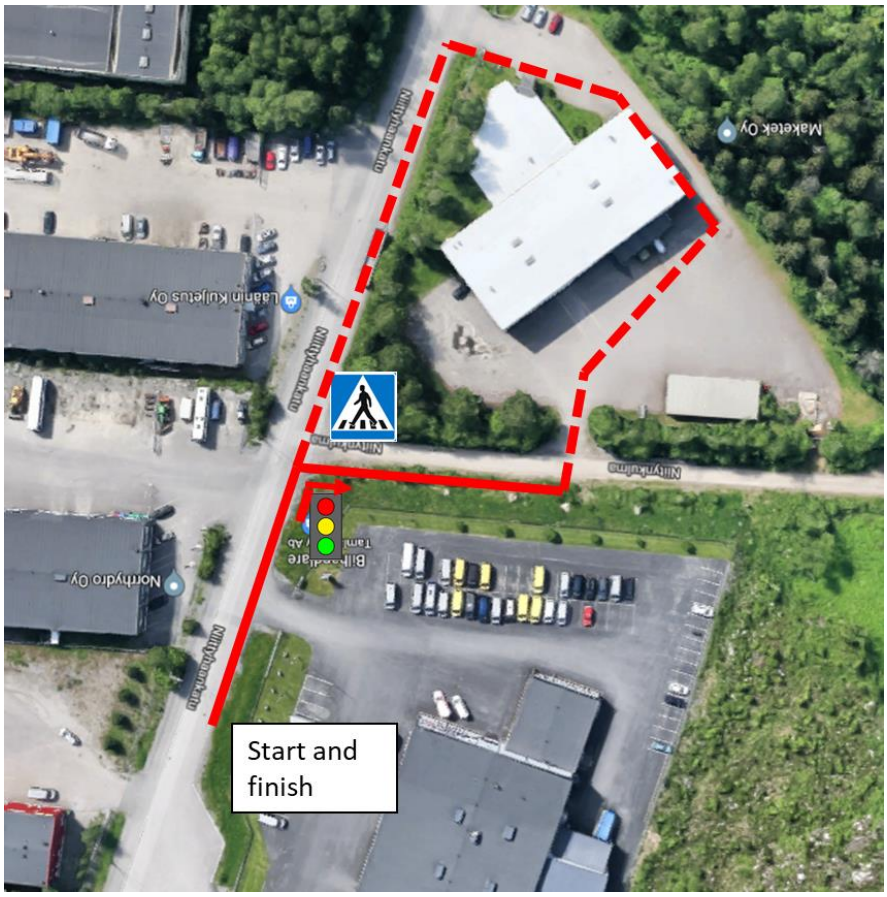
Tampere UD

1 Background

The Tampere UD user testing took place in May 2019 (7th–8th) at VTT's facilities in Tampere, FI. Twentyseven (27) participants took part, recruited through an external company (Testaamo). The tests took place in groups of 2 to 3 participants. Seven participants had participated in the user tests of Automated Valet Parking organized in the fall 2018.

2 Test Protocol

Introductory presentations were given in Finnish. Description of the technology and test were also carried out in Finnish. After the briefing the participants filled out the pre-test questionnaire. Then the actual test was carried out on the parking place outside. The test route was driven three times to allow each participant to sit in the front seat.



After the test the participants filled out the post-test and background questionnaires. Questionnaires were in Finnish and carried out on portable computers by the participants, through the online survey tool, 'Limesurvey'.

3 Technical problems

There was some minor technical problems (positioning) but at least one of the three test rounds were successful for all test groups.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 5 point scale. This was rated 2 to -2 (eg Positive = 2, Negative = -2).

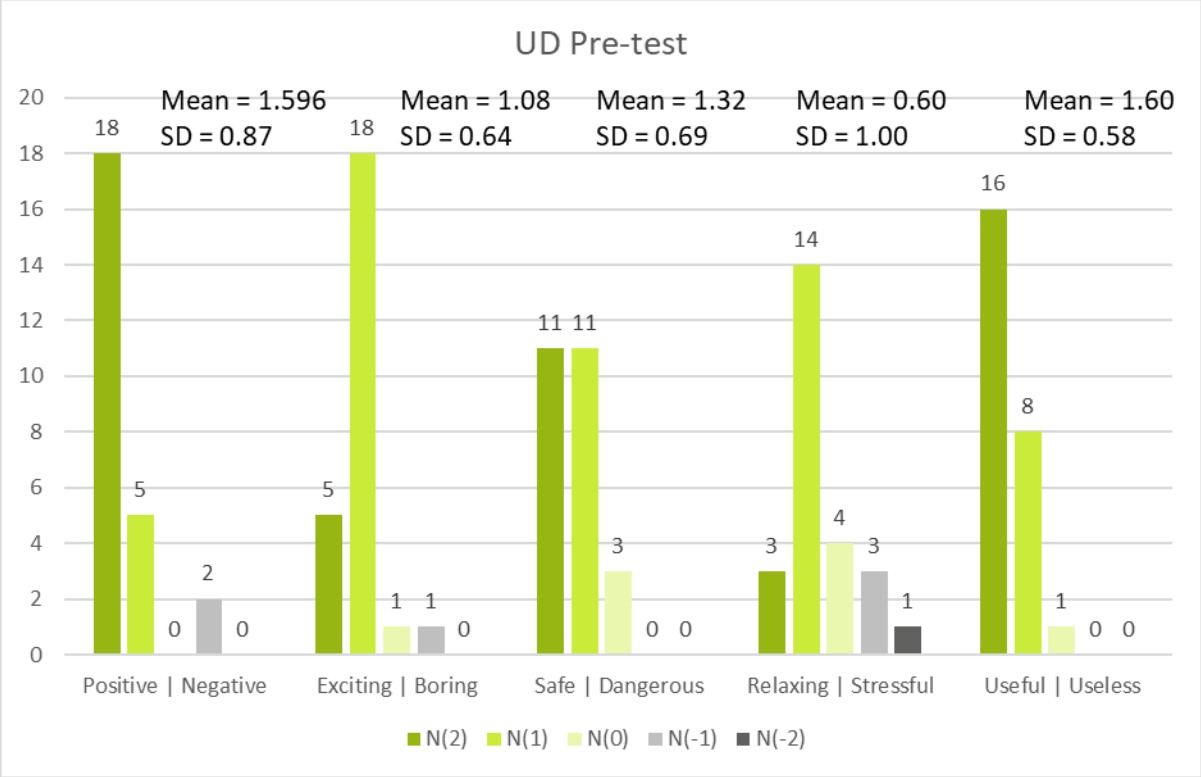


Figure 1: Participants expectations on the test and usefulness of the service

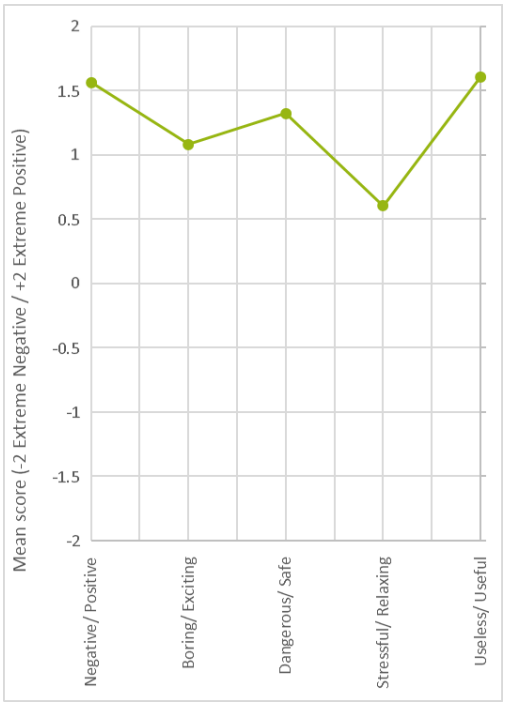


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service.

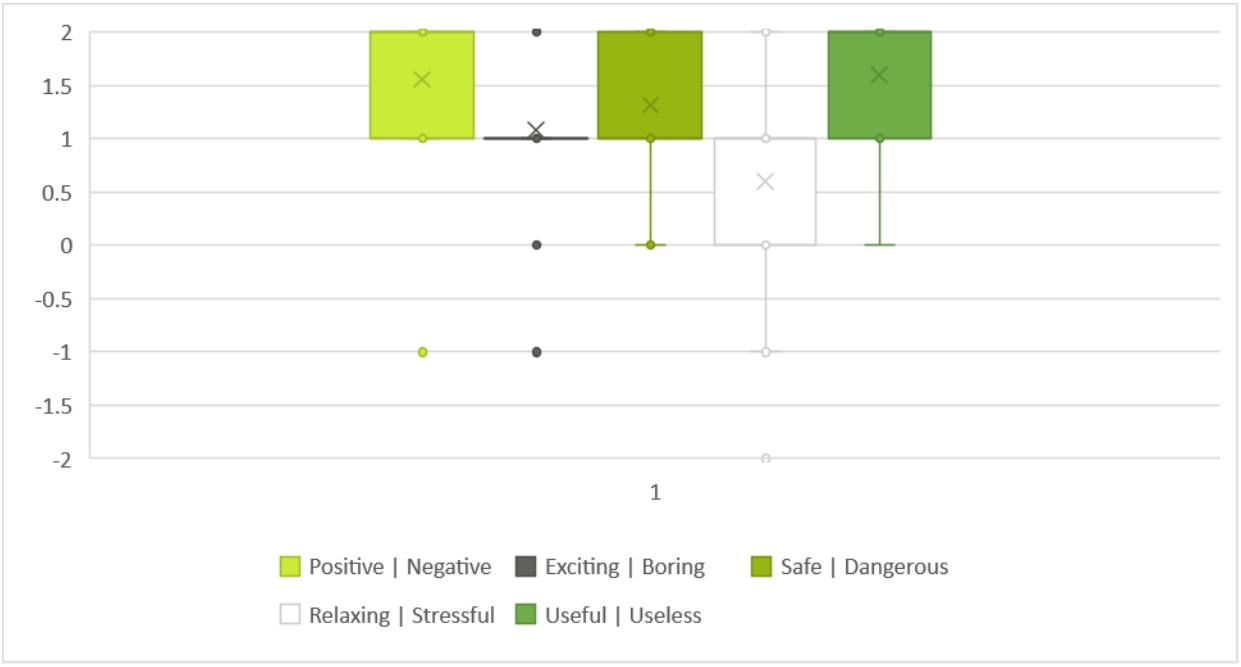


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- One to two participants thought that the experience would be negative or boring. Four participants thought that the experience would be stressful.
- Three to four participants were neutral about how stressful and dangerous the experience would be and one were neutral about how boring it would be.
- The least positive expectation was around how relaxing the experience would be

- The most positive expectation was around how positive the experience would be and how useful the system would be
- The greatest variation across all participants was about how relaxing or stressful the experience would be

Motivation for taking part in the study[1]

- I want to learn about the new developments. New side of new developments in transport
- I have been working with professional transport all my life. I am interesting in everything related to the field. .
- Out of interest, I have a car with normal gear
- Out of interest. The technical development has been so amazing and it has made it easier to function.
- Self driving cars and new technology are of interest
- To hopefully take the development forward
- The study seemed interesting, how driving can be developed by using computers.
- Interest in things assisting driving. I drive a lot for work and driving is quite tiring.
- Interest
- I am interested in all kinds of utilities for driving because the world is changing
- Interest in technical solutions and innovations in general as well as driving and its future
- Self driving cars are part of the future
- Interesting, opportunity of the future
- interest in new technology, willingness to participate in a potential improvement of safety
- Out of interest. I have always been interested in different technological applications and their impact on everyday life.
- I was interested in the idea of an automated vehicles and I had an opportunity to participate in the study
- I am very interested in technology, information technology and their development. I always gladly participate in studies
- Interesting topic. The possibilities for automation and artificial intelligence to make everyday life easier for a normal person is interesting
- I get information about a project under development, be part of the development and research. Interesting to participate in such a thing!
- I am happy to participate in different studies to enable the development of different services. It is also interesting to get to see and try a service even before it becomes available for everyone.
- I think the technology in question is interesting and it is fun to get to test how it works at this stage.
- I am very interested in self driving cars. Their technology, sensors and artificial intelligence.
- The topic is interesting and I follow the development actively
- I like to participate in studies and it is interesting to know what kind of things are studied and developed. I am interested in technology.
- Interesting and nice to get new information about the future.

[1] Translated from Finnish

- Out of interest towards combining information technology and driving

Other pre-test comments and expectations[2]

- Interested in how the automated vehicle reacts to unexpected situations. In the long run: how does it react in traffic towards humans sudden lane changes etc.
- Great interest towards the technology
- I look forward how smooth the course of the vehicle is overall
- Look forward to the test with great interest
- I wonder how the automated vehicle notices an abnormal pedestrian i.e. cyclist, wheel chair user etc. I look forward to the experience.
- I look forward to what is coming.
- I believe they will become very common in certain use cases in the future. Not maybe in personal cars on a daily basis driving from work to home, but for example in public transport, freight etc. And not necessarily at every parts of the drive, but in those "boring" routine parts
- Interesting to see where the research is at the moment when for example Tesla already has brought similar functionalities to traffic

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -2 to 2(eg Positive = 2, Negative = -2), in five areas. The same categories were used as in the Pre-Test.

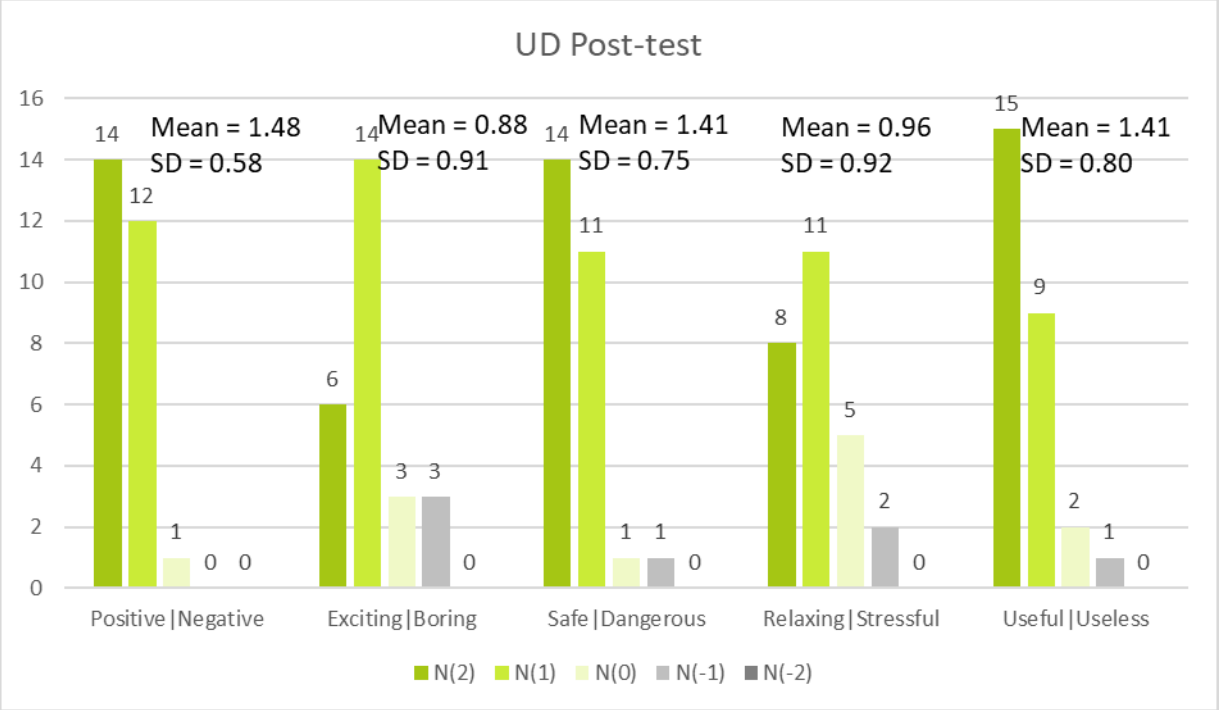


Figure 4: How participants felt about the test and usefulness of the service

[2] Translated from Finnish

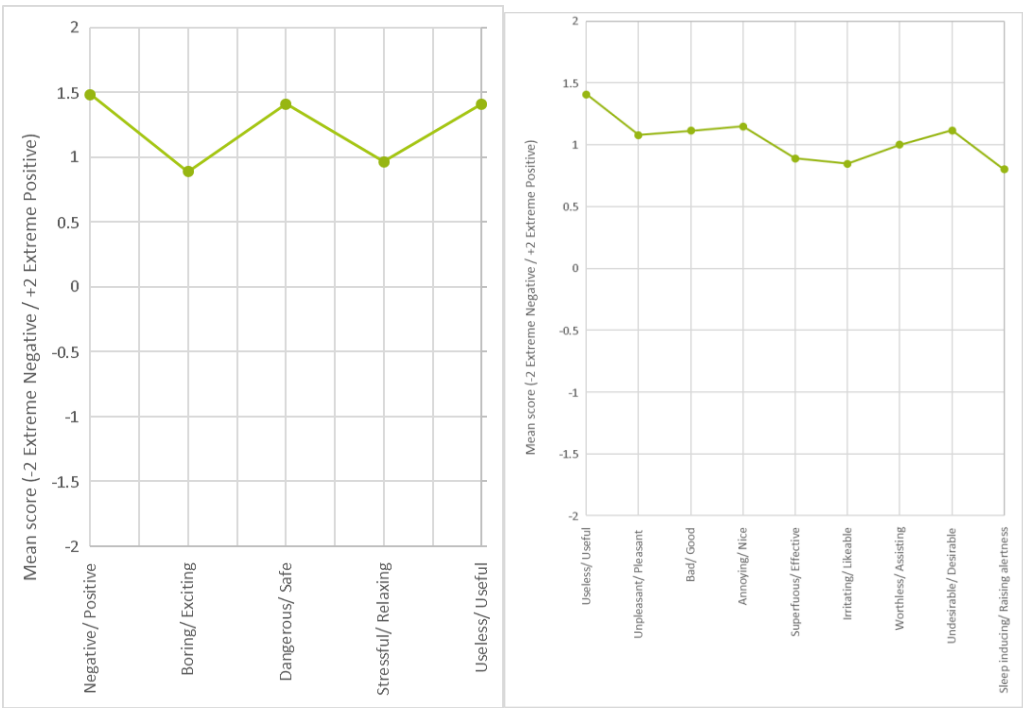


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

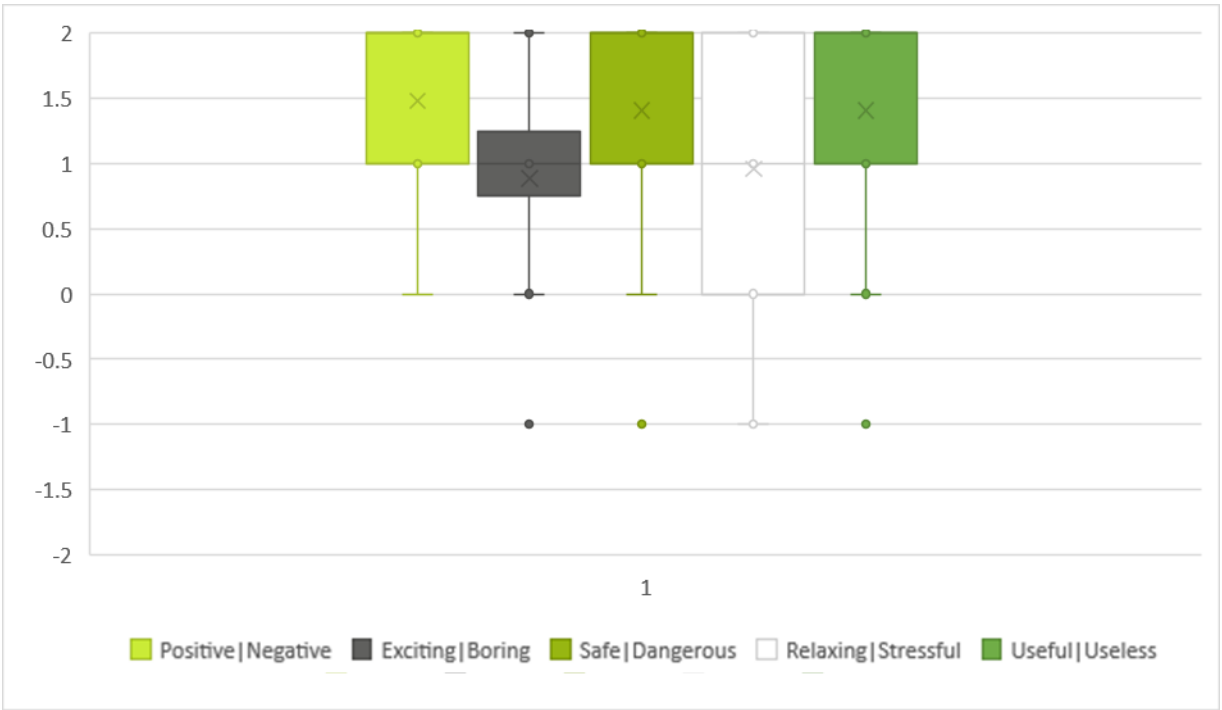
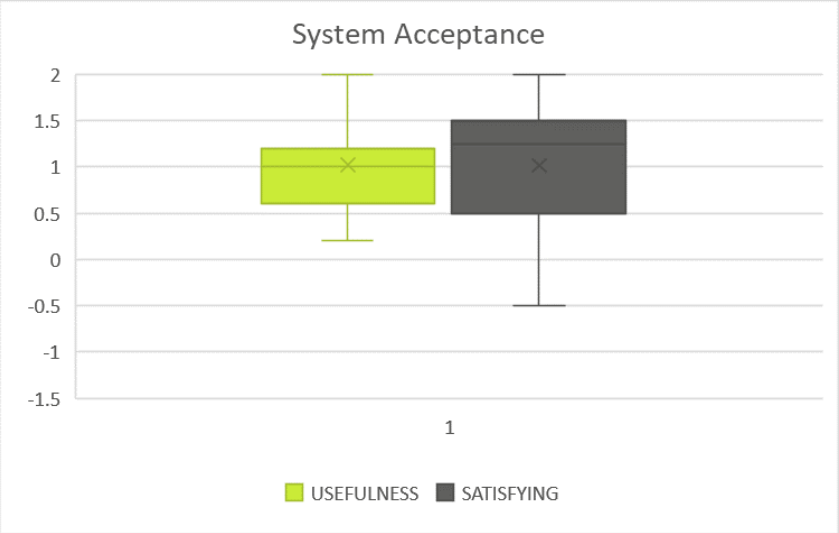


Table 1: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- One participant found the experience dangerous and one participant found it useful
- Three participants found the experience boring and two found it stressful
- Five participants were neutral about how relaxing or stressful the experience was
- The least positive reaction was regarding how exciting the experience was

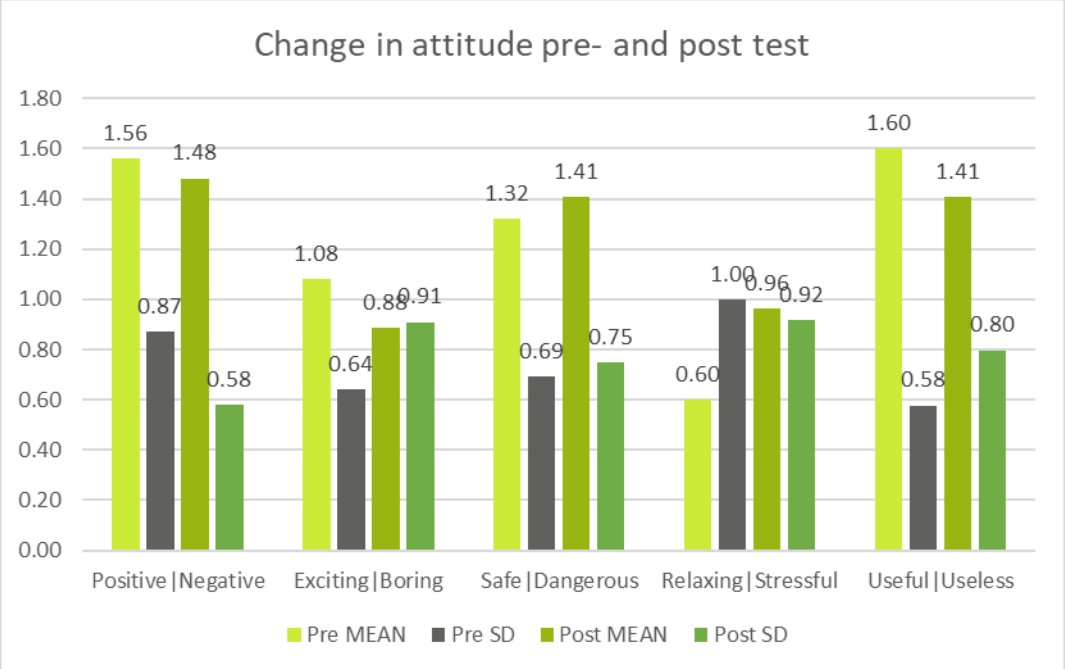
- The most positive reaction was about how positive the experience was
- The greatest variations across all participants were about how relaxing or stressful and exciting or boring the experience was

Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[3] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more satisfying than useful.



4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the five areas are below.



[3]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

Positivity of Experience

- The pre-test expectation was more exciting than the post-test reaction
- The pre-test expectations had a larger deviation than the post-test reactions
- This was the biggest change in SD from pre-test to post-test

Excitement of Experience

- The pre-test expectation was more exciting than the post-test reaction
- The pre-test expectations had a smaller deviation than the post-test reactions
- This was the smallest change in SD from pre-test to post-test

Safety of Experience

- There pre-test expectation was less safe than the post-test reaction
- This was one out of two areas which had a positive change from pre to post test

Stress of Experience

- The pre-test expectation was more relaxing than the post-test reaction
- It was the least positive area both pre and post test
- This was one out of two areas which had a positive change from pre to post test
- This was the biggest change in mean from pre-test expectations to post-test reactions

Usefulness of Service

- The pre-test expectations were more useful than the post-test reactions.
- It was the most positive area pre-test

Initial Post-Test Reactions[4]

Around half of the participants made a positive comment (marked green) and around half of the participants expressed some form of disappointment (marked red).

- A really positive experience
- Interesting experience. Started immediately thinking how that technology could be utilized for heavy good vehicles.
- I want a similar car for myself, was a really handy thing.
- Apparently the functionality adds safety. Giving way to the pedestrian was a good thing.
- Improves safety while communicating with the environment.
- Maybe not yet for sale
- Very interesting experience. A future that interests once it will work in traffic.
- Slighlty disappointed, so I was expecting a more mature "device"
- The service is still unfinished but you can see that the car can operate independently in traffic in some ways but not completely without a human driver.
- Useful service as long as the sensors in the car gets the information without the traffic cameras.
- All in all still quite in the beginning…but we are coming to that point where cars moves by themselves
- Interesting, a lot of phases still to solve but I am waiting with interest towards this future.
- Very qualified proof of concept of one kind of traffic light crossing situation
- Interesting, informative
- Interesting, slightly confusing, I missed some things
- Quite unfinished feeling of the service and its benefits were not yet evident without the

[4] Translated from Finnish

specific questions about goals and what concrete benefits the service could offer

- Braking was quite sudden with the automated vehicle. Quite interesting experience. I was wondering that the automated vehicle did not use a blinker while turning in the intersection.
- Very interesting and good thing and necessary.
- Interesting idea
- A necessary and useful addition to driving and support to drivers' eyes
- Interesting, clearly still in the piloting phase, still a lot to develop
- I was expecting the drive to be a lot smoother, especially in terms of braking, but otherwise everything seemed to work like I expected
- First I was surprised that all sensors were not in the car itself but they were included in the infra such as a pedestrian crossing camera and a traffic light status sensor. But this too is a reasonable angle to the problem. I now understand better what IoT and intelligent transport systems can mean as a whole and what the benefits could be.
- The idea is good, but the first experience was a bit confusing
- Definitely a useful feature in addition to the cars own sensors
- Interesting and surprisingly comfortable
- Interesting vision for the future

10 participants reported that they did not feel unsafe or uncomfortable during the test. 12 participants reported some behavior that made them feel uncomfortable:

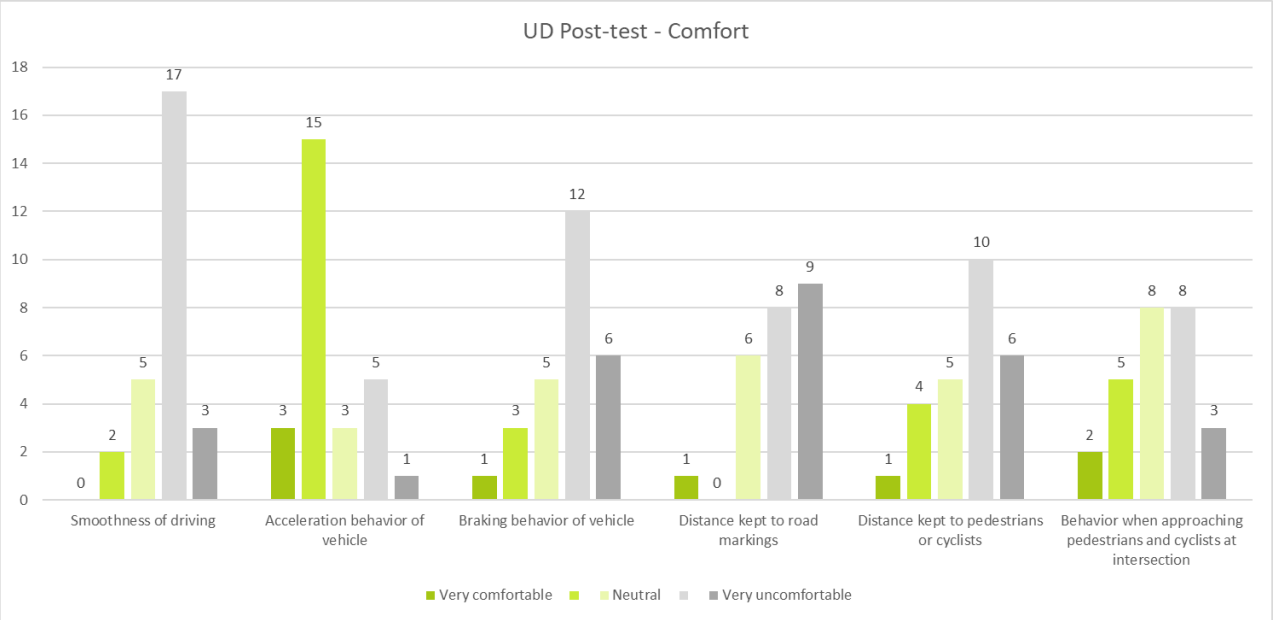
- Sudden braking
- The car stopped quite close to the pedestrian, the ride was safe and calm.
- Mostly afraid for the pedestrian
- Not unsafe but the movement of the car is not yet that smooth that you could sit calmly in the ride and trust that everything would work in busy traffic.
- Slow internet connection, does data run fast enough to prevent accidents
- Braking was so hard, it made me feel unsafe
- When departing the robot control swayed from the side to the other lane, departures and stops were aggressive and sudden.
- Not really, but the feeling is that I would not dare to go outside the test area to test when e.g. the connection of information systems before departure was off and it took a while to get back on
- The car continued driving surprisingly long even though the obstacle was already ahead. This made me wonder how to get the car to stop on time, at what point the driver panics, whether the obstacle has been detected since the car is still moving since I would have braked already etc. The movements of the car are at least in this stage still quite sudden. We did not go straight on the road but the steering wheel swung from side to side.
- The stops were a bit stiff and bumpy. The car gave well way to the pedestrian but as a human driver I would have stopped smoother a bit farther away.
- The driver had to interfere slightly with the braking. The car swayed a bit which did not seem very good.
- Sudden braking was a little hard.

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 Comfort whilst experiencing the service

Participants were asked to comment on the perceived comfort of various aspects of the service. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice.



- 20 participants thought that the smoothness of driving was uncomfortable
- 18 participants thought that the acceleration behavior of vehicle was comfortable
- 18 participants thought that the braking behavior of vehicle was uncomfortable
- 17 participants thought that the distance kept to road markings was uncomfortable
- 16 participants thought that the distance kept to pedestrians and cyclists was uncomfortable
- 11 participants though that the behavior when approaching pedestrians and cyclists at intersection was uncomfortable
- Three to eight participants were neutral for each aspect; highest share of neutral was for behavior when approaching pedestrians and cyclists at intersection

Participants were also asked if there was any other behavior of the vehicle that made them feel uncomfortable. The answers of the participants are [5]:

- On the straight road, it did too sudden steering movements unnecessarily, gradually, gradually. The same with braking: gradually
- At some point, the car wandered on the road looking for direction
- It was a bit disturbing with the "bumpy" movements. The movement should be made soft
- The car's location of its position on the road without the road markings was quite going back and forth
- Only the sudden stopping during braking
- The so called human touch was missing from the braking i.e. the braking came really hard, inevitably affecting all kind of situations caused occurring in the curve by the person on the sidewalk caused
- On the straight sections, the vehicle searched for a straight line a bit windingly. It did not give a very reliable picture, especially once you add the relatively low speed of the vehicle.
- There could perhaps be a few centimeters more distance to the pedestrian when the car stops.

[5] Translated from Finnish

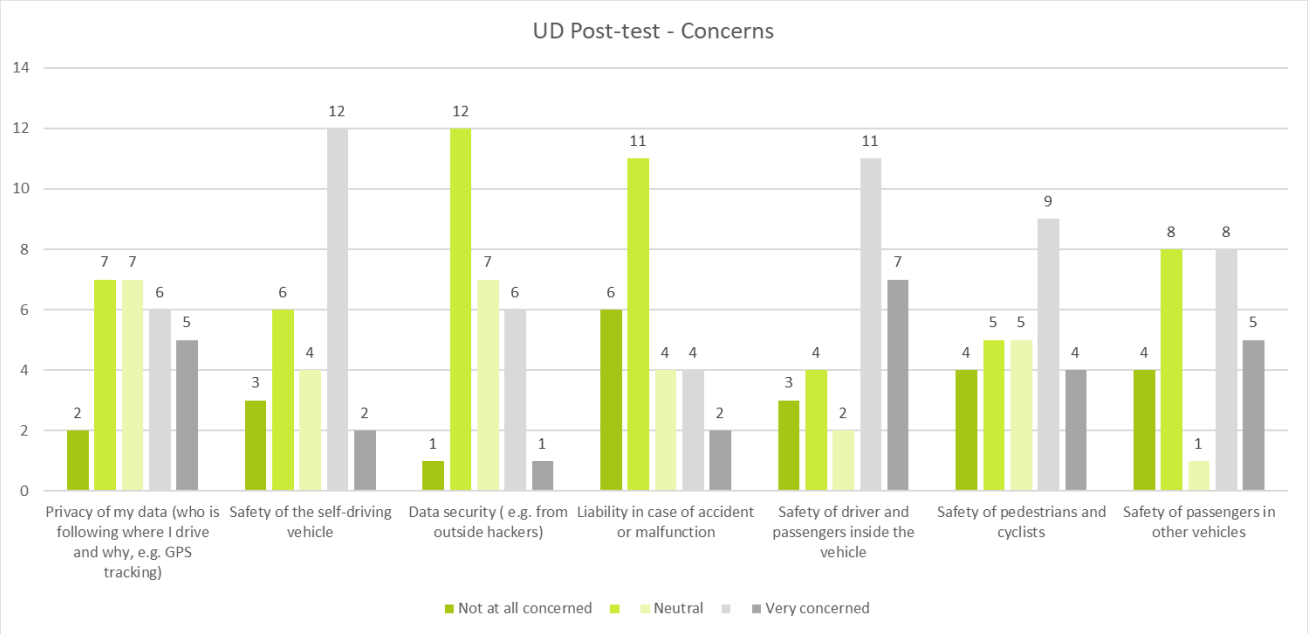
- As the pedestrian approached, it seemed that it would not stop, but stopped however a little later
- On the straight section the car "swayed" a little and did not stay completely on the lane
- It drove quite close to the pedestrian and the braking was sudden. The driving did not feel very anticipatory.
- The car winded on the straight section.

4.4.2 Motion sickness

Participants were asked whether they experienced motion sickness. One participant indicated that they became slightly nauseated and in gave the following comment “I am very sensitive to motion sickness as a passenger, so no wonder if some of such feelings occur in such a situation”.

4.4.3 Concerns of the tested service

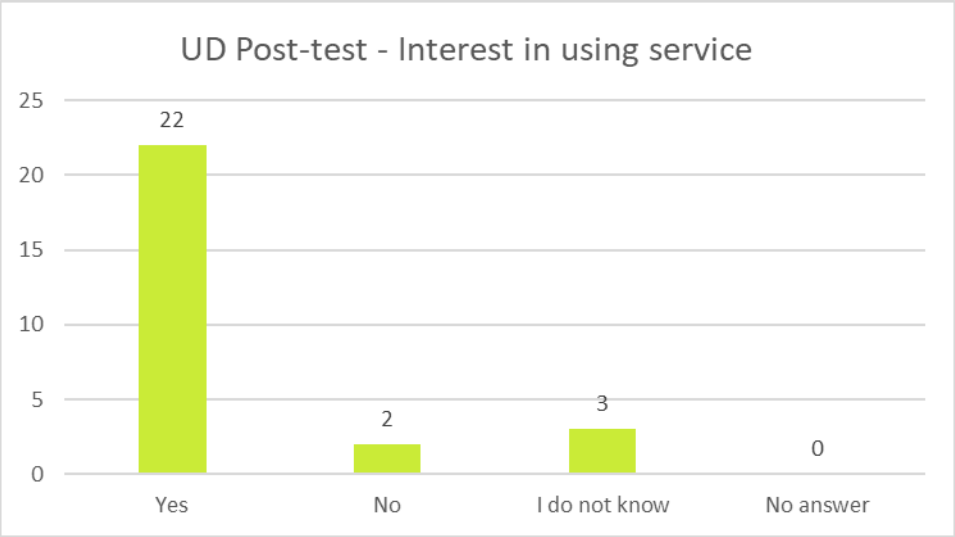
Participants were asked to comment on their concerns of various aspects of the service. They were ranked from Very concerned to Not at all concerned, with Neutral as a central choice.



- 11 participants were concerned with privacy of my data
- 14 participants were concerned with the safety of the self-driving vehicle
- 6 to 7 participants were concerned with data security and liability in case of accident or malfunction
- 18 participants were concerned with safety of driver and passengers inside the vehicle
- 13 participants were concerned with safety of pedestrians and cyclists and passengers in other vehicles
- Participants were least concerned about data security and liability in case of accident or malfunction
- Participants were most concerned about safety of driver and passengers inside the vehicle
- For each of the aspects, one to seven participants were neutral

4.4.4 Interest in service

Participants were asked whether they would be interested in using the service regularly if it was available (in full operation, as this was a limited trial). The options were yes, no, I do not know and no answer.



- The majority of participants (81%) would be interested in using the service regularly if it was available in full operation
- 3 participants did not know whether they would be interested

The following explanations were provided by the participants who said they would be interested:

- Yes it would increase safety
- It is extremely nice to see how automation works in practice
- For example in an unknown city
- An automated vehicle would make life easier and leave time for other things
- Especially if it is free, then in use
- It would help a lot while driving daily travelling
- Travel time could be more efficiently used e.g. working
- If it would work perfectly
- Good for shared and rented vehicles. The parking service would be interesting as well, no bumps if the drivers did not drive into narrow parking garages.
- I would use it but I would also like to choose to drive myself
- In certain situations easier and even desirable
- If the service works fluently and smoothly complementing your own driving and increasing safety by adding an "extra" sense
- I could for example do work things while driving
- Especially in congested areas where a lot of different obstacles are moving, especially fast going bikes. On the other hand in quiet areas where you might not always remember to observe and then today someone else might be coming for example at low visibility points.
- Extremely welcomed addition to safe driving both for oneself and for extra sensing specifically in "dead corners"
- On commuting trips, you could already focus on work, read and answer emails. No need to stress in congested traffic
- Possibly if the service is completely integrated in the other features of the car and if the price

is reasonable.

- If it would work as well as a human driver. Or if you would get the information yourself and as a driver make the decision based on that. Because you could see whether the information from the IoT is true or not.
- It would be easy if the car stopped by itself when a pedestrian rushes out if I did not notice it.

The following explanations were provided by the participants who said they would not be interested:

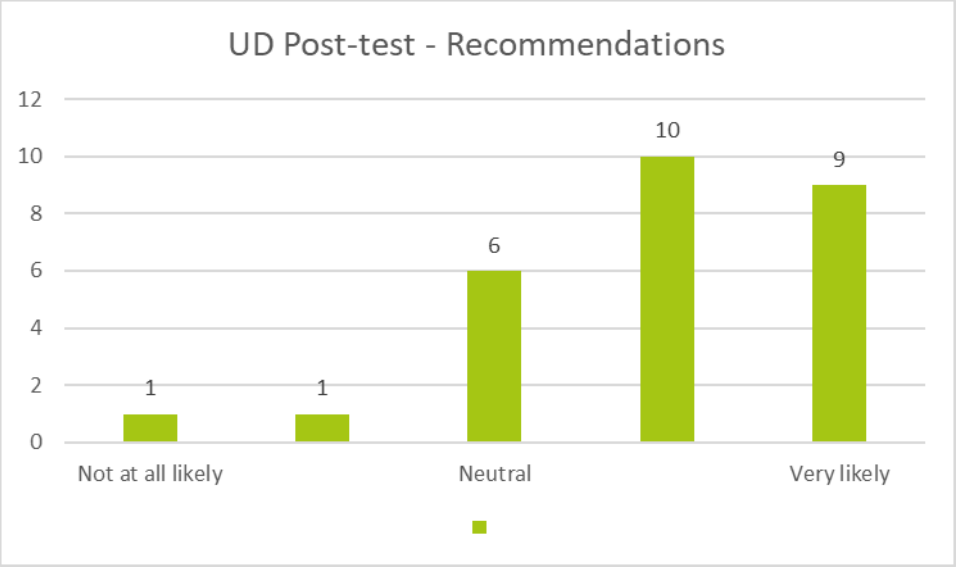
- I might consider the service and use it in real situations but I trust more the logic and judgement of human minds in a real situation and I would probably not use the service.
- Letting the automated vehicle drive causes stress and tension. I would not with the current sudden moves let it drive for me. The parking I could happily let the vehicle do for me.

The following explanations were provided by the participants who said they did not know whether they would be interested:

- The price can be high.
- Should be standard equipment in all cars
- Still quite a long way before it is suitable for road traffic, it would be interesting to come test again once the testing has developed

4.4.5 Recommendations

The participants were asked how likely they would recommend the service to a friend or colleague. They were ranked from Very likely to Not at all likely, with Neutral as a central choice.



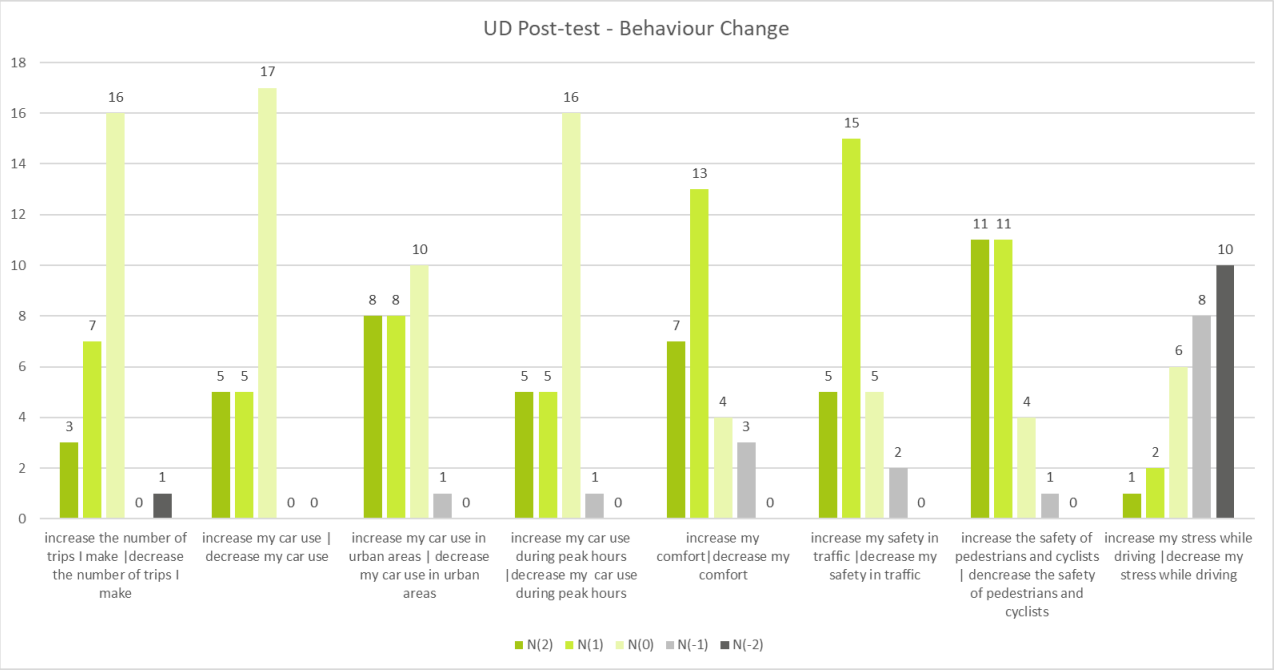
- The majority of participants would recommend the service to a friend or colleague; 19 participants were likely to recommend
- Six participants were neutral about recommending the service to a friend or colleague

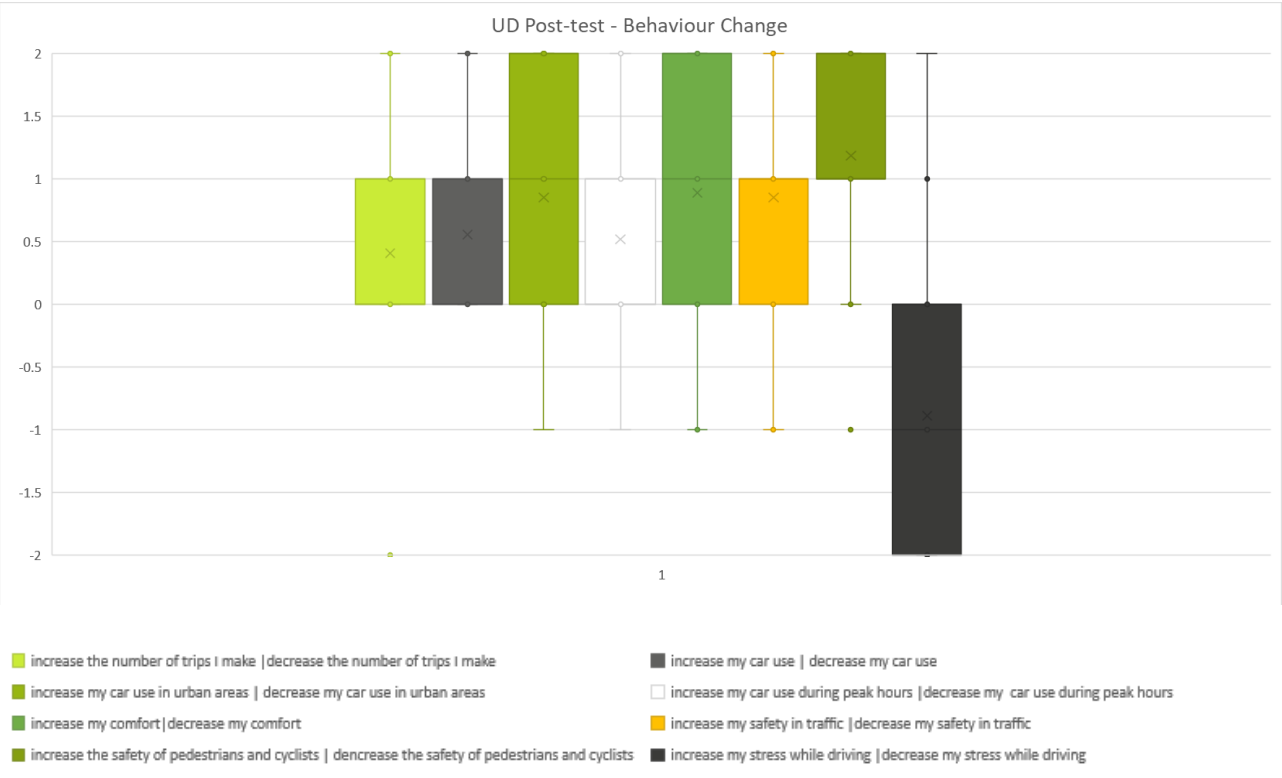
4.5 Post-Test Thoughts on Future Use

Participants were asked to comment on how they might use the service if it was available.

4.5.1 Behaviour Change

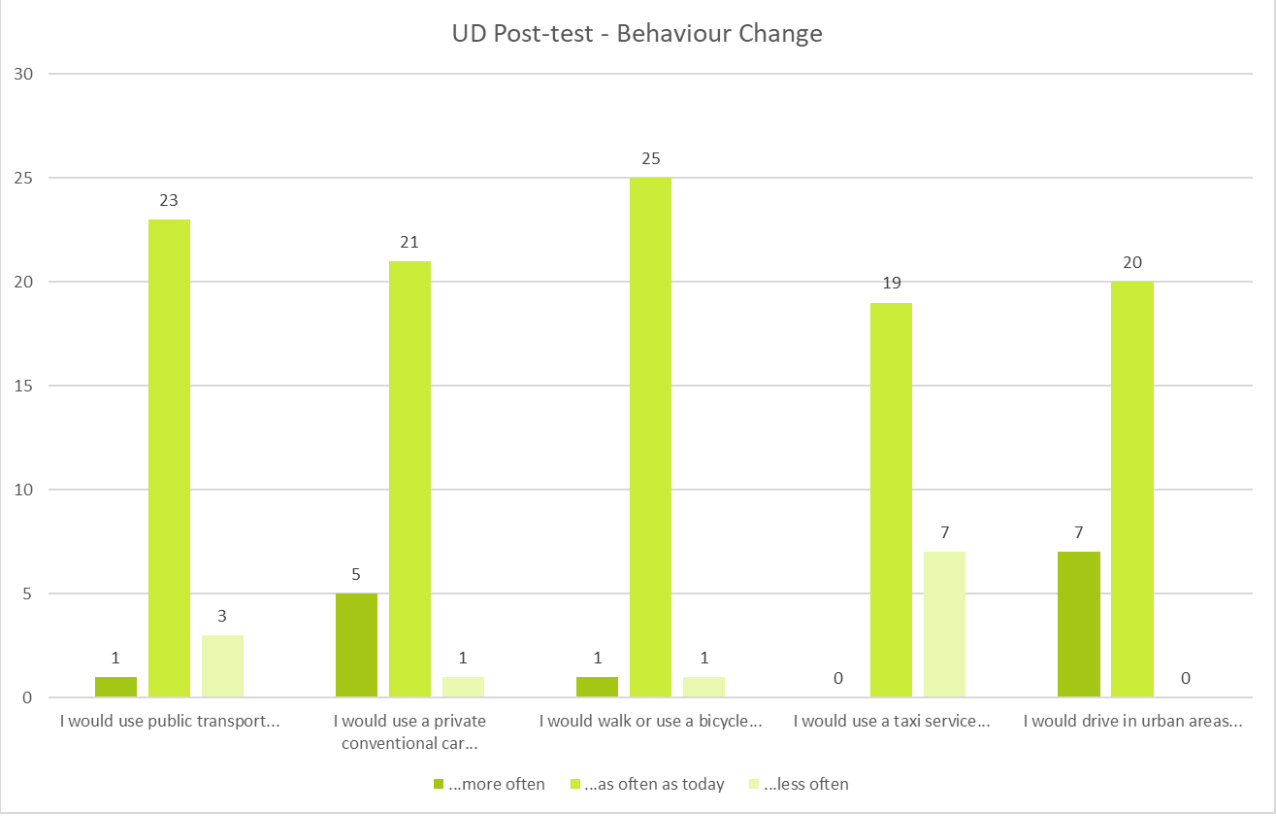
Participants were asked how the service might affect their usual travels as both a leader and a follower. This included how trips, private car use, traffic safety, stress and comfort would change (ranked between -2 and 2).





- 10 participants thought the service would increase their overall number of trips and 16 participants thought it would not change their overall number of trips
- 10 participants though it would increase their private car use and 17 thought it would not change
- 16 participants thought that the service would increase their car use in urban areas and 10 thought it would not change
- 10 participants thought that the service would increase their car use during peak hours and 16 thought it would not change
- 20 participants thought that the service would increase their comfort and 4 thought it would not change
- 20 participants thought that the service would increase their safety in traffic and 5 thought it would not change
- 22 participants thought that the service would increase safety of pedestrians and bicyclists and 4 thought it would not change
- 18 participants thought that the service would decrease their stress while driving and 6 thought it would not change

Further to behavior change, participants were asked how the service would affect their choice of travel mode and driving environment. The response alternatives were …more often; …as often as today; …less often.

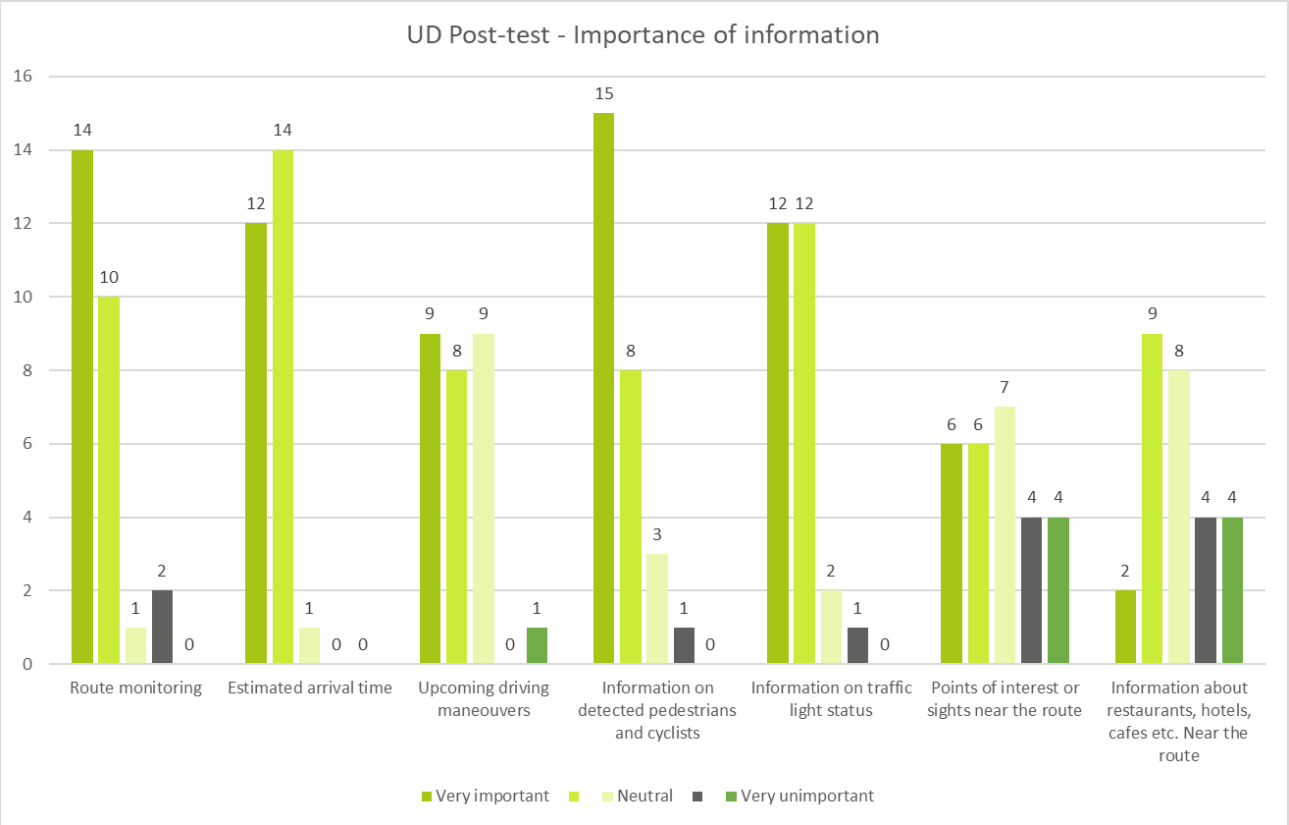


- A majority of respondents (70–86%) would not change their choice of travel mode or driving environment.
- 3 participant said they would use public transport less often than today
- 5 participants said they would use a private conventional car more often than today

- 1 participants said they would walk or bicycle less often than today
- 7 participants said they would use a taxi service less often than today
- 7 participants would drive more often in urban areas than today

4.5.2 Importance of Information during Service

Participants were asked about the importance of various aspects of information that could be provided through the service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- A majority (23 to 26) of participants found it important to get the following information: route monitoring, estimated arrival time, information on detected pedestrians and cyclists and information on traffic light status
- 17 participants found it important to get information on upcoming driving maneuvers
- 11 to 12 participants found it important to get information on points of interest or sights near the route and information about restaurants, hotels, cafes etc. near the route
- 8 participants found it unimportant to get information on points of interest or sights near the route and information about restaurants, hotels, cafes etc. near the route

Participants were also asked if there is any other information that they would like to have. The answers of other information that participants would like to have are [6]:

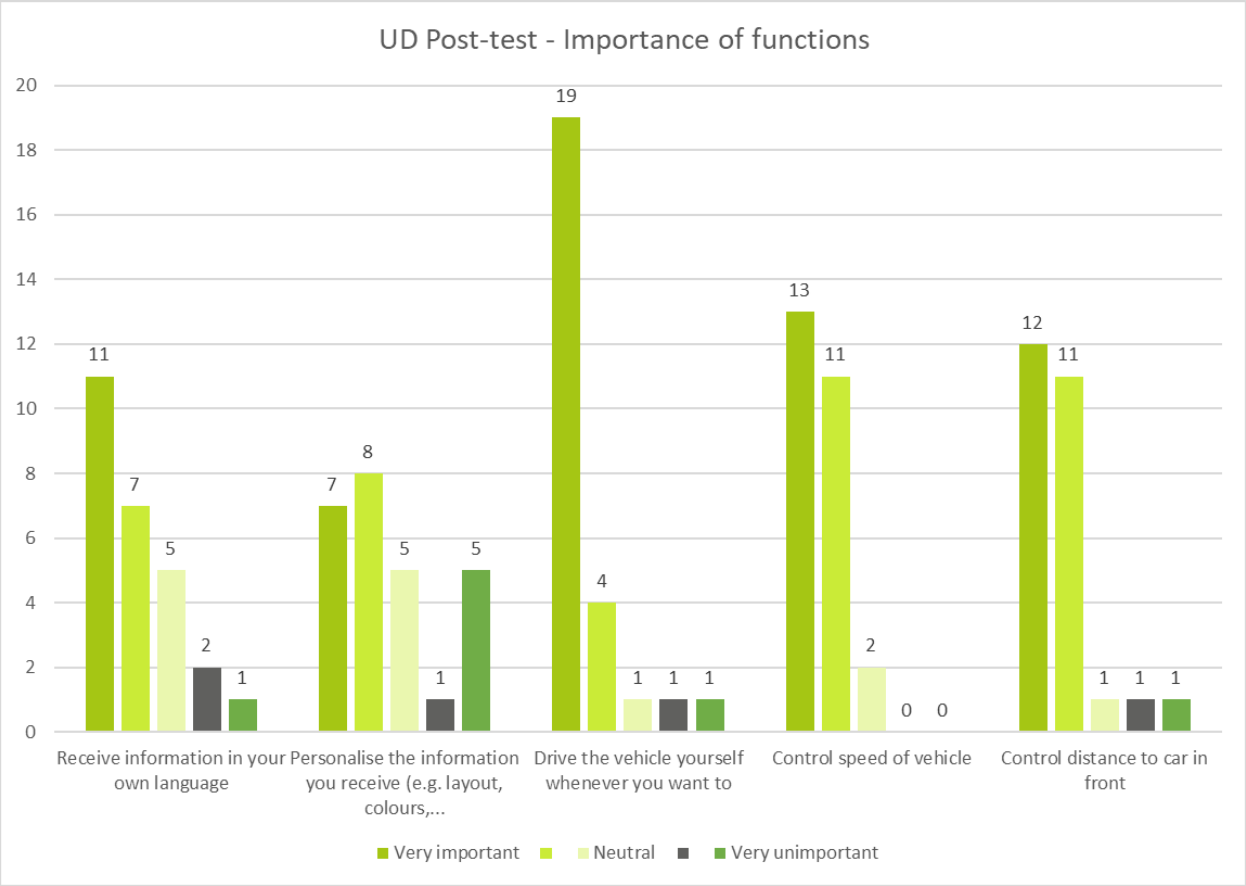
- Blind spots as signal sounds, would utilise parking radars in the car to account for pedestrians and bicyclists around the car

[6] Translated from Finnish

- Information about congestion, alternative routes
- All wishes are almost solely related to functioning in an unknown environment e.g. in a foreign city. No arrival time needed in Tampere.
- Target speed for driving in green wave in consecutive traffic lights
- Accident sites along the route and congestion. Give information on a possible detour to the driver in good time
- Information on free parking spots
- Free parking spots and availability and proactive congestion information
- Potential traffic jams and road works that could help you plan your driving better
- Free parking spots and their fees
- Weather conditions and their impact on reactions, visibility, brakings etc.
- General traffic situation, congestion and disturbances
- Information on animals, e.g. moose and reindeers. For example, if during the last quarter a vehicle has detected an animal on my route, I would be informed if I would arrive at that spot in that time frame. Information about road works, congestion and all changes on the road. Information on particular dangerous spots. Information on weather and road conditions (slipperiness, amount of snow). Estimated fuel consumption on the route, i.e. some "profile" on the route and terrain.

4.5.3 Importance of Functions of the Service

Participants were asked about the importance of various functions during the service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



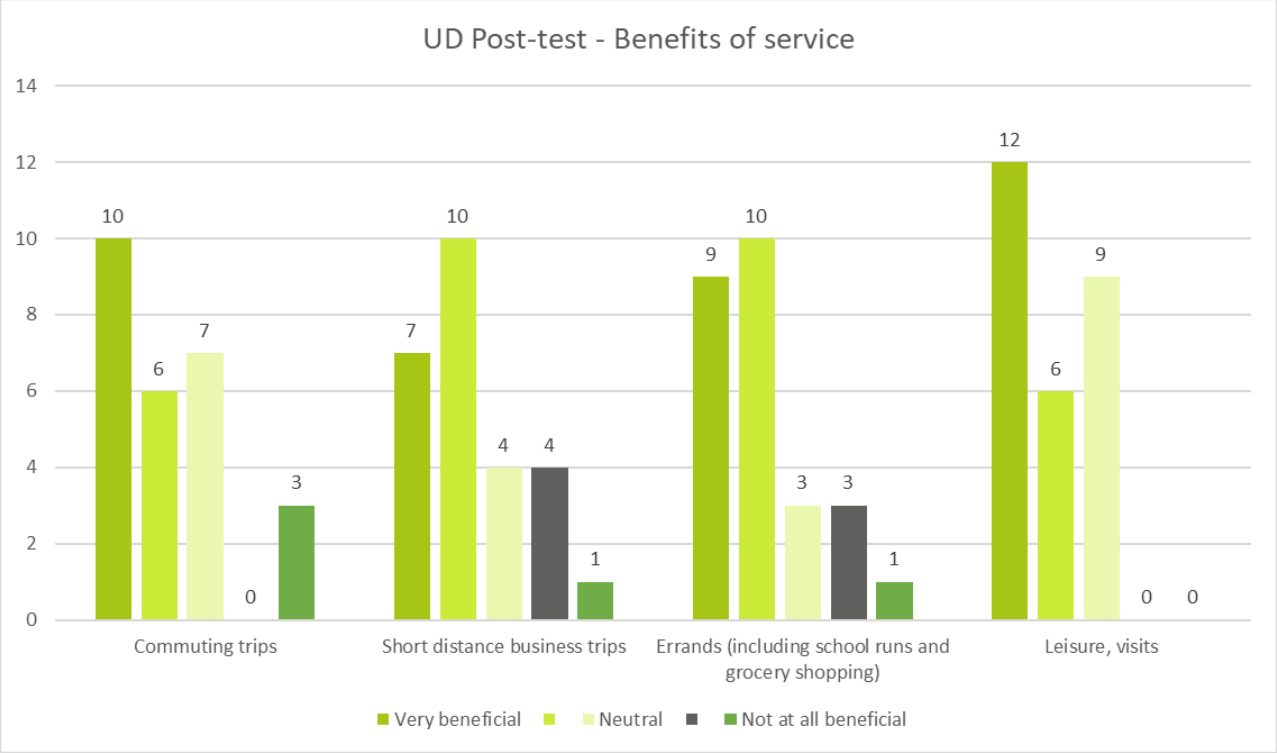
- 19 participants found it important to get information in their own language
- 15 participants found it important to personalize the information they receive
- 23 participants found it important to drive the vehicle themselves whenever they want to
- 24 participants found it important to control the speed of the vehicle
- 23 participants found it important to control the distance to car in front

Participants were also asked if there is any other function that they would like to have. The answers of other functions that participants would like to have are [7]:

- Animals (that might run from the forest in front of the car) outside urban areas
- Adjust the speed from optimum to required arrival time, taking into account fuel consumption and possibly weather conditions
- Autonomous parking
- To be able to view nearby objects (i.e. objects to give way to)

4.5.4 Benefits of Service

Participants were asked how beneficial the service would be to them on their regular or daily trips. These were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



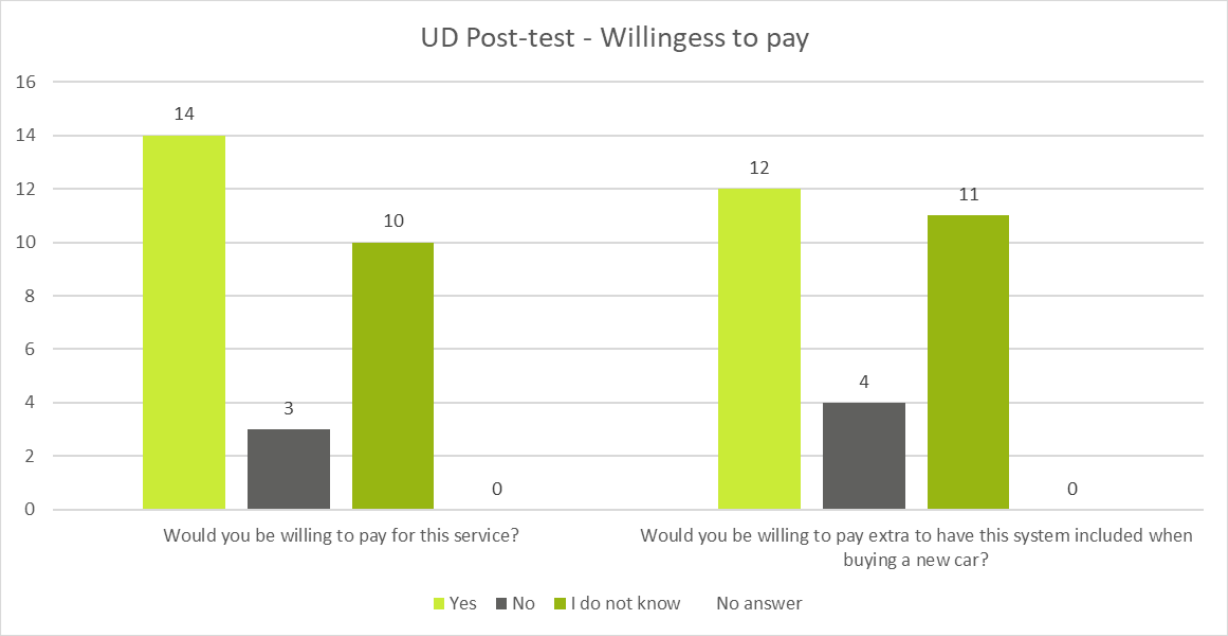
- The majority of participants thought that the service would be beneficial on all types of trips
- For commuting trips; 16 participants thought the service would be beneficial and 3 thought that it would not be beneficial
- For short distance business trips; 17 participants thought the service would be beneficial and 5 thought that it would not be beneficial
- For errands; 19 participants thought the service would be beneficial and 4 thought that it would not be beneficial

[7] Translated from Finnish

- 18 participants thought the service would be beneficial on leisure visits
- The service was seen as most beneficial for errands and least beneficial for commuting trips

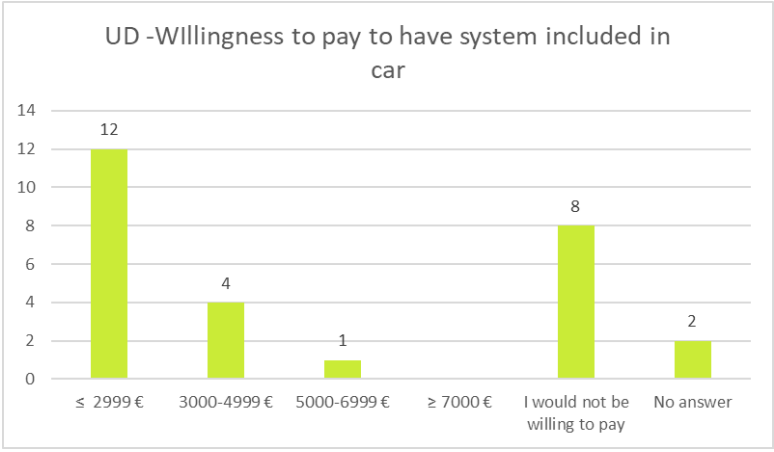
4.5.6 Willingness to pay

The participants were asked if they would be willing to pay for this service and pay extra to have this system included when buying a new car.



- 14 participants would be willing to pay for the service
- 12 participants would be willing to pay extra to have the system included when buying a new car
- 10 to 11 participants did not know whether they would be willing to pay for the service or to have the system included when buying a new car

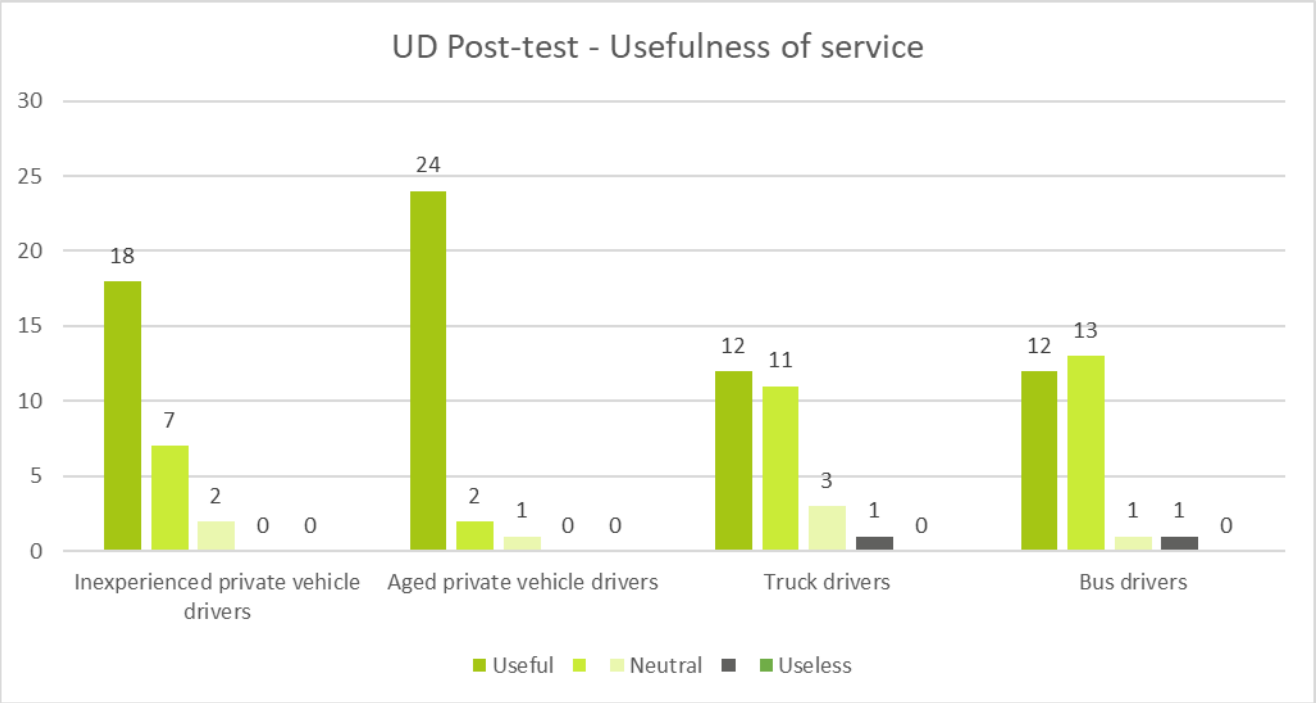
The participants were asked how much they would be willing to pay for including this system in their car



- 12 participants were willing to pay less than 2999 € to have the system included in their car

4.5.7 Usefulness of Service

Participants were asked how useful the service would be for different types of users. These were ranked from Useful to Useless, with neutral as a central choice.



- 25 participants found the service useful for inexperienced private vehicle drivers
- 26 participants found the service useful for aged private vehicle drivers
- 23 participants found the service useful for truck drivers
- 25 participants found the service useful for bus drivers
- One participant found the service useless for truck drivers and bus drivers repsectively

4.5.8 Additional feedback

Participants were given the opportunity to give further feedback to designers of the system on anything else that might make it more useful to them:

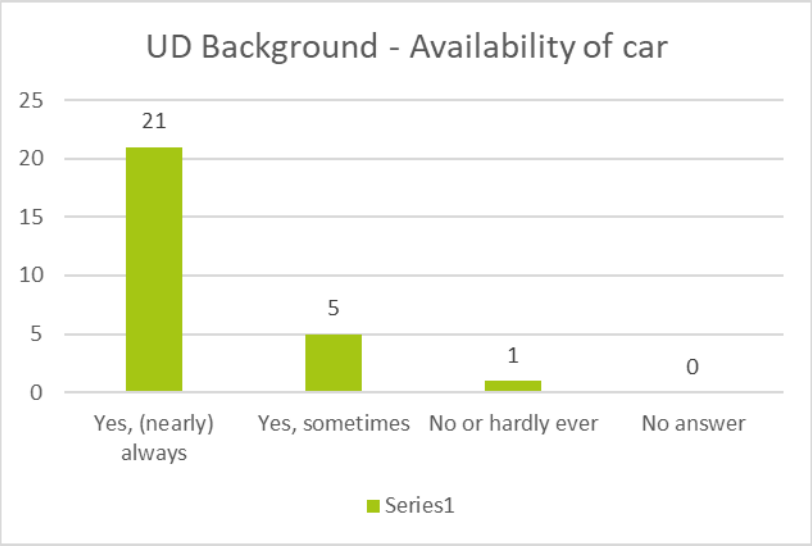
- Free
- When this is ready is there a need for these drivers?
- I don't think it would be good for the inexperienced since they would not then learn to drive without the service
- Forecasting and availability of parking spaces
- It could be more clearly defined what this service includes (vs. the vehicles own automated functions). The experience must be well integrated into the vehicle's own features and interface
- A little calmer stop in the future

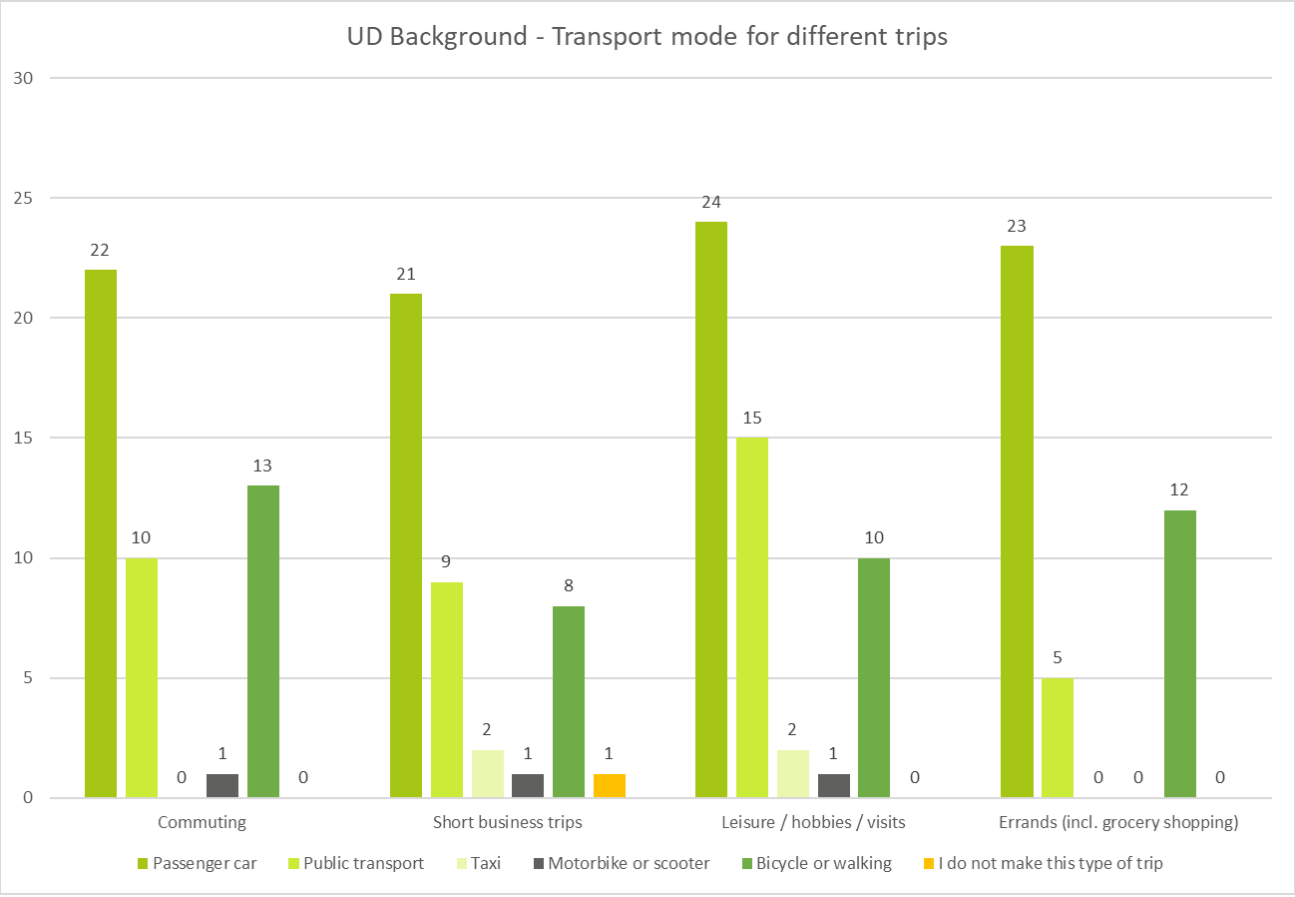
5 Background

Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

5.1 Travel Habits

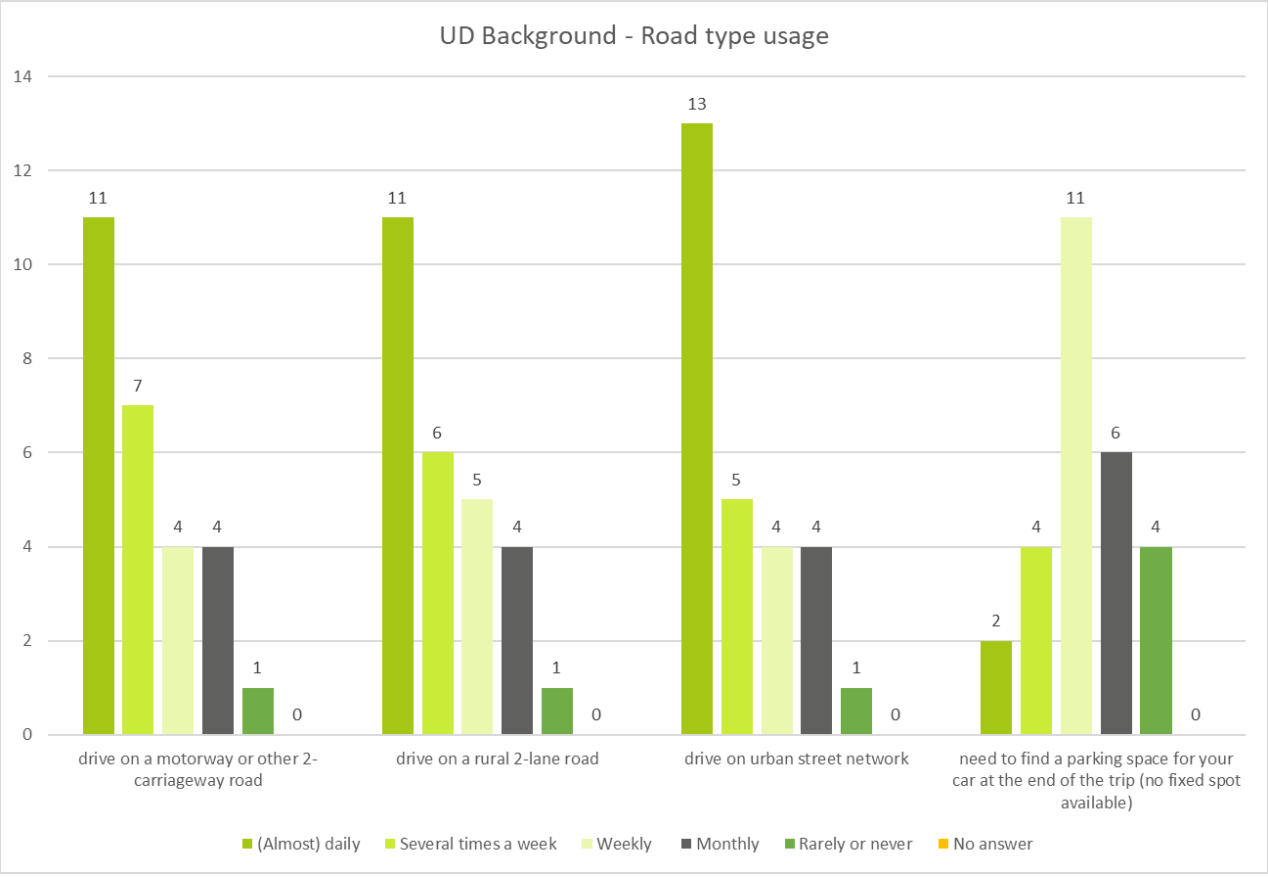
Participants were asked whether they had a car available and what transport modes (1-3 options) they used for various trip types.





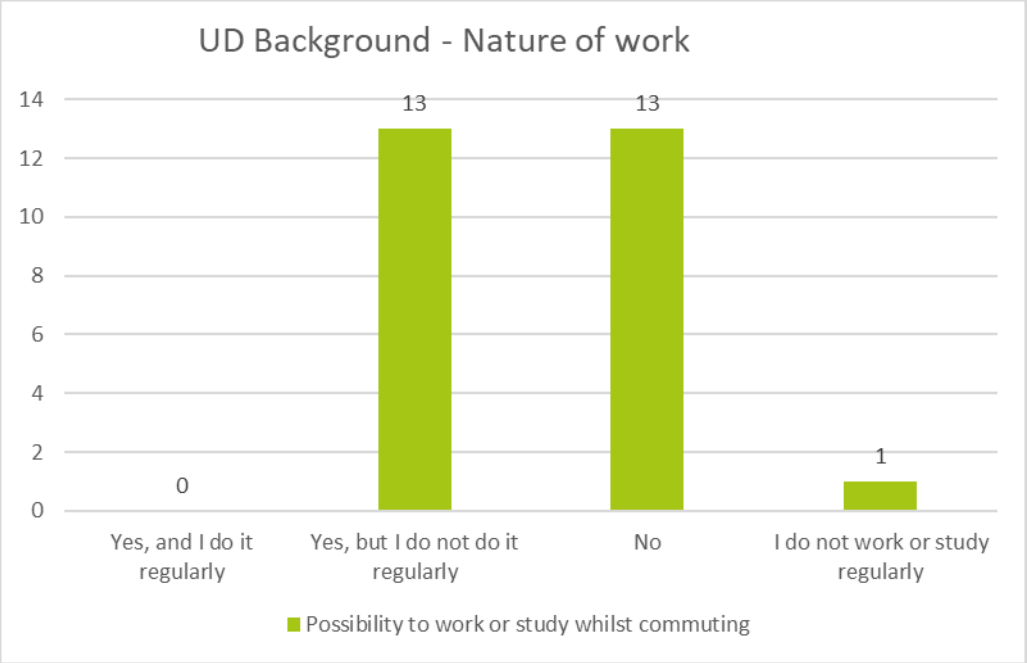
- 21 participants had a car available nearly always
- For commuting trips 22 participants used passenger car, 10 participants used public transport, and 13 participants bicycled or walked
- For short business trips 21 participants used passenger car, 8 to 9 participants used public transport or bicycled or walked
- For leisure, hobbies and visits 24 participants used passenger car, 15 participants used public transport and 10 bicycled or walked
- For errands 23 participants used passenger car, 5 participants used public transport and 12 bicycled or walked
- Passenger car was the most used transport mode for all trip types
- Public transport was the second most used transport mode for short business trips and leisure, hobbies and visits
- Bicycle or walking was the second most used transport mode for commuting and errands
- Taxi and motorbike or scooter was used by one to two participants respectively for all trip types except errands
- One participant did not make short business trips

Participants were asked how often they drove on different road types and how often they had to find a parking spot at the end of the trip.

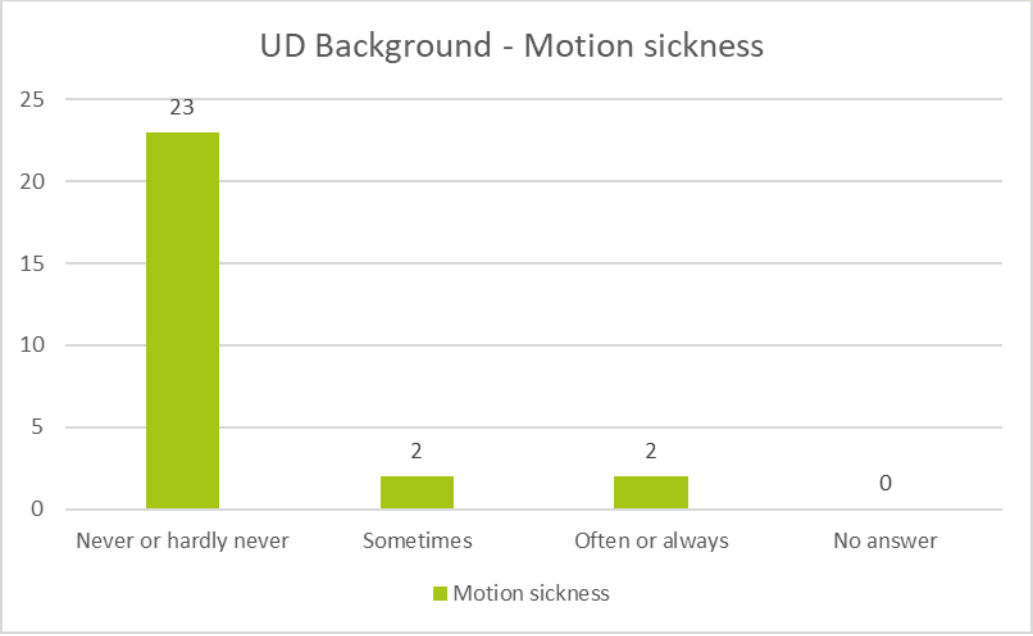


- Over half of participants (17 to 18) drive on all road types at least several times a week
- Four to five participants drive weekly on all road types
- Five participants drive monthly or less often on all road types

- 16 participants have to find a parking space at the end of the trip at least weekly
- 10 participants have to find a parking space at the end of the trip monthly or less often



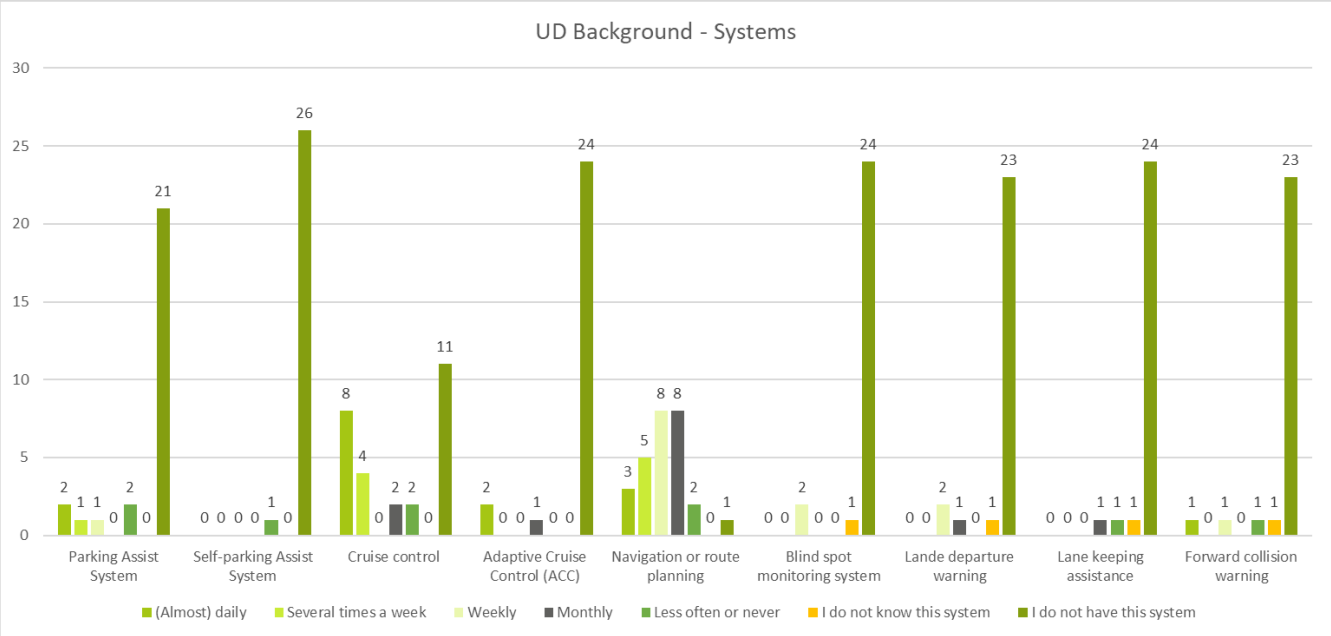
- 13 participants could work or study whilst commuting but they do not do it regularly
- 13 participants do not have possibility to work or study whilst commuting and 1 participant do not work or study regularly



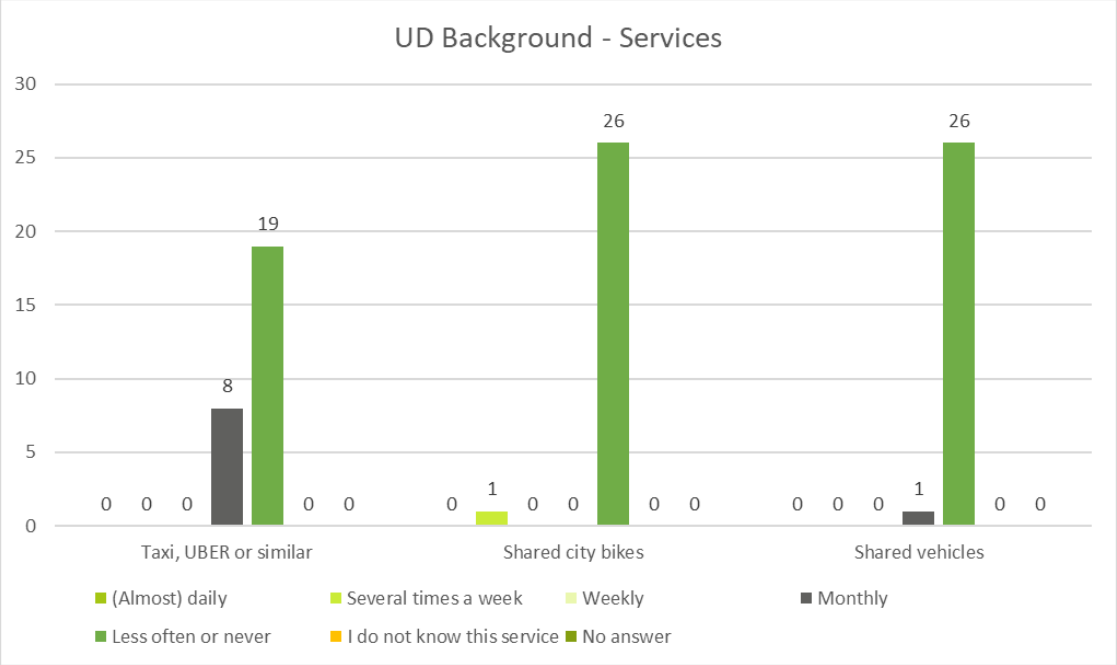
- 23 participants never or hardly never experience motion sickness while travelling
- 2 participants experience motion sickness sometimes or often or always respectively

5.2 System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



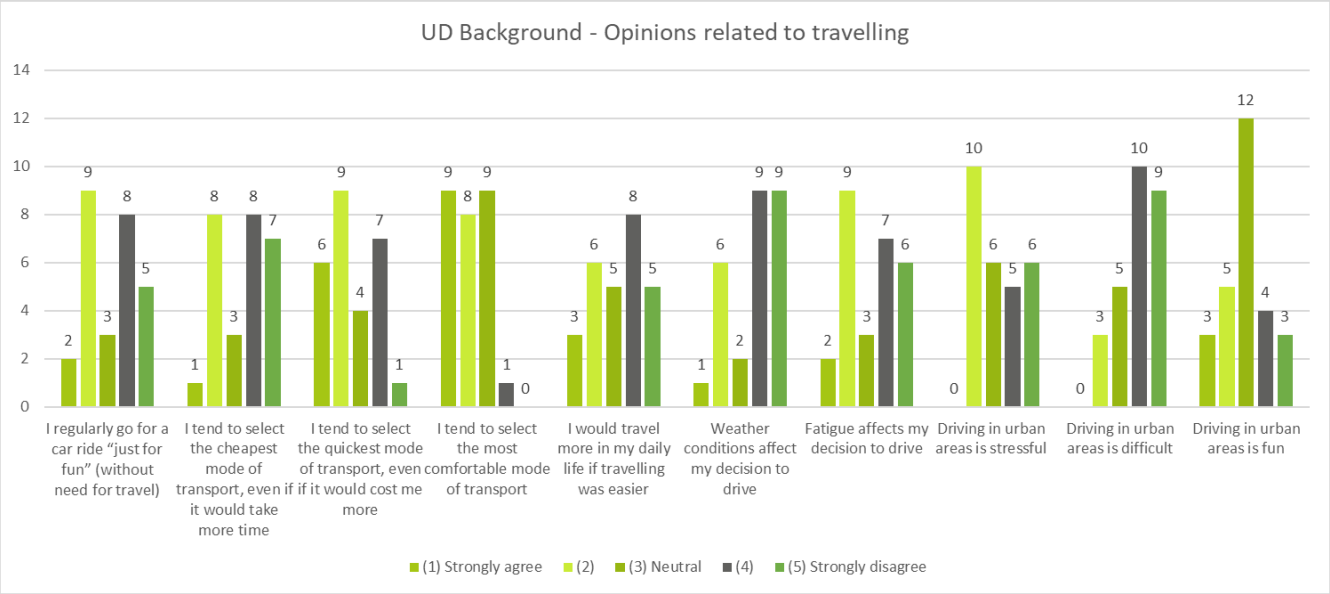
- 12 participants use cruise control (almost) daily or several times week
- 8 participants use navigation or route planning(almost) daily or several times week and 8 use it weekly
- 21 to 26 participants did not have parking assist system, self-parking assist system, adaptive cruise control, blind spot monitoring system, lane departure warning, lane keeping assistance or forward collision warning
- One participant did not know blind spot monitoring system, lane departure warning, lane keeping assistance or forward collision warning



- Taxi, UBER or similar was used monthly by 8 participants and less often or never by 19 participants
- Shared city bikes was used weekly by 1 participant and less often or never by 26 participants
- Shared vehicles was used monthly by 1 participant and less often or never by 26 participants

5.3 Opinions related to travelling

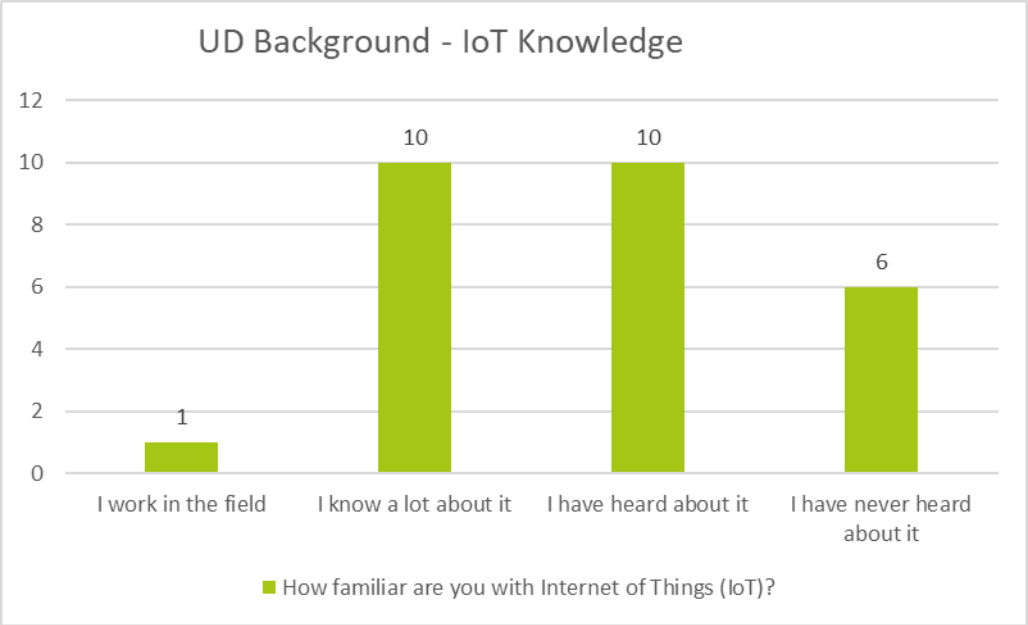
Participants were asked about their attitude and experience towards driving and travelling. These were ranked from Strongly agree to Strongly disagree, with Neutral as a central choice.



- 13 participants do not regularly go for a car ride "just for fun"
- 15 participants do not tend to select the cheapest mode of transport even if it would take more time
- 15 participants tend to select the quickest mode of transport even if it would cost them more
- 17 participants tend to select the most comfortable mode of transport
- 9 participants would travel more in their daily life if travelling was easier
- 7 participants driving decisions are affected by weather conditions
- 11 participants driving decisions are affected by fatigue
- 10 participants find driving in urban areas stressful
- 8 participants find driving in urban areas difficult
- 8 participants find driving in urban areas fun

5.4 IoT Knowledge

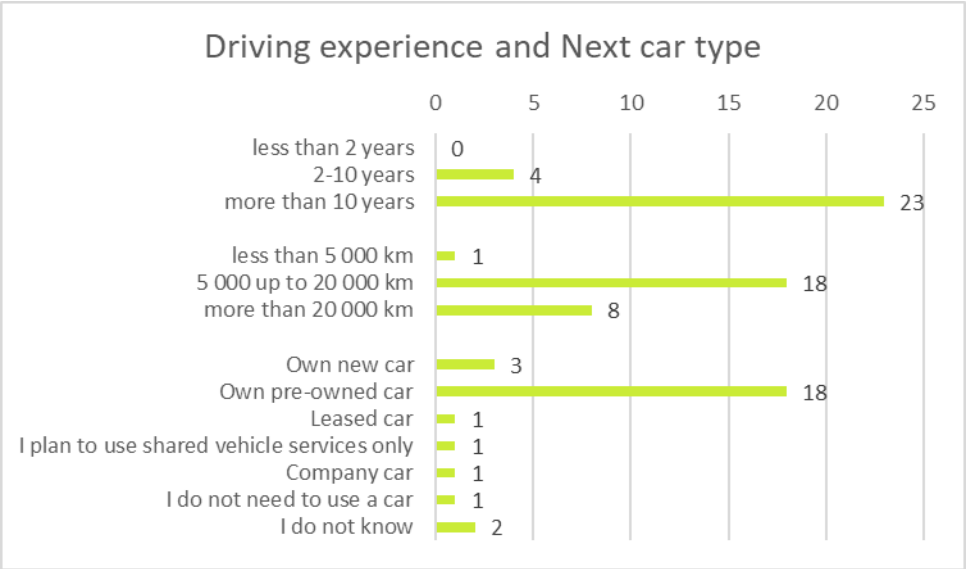
Participants were asked how aware they were of Internet of Things.



- 11 participants either work in the field or know a lot about IoT
- 10 participants have heard about IoT
- 6 participants have never heard about IoT

5.5 Driving experience and next car

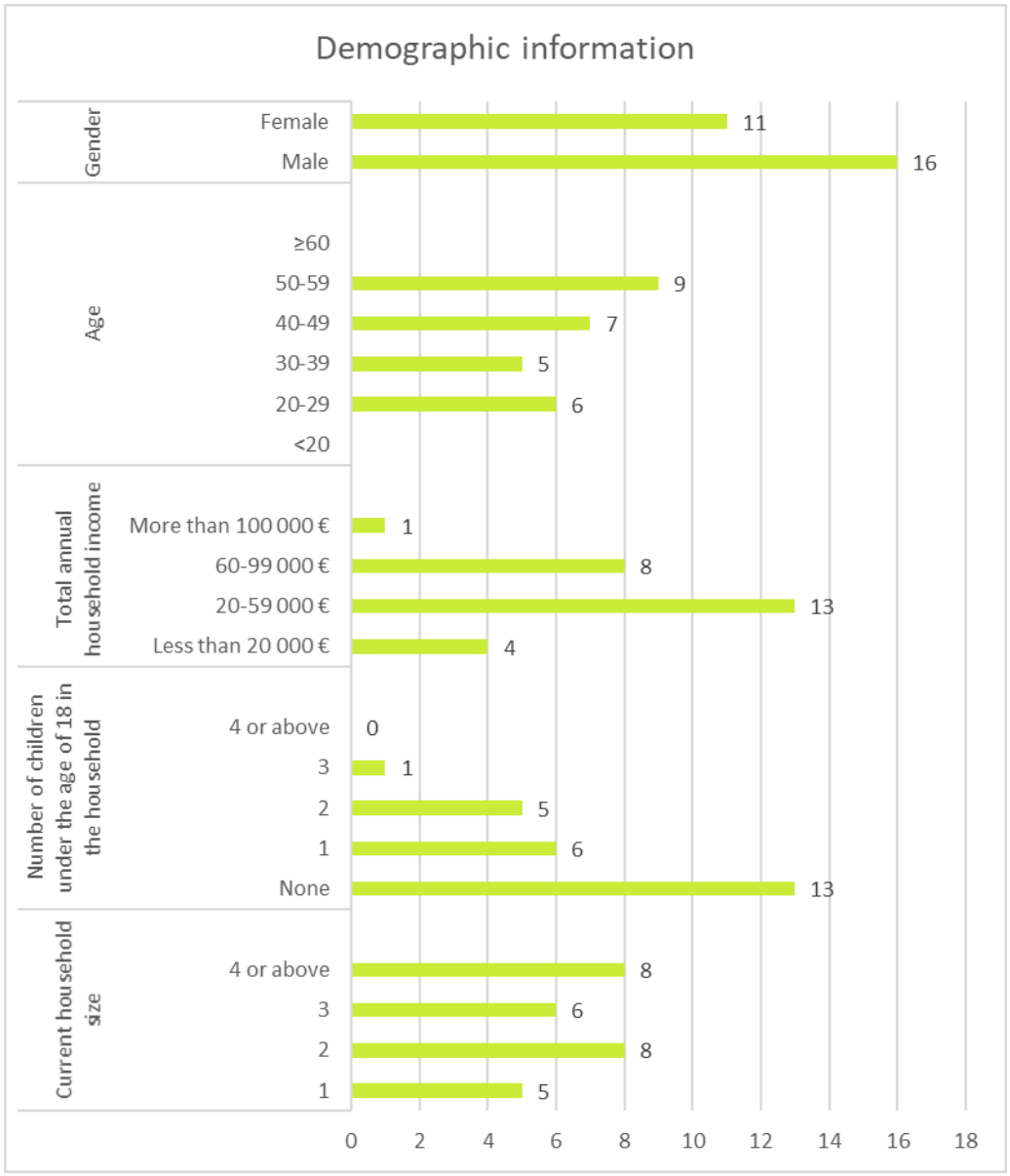
Participants were asked about their driving experience and their next (most probably) car type.



- The majority of participants (85%) have been driving for more than 10 years
- Over half of participants (67%) drive between 5 and 20 km a year
- Over half of participants (67%) plan to own a pre-owned car

5.6 Demographic Information

Participants were asked about their background to establish representation of the test group.



- 11 participants were female and 16 male
- Of the participants, 5 were aged 20–29, 5 were aged 30–39, 7 were aged 40–49 and 9 were aged 50–59.
- 13 participants had a household income of 20–59.000 € and 8 participants had a household income of 60-99.000€
- 5 participants had a household size of 1, 6 participants had a household size of three and 8 participants had a household size of 1 or 4 or above respectively
- 13 participants had no children under 18 in their household

Versailles Urban Driving

1 Background

This document presents the results from the analysis of the questionnaire completed by users participating in the Versailles pilot in the framework of the UD. The user tests took place in Versailles from the 15th to 25th of April 2019 (that is 6 days of testing, as one day was dedicated to the stakeholder workshop). 25 participants took part to the experimentation and filled the online questionnaire. They were recruited through social media and professional network. Responses from 20 participants were included.

2 Test protocol

Mean age 43.3±12.95 years women: 44.4±12.64; male: 41.5±13.94).

Since the vehicle used for the experimentation is a Tweezy, every participant was alone with the VEDECOM engineer in the vehicle. A test lasts approximately 2 hours including the presentation of the project and of the experimentation, the test it-self in the vehicle, and the questionnaire. Most of participants get the explanations in French, except one who is English speaker. The questionnaire was also filled in the French version on paper, except one in English. Some modifications to the questionnaire have been asked at the beginning of the period regarding some questions with multiple answers, and to add an open question on the notification of points of interest.

Figure 1. Car sharing trip

Analyses included are presenter per questionnaire section, i.e. a) Pre-testing, b) after each ride: i) car-sharing and manual driving in the city of Versailles with Points of Interest (PoIs) notification (users were informed about places of touristic interest (e.g. historic monuments) ii) first automated drive within the Gardens of Versailles with Points of Interests (PoIs) notifications and ii) second automated drive in the Gardens of Versailles with PoIs and VRU detection (pedestrian and cyclist) (Figure 2).

Figure 2. Automated drive in the Gardens of Versailles – Detection of pedestrian

3 Results

3.1 Pre-testing expectations

Participants were asked to rate their expectations of the test experience in four areas on a 7-point scale (Figure 3). This was rated 3 to -3 but was transformed in to a 5-point scale (i.e. Positive = 2, Negative = -2) (Figure 3).

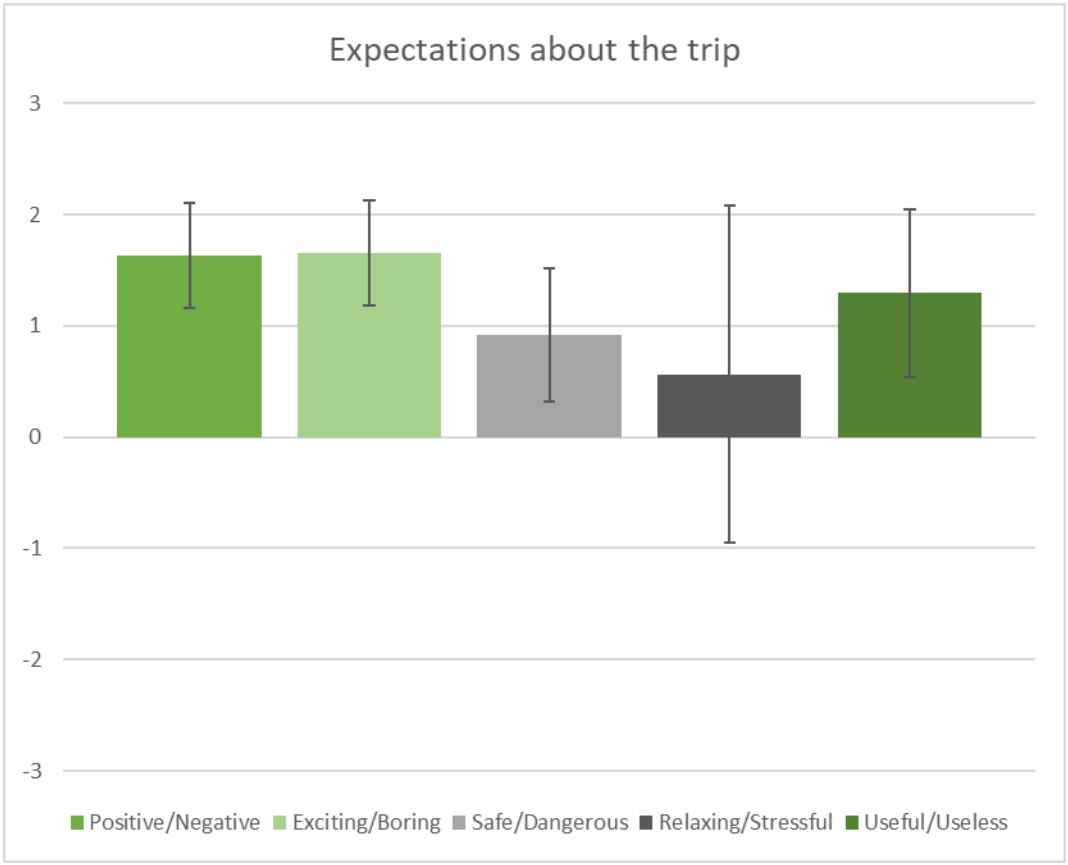


Figure 3. Pre-testing expectations about the trip

Overall, the whole experience is anticipated to be positive for all four dimensions. Greater variance

is reported for perceived stressfulness of the whole experience, because 4 users are expecting it to be stressful. This finding agrees with Brainport results.
Their expected usefulness of the service was rated in a 7-point scale (-3 to 3) and transformed into a 5-point scale (-2 to 2). Mean **expected usefulness** was **1.29± 0,751**. Although, the users anticipated this trip to be a positive experience, they were not sure about its usefulness.

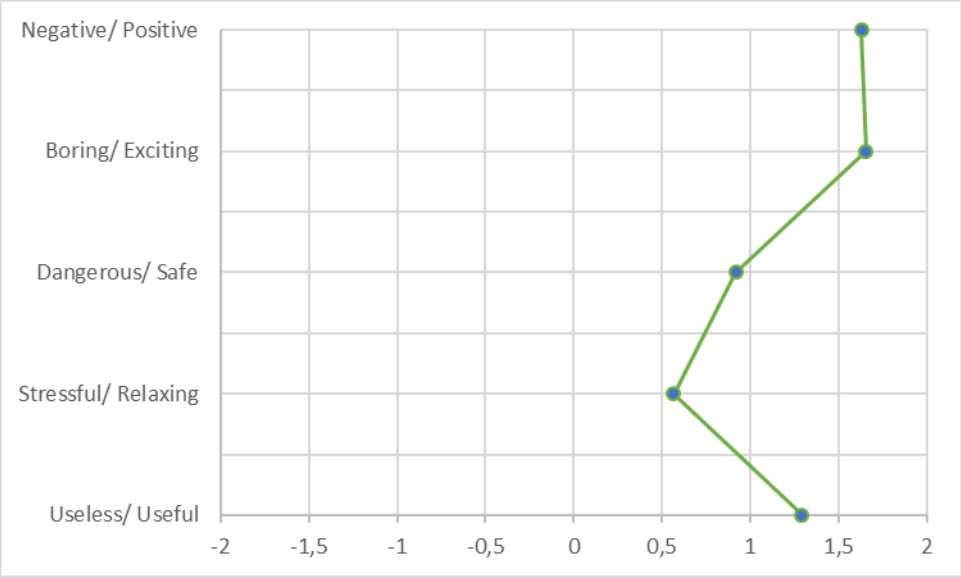


Figure 4. Perceived expectations about the trip (semantic differential chart)

The main reasons that motivated users to participate in the user testing sessions were the following:

- Interest to contribute to research and innovation
- Curious to experience the drive in an autonomous vehicle
- Professional interest/ future involvement in autonomous research/development
- Interest in energy efficient and sustainable transportation
- General interest in new technologies

A participant was so excited that wanted to state their availability to additionally participate in the second round of pilots in Versailles with the platoon formation.

3.2 Post-testing experience

Note for test facilitators: **Questions 1 to 5** will be administered **three** times: a) for manual driving, b) for AD ride with PoI notifications, and c) for AD ride with PoI notifications and IoT. The remaining questionnaires focuses solely on condition c, as it is the primary focus of the evaluation (IoT in AD).

Most scales have been reversed in order to graphs make sense. For example, if the lowest option (i.e. 1) had the highest value, e.g. agree/important, etc., then the scale was reversed.

3.3 Car sharing – Manual driving in Versailles city centre

This part involved manual driving in the city of Versailles with PoIs notifications and information.
The manual drive in the city of Versailles was most of all, perceived as positive (1.5±.69) and safe (1.5±.83). No negative mean scores were found as it is in Figure 5. Overall, the scores were positive:

- 1 only user (the same one) thought the experience was dangerous and unsafe.

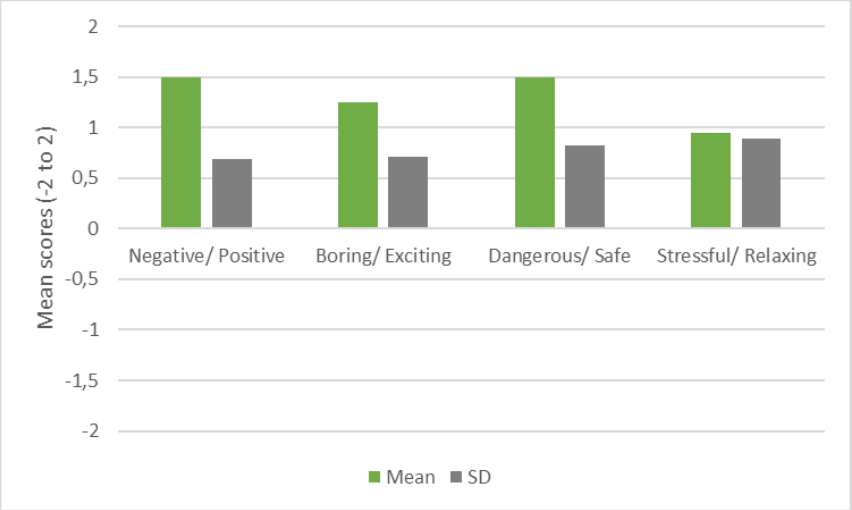


Figure 5. User experience during the manual drive in the car sharing part of the trip

The boxplot in shows the variations and the outliers are shown in Figure 6. The only one outlier was found the participant who thought that the whole experience was not safe. In addition, a semantic differential graph was created to present the same information in Figure 7.

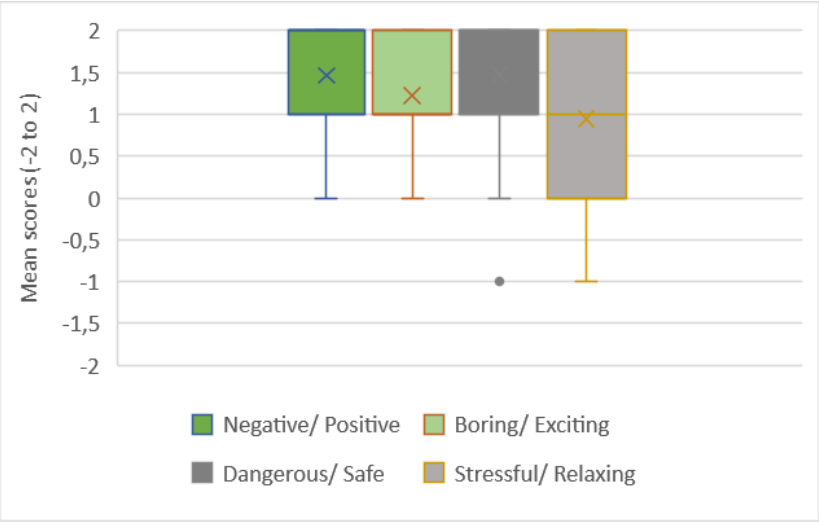


Figure 6. Mean perceived experience boxplots of the car sharing trip

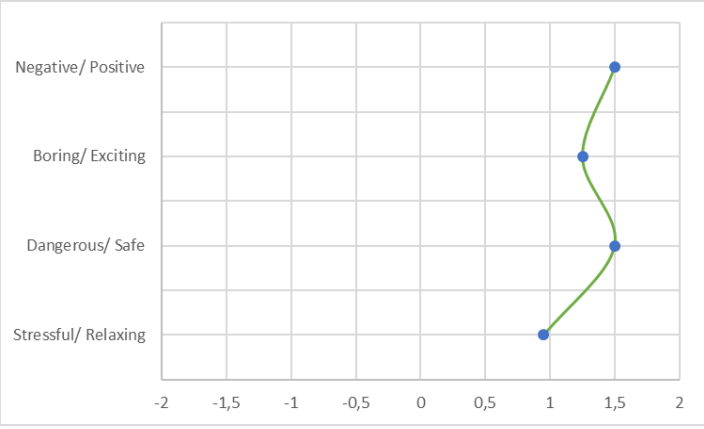


Figure 7. Mean perceived experience of the car sharing part of the trip

Participants own descriptions of the actual experience during this trip were clustered around the categories presented in Figure 8.

Figure 8. Word clouds depicting positive (left) and negative (right) experiences (car sharing trip)

Users rated positively all dimensions related to Van der Laan acceptance scale, as it is obvious from Figure 9 and Figure 11. The overall usefulness (1.17 ± .77) and satisfaction (1.22 ± .76) are slightly above 1, as shown in Figure 12.

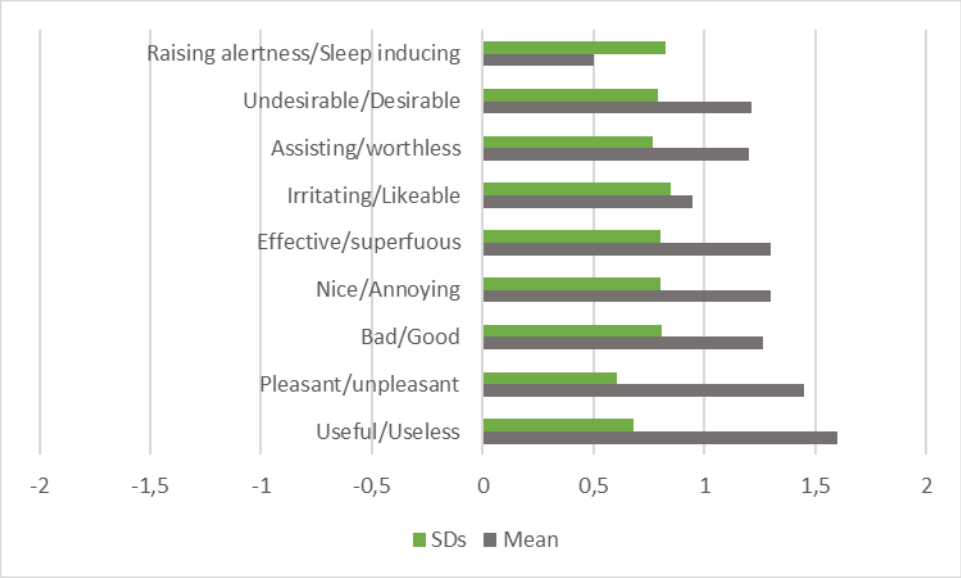


Figure 9. Perceived experience of the car sharing application

Lowest mean scores were reported for likeability (.95±.85) and alertness (.5±.83) and highest rates usefulness (1.6±.68) and pleasance (1.45± .6). Only one participant negatively rated (-1) in the sleepiness scale, i.e. they perceived the whole experience during the car sharing ride as sleep inducing. No other negative ratings were made (Figure 10).

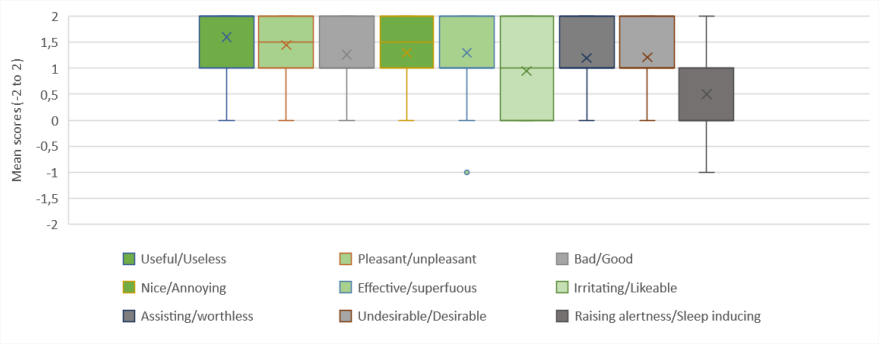


Figure 10. Mean perceived experience boxplots of the car sharing app

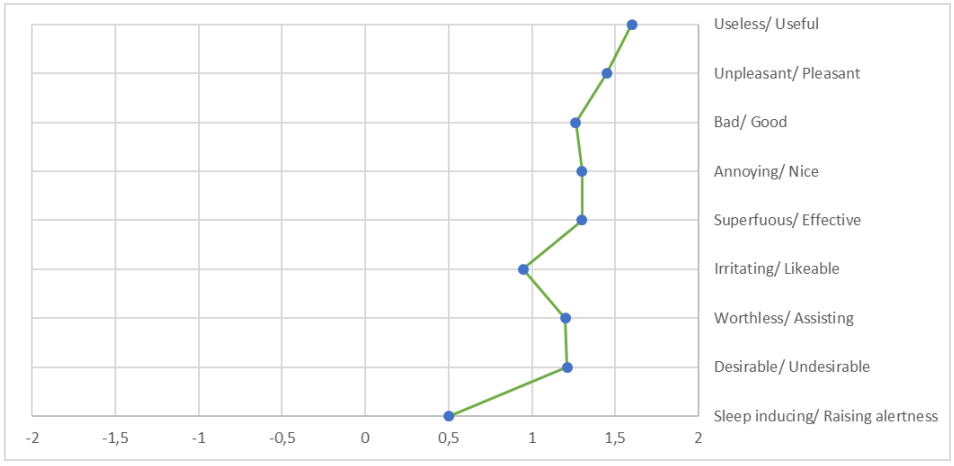


Figure 11. Perceived experience of the car sharing part of the trip (semantic differential graph)

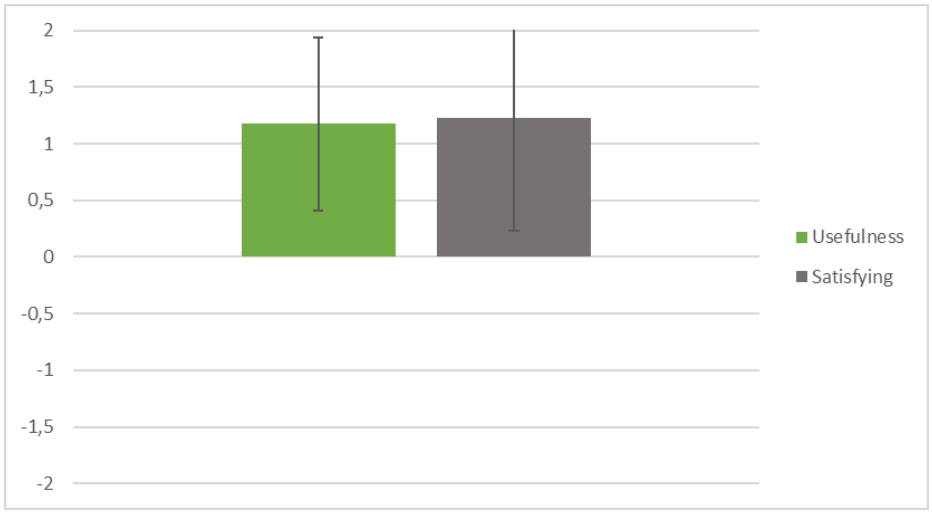


Figure 12. Mean and SD scores of perceived usefulness and satisfaction of the car sharing application

Overall comfort in relation to smoothness (4.45±..6), acceleration (3.6±1.35) and braking behaviour (3.3 ± 1.3) were rated as above average with highest rating for smooth driving experience (Figure 13).

- No negative responses were made for the smoothness of the ride
- participants found the acceleration behaviour of the vehicle uncomfortable
- 6 participants found the braking behaviour uncomfortable

However, it is important to note that users were driving the vehicle, so any discomfort reported is in relation to the vehicle and not the technologies and/or the automation aspect. However, this discomfort can affect the outcome of the experience, as it is obvious from the wordclouds presented in Figure 8.

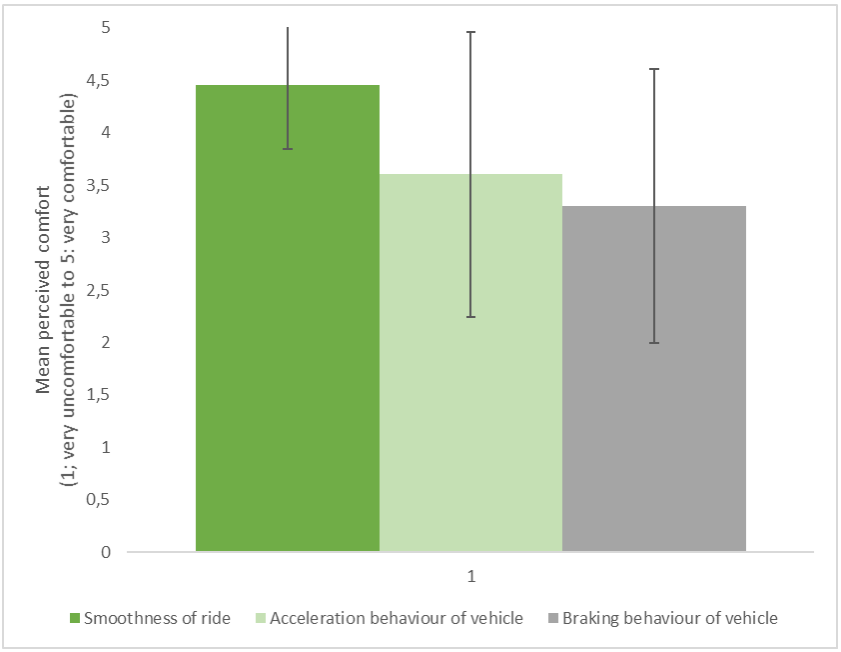


Figure 13. Mean perceived comfort scores per driving behaviour aspect of the vehicle (manual driving part)

3.4 Automated driving in the Gardens: 1st round

These results refer to the users' experience after they switched on automated driving mode and completed the first round in the Castle's Gardens.
Comments about what made them feel comfortable and uncomfortable during this trip were transformed in word clouds that are presented in Figure 14. Braking behaviour was perceived at some occasions as being abrupt or with no reason. A participant mentioned that the trip fulfilled their expectations and another mentioned that the car behaved as they would in a similar situation.

Figure 14. Positive (left) and negative (right) experiences during the 1st round in Castle's Gardens

The experience remained positive after the 1st automated driving round in the Gardens. Participants felt excited (1.6±.5)) and positive (1.75±.55) about the experience but agreement is not reached on how relaxing the whole experience was (.85±.93) (Figure 15 and Figure 16). High variation is evident in stress reaction during the first automated trip in the Gardens (i.e. the variations are higher than the mean value).

- Only one participant perceived the first automated trip as stressful.
- 2 participants were neutral about the safety of this trip.
- Only one participant was neutral about characterising the experience as being positive or negative.
- 7 participants did not perceive the experience as relaxing or stressful even if they do not have to drive.

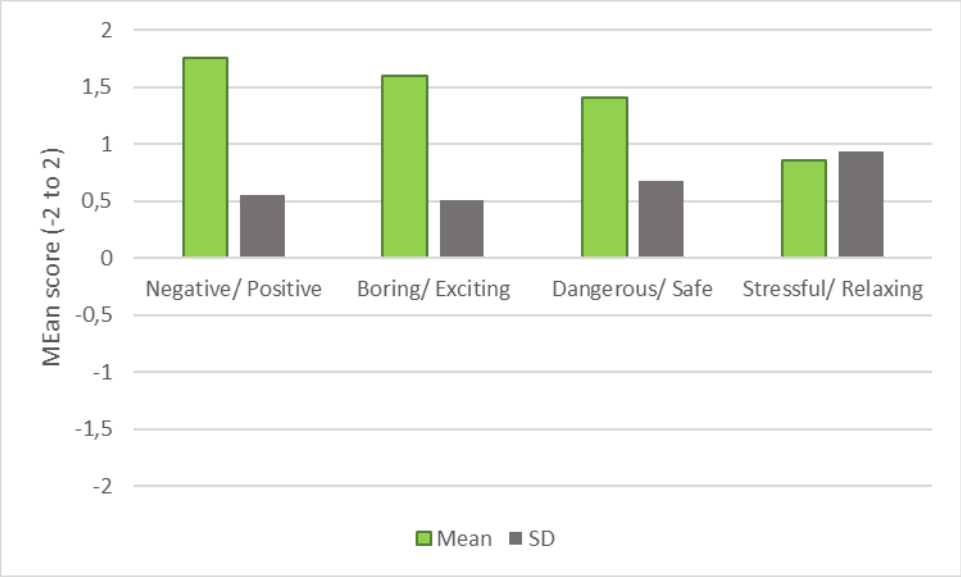


Figure 15. User experience during the automated driving part of the first round in the park

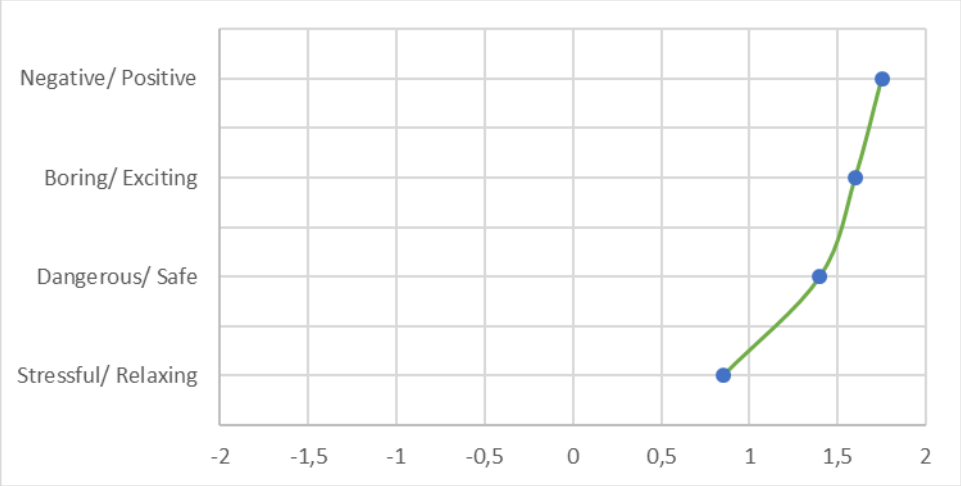


Figure 16. Mean perceived experience of the 1st trip in the Castle's Garden

As shown in Figure 17, only one outlier has been found for the first dimension (negative/ positive)

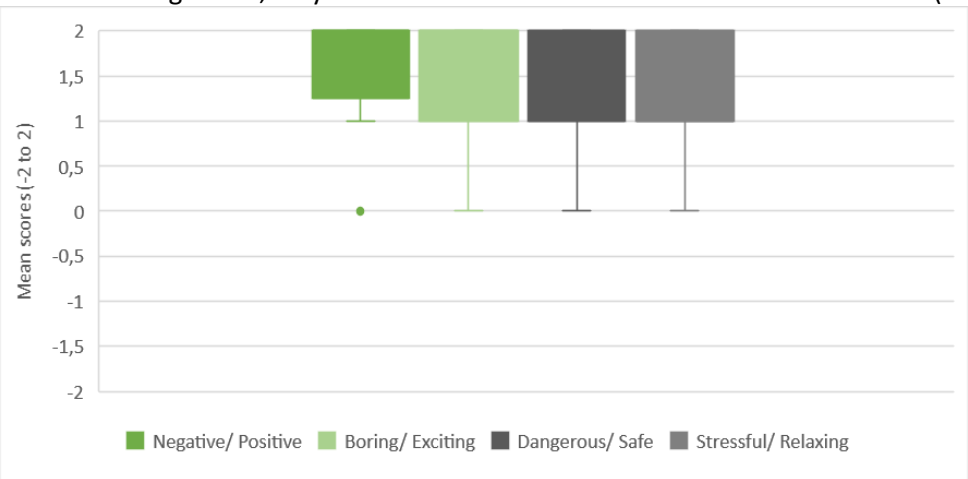


Figure 17. Mean perceived experience boxplots of the 1st trip in the Castle's Garden

No negative scores were reported after the 1st round in Gardens. Users scored the system offered

higher for usefulness and niceness, practical aspects of the system. Lower scores were the for alertness, desirability and assistance (Figures Figure 18Figure 20).

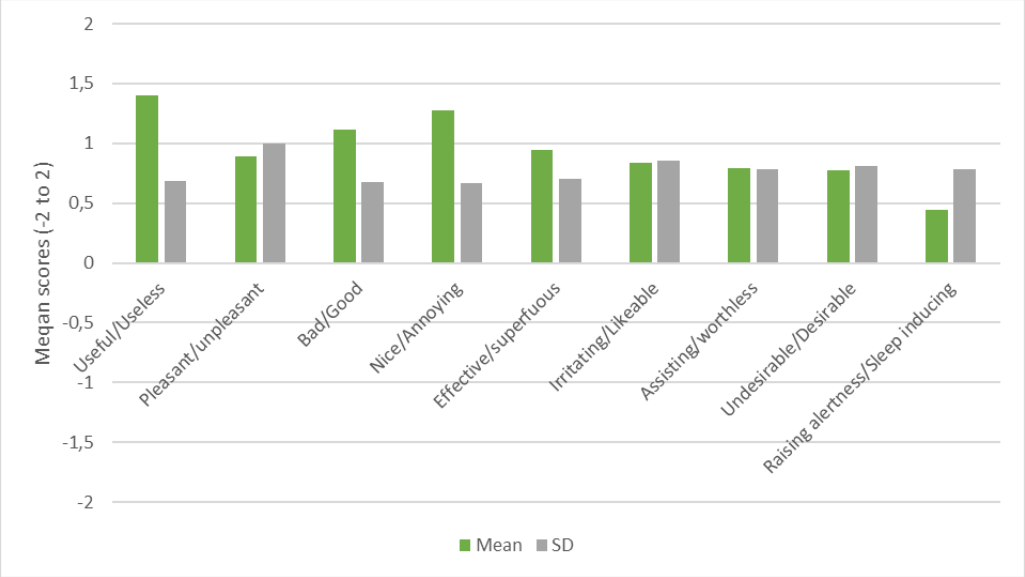


Figure 18. Mean and SD scores per Acceptance scale dimensions (1st round in Gardens)

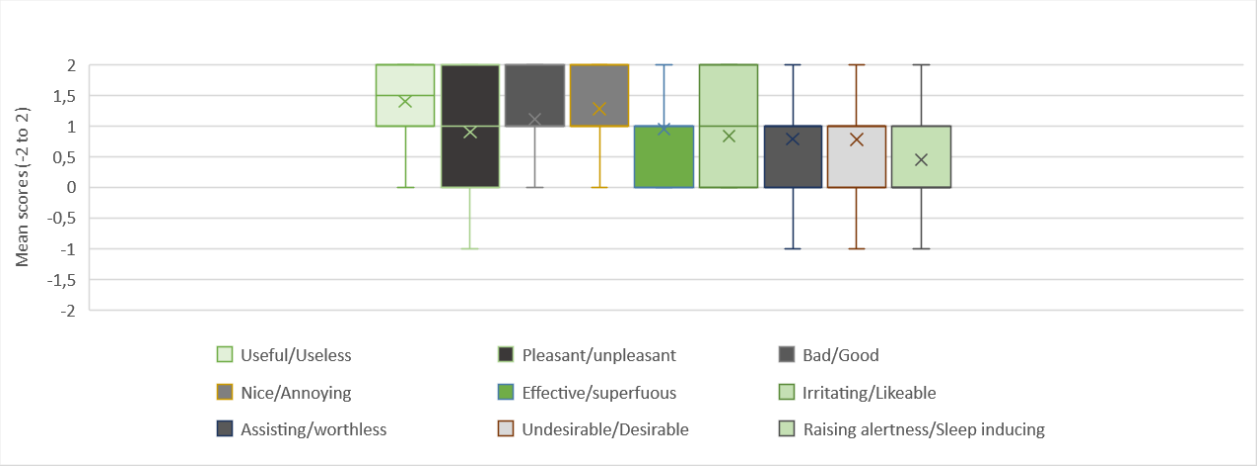


Figure 19. Mean perceived acceptance boxplots of the automated function with the PoIs via the app

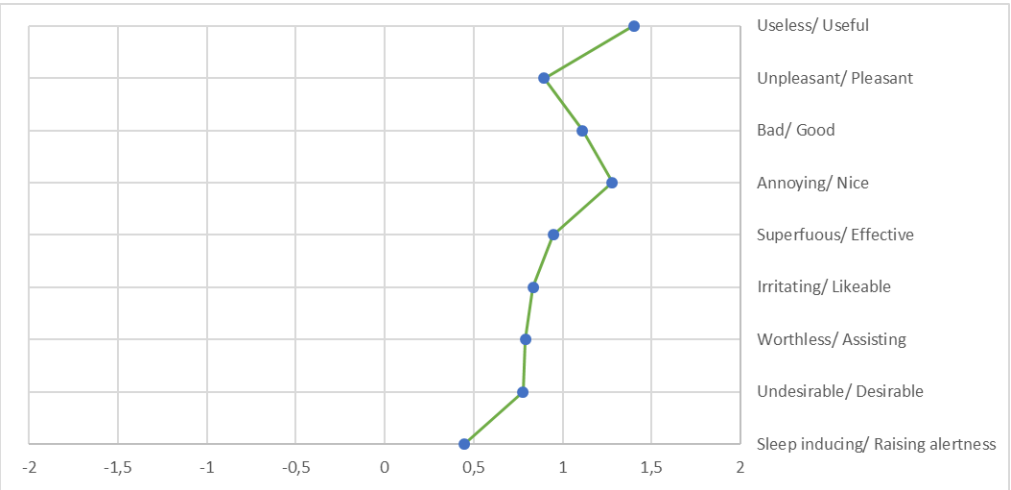


Figure 20. Mean scores per Acceptance scale dimensions – semantic differential (1st round in Gardens)

The evaluation of the **usefulness** (0.94±0.73) and user **satisfaction** (0.82±0.83) of the AUTOPILOT

service (automated driving and PoIs) was above average and positive (Figure 21).

- 3 users thought the system was unpleasant;
- 1 user thought the system was worthless;
- 1 user thought the system was undesirable;
- 1 user thought the system was sleep inducing (not the same user as above).

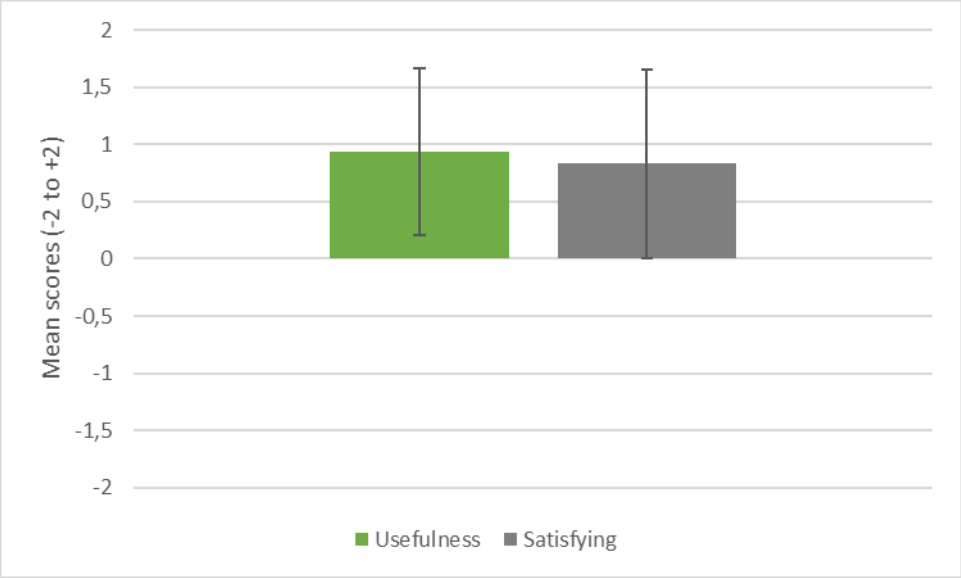


Figure 21. Mean (and SD) scores of perceived usefulness and satisfaction of the automated driving system with the availability of POIs notifications

Mean perceived comfort of smoothness, acceleration was high and above 4 (Figure 22), whereas for braking and VRU approaching styles where above average but lower than the other two parameters.

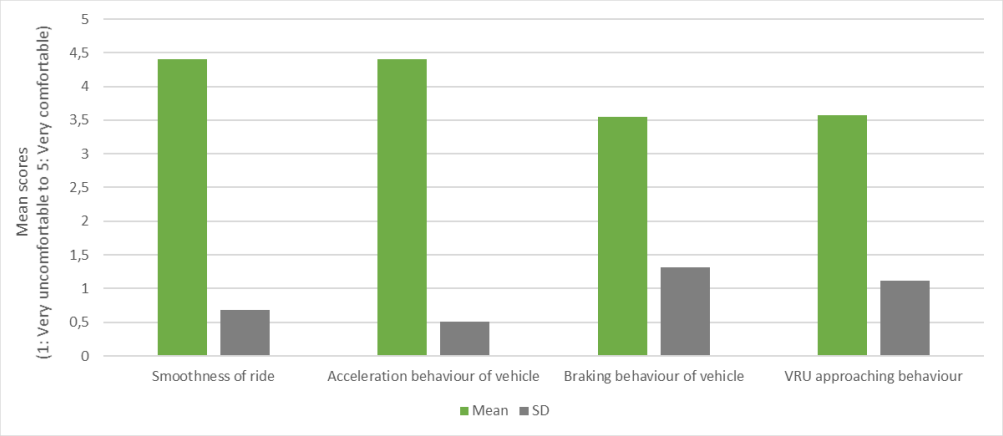


Figure 22. Mean perceived comfort for different vehicle related driving behaviour parameters during the first round in the park

- 4 users felt discomfort when the vehicle was near pedestrians or cyclists.
- 6 users felt discomfort when the vehicle was braking.

3.5 Automated driving in the gardens: 2nd round

This refers to the part of the trip where the was on automated driving mode for the second time and completed the second round in the Castle's gardens.

The negative aspects that participants reported that could have made them feel unsafe or uncomfortable are shown in a word cloud below (Figure 23). Braking behaviour with no apparent reason appears to be the most frequent complaint.

Figure 23. Negative remarks (second round in Gardens)

Overall, the experience remains positive (1.7±.57), exciting (1.45±.68) , safe (1.4±.68) and relaxing (1.25±.79) in the final trip in the Gardens.

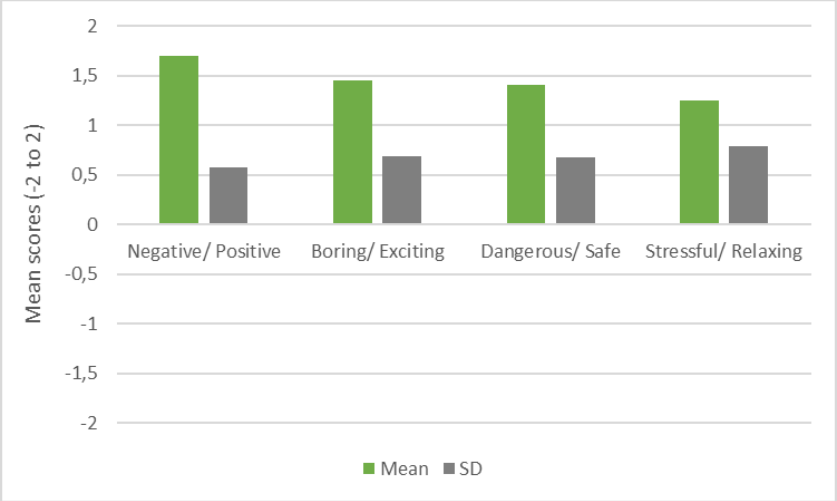


Figure 24. Perceived mean (and SD) scores of user experience during the second round in the park

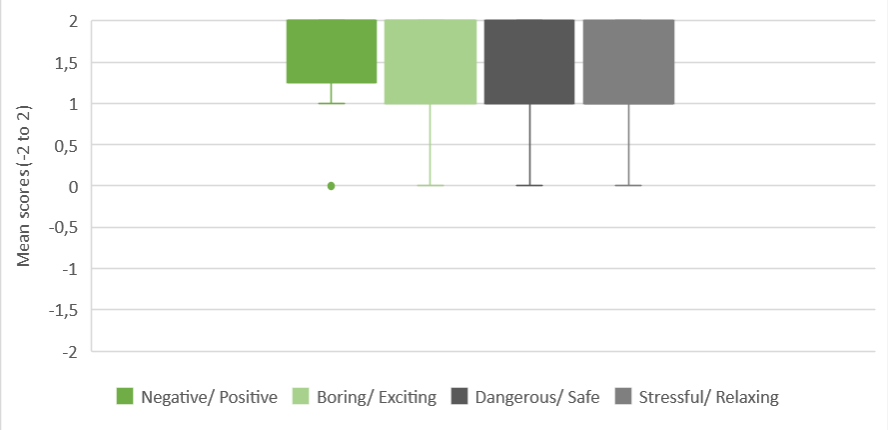


Figure 25. Mean perceived experience boxplots of the automated function with the PoIs and the VRU detection system

One participant (outlier in Figure 25) was neither bored nor excited during this trip. Overall, the mean scores in all experience dimensions were above 1 (positive) with higher scores on positivity and lower scores on relaxation aspects (Figure 26).

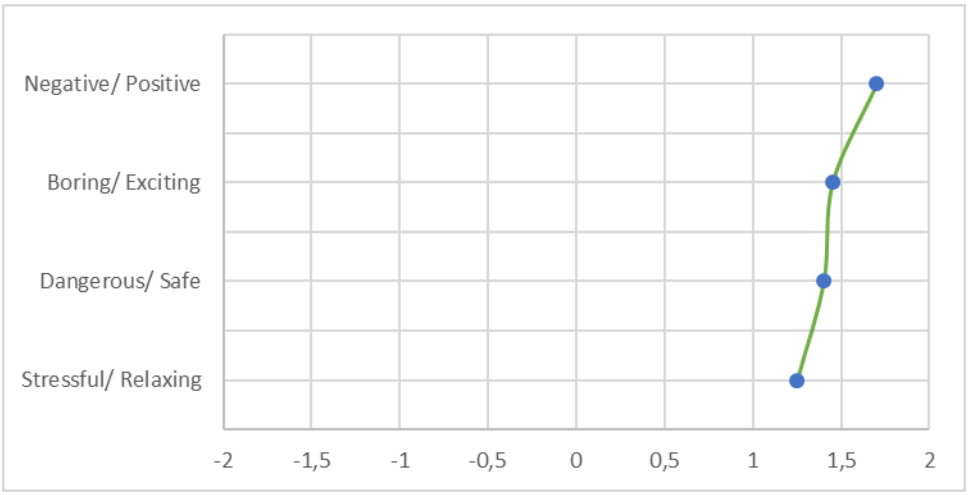


Figure 26. Mean perceived experience of the 2nd trip in the Castle's Garden

Higher variation in responses was found in the usefulness of the system, its effectiveness and annoyance (Figure 27).

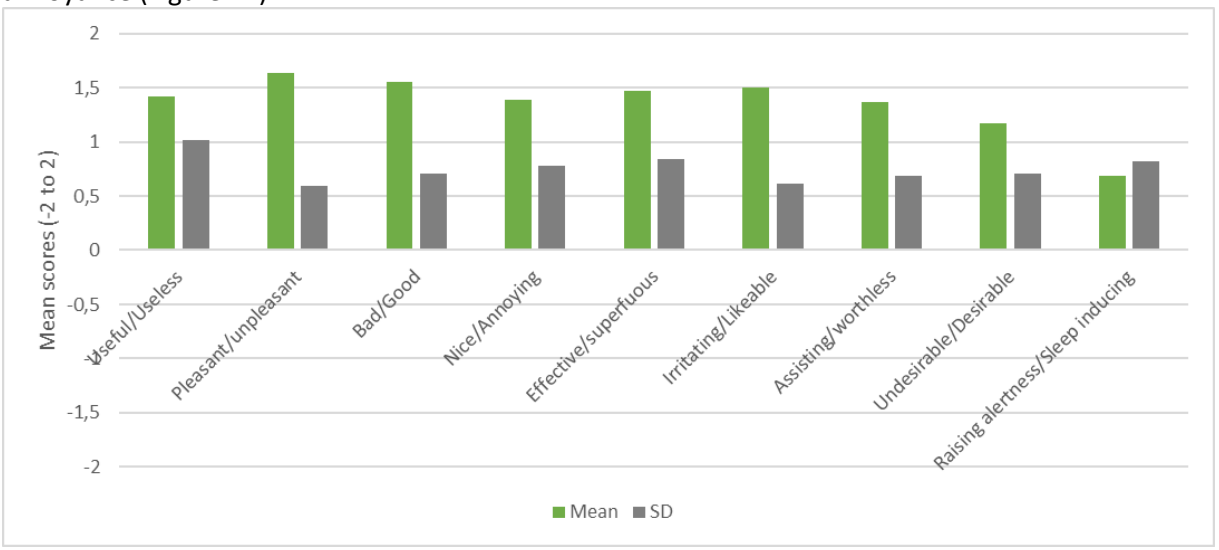


Figure 27. Mean and SD scores per Acceptance scale dimensions (2nd round in Gardens)

All the dimensions in the acceptance scale were positive but:

- 1 user thought the system was useless (outlier in Figure 28) and another participant stated that it was sleep inducing. These were different participants.

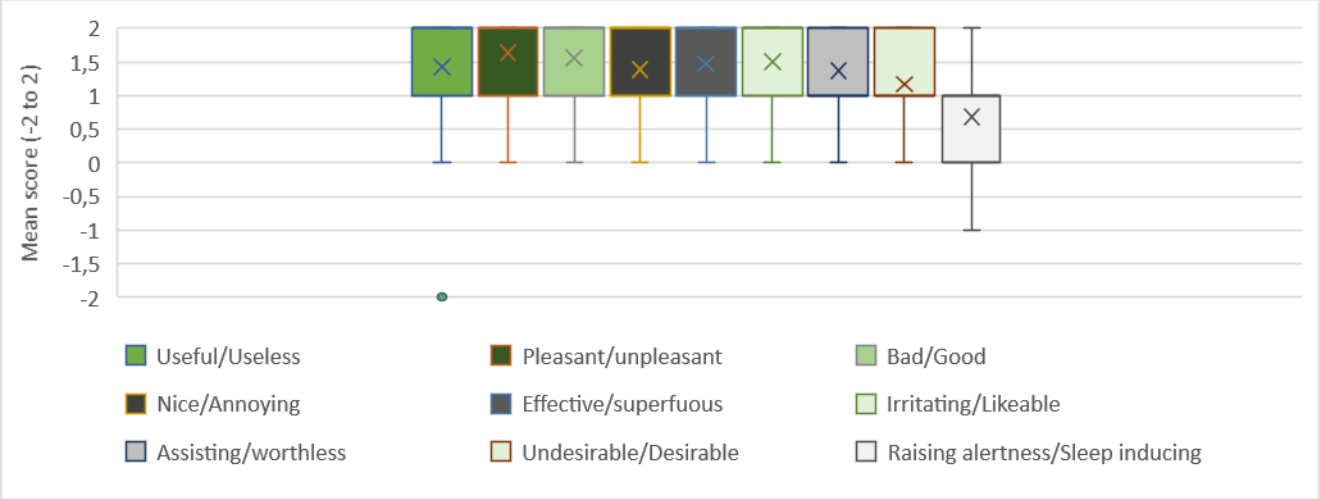


Figure 28. Mean perceived experience boxplots of the automated function with the VRU detection and POIs systems

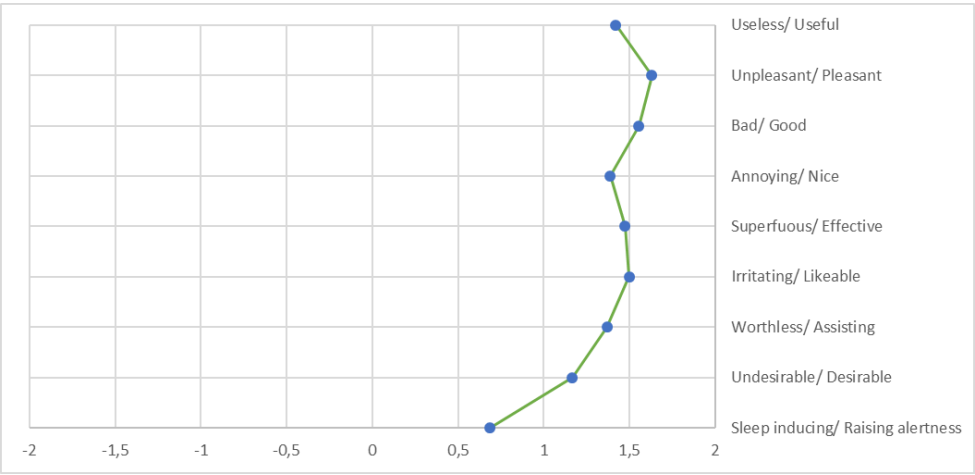


Figure 29. Figure 30. Mean scores per Acceptance scale dimensions – semantic differential (2nd round in Gardens)

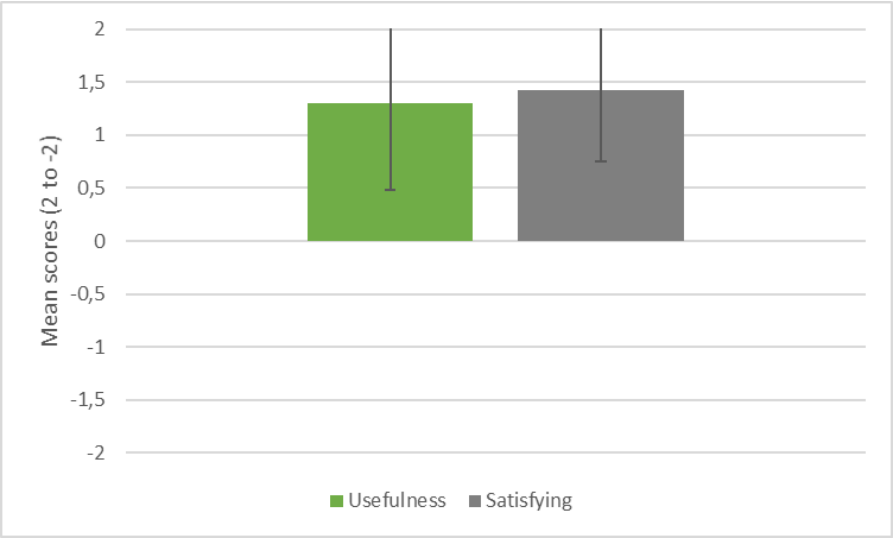


Figure 31. Mean (and SD) scores of perceived usefulness and satisfaction of the POIs and VRU detection

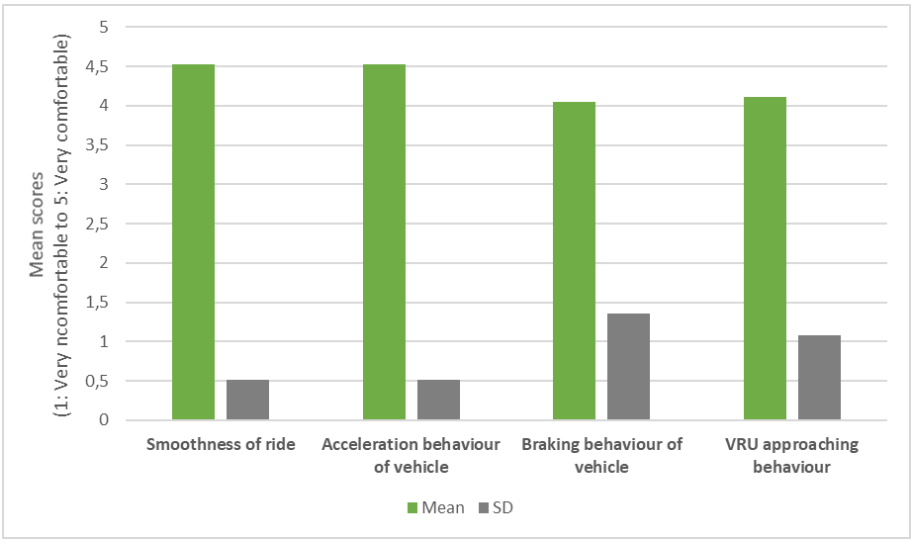


Figure 32. Mean perceived comfort (and SD) scores related to certain driving behaviour parameters during the second round in the park

3.6 Comparisons

Comparisons in experience and comfort were carried out between the pre-expectations and the participants' experience before and after each of the three parts of the trip (Figure 33). In addition, differences in comfort and acceptance were investigated ().

3.7 Experience

Overall, experience was positive before and after the trips with mean scores being very close. However, reduction in positive regard was found only the car sharing trip. The latter was a manual driving experience that participant could easily compare to the ones with their own vehicle. Both automated trips were perceived as slightly more positive when compared to expectations but still very close (Figure 33).

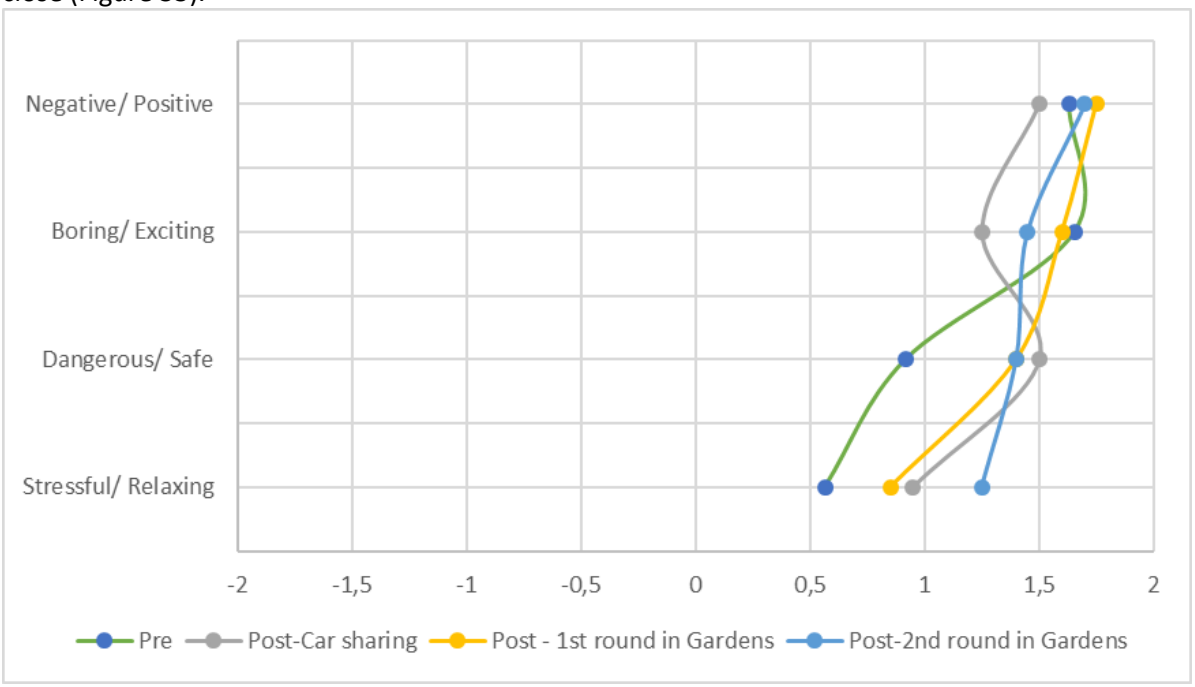


Figure 33. Mean perceived experience before and after the trips

Users' excitement was highest before testing start, dropped after the manual driving and was increased after the 1st round in the Gardner and decreased after the second round in the Gardens. Hence, potentially their excitement is related mostly with the automated experience of the vehicle.
Moreover, the experience was perceived as safer than originally anticipated with automated trips perceived as safer than they were expected to be but still less safe than the car sharing (manual) experience.
Likewise, the experience was more relaxing than anticipated with final round in the Gardens felt to be the most relaxing (i.e. the only round that was like the previous one), whereas the manual and 1st round in the Gardens were perceived almost equally relaxing.

3.8 Acceptance

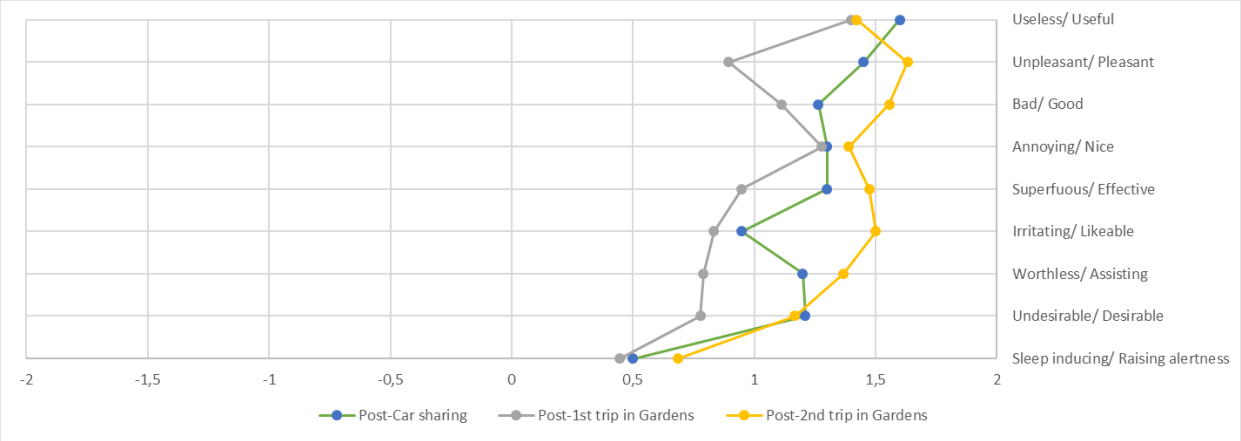


Figure 34. Mean acceptance of services offered per trip

The usefulness of the second round in the Gardens was rated slightly higher when compared to the other two parts of the trip. Lower usefulness and satisfaction were found in the first round in the Gardens (Figure 35).

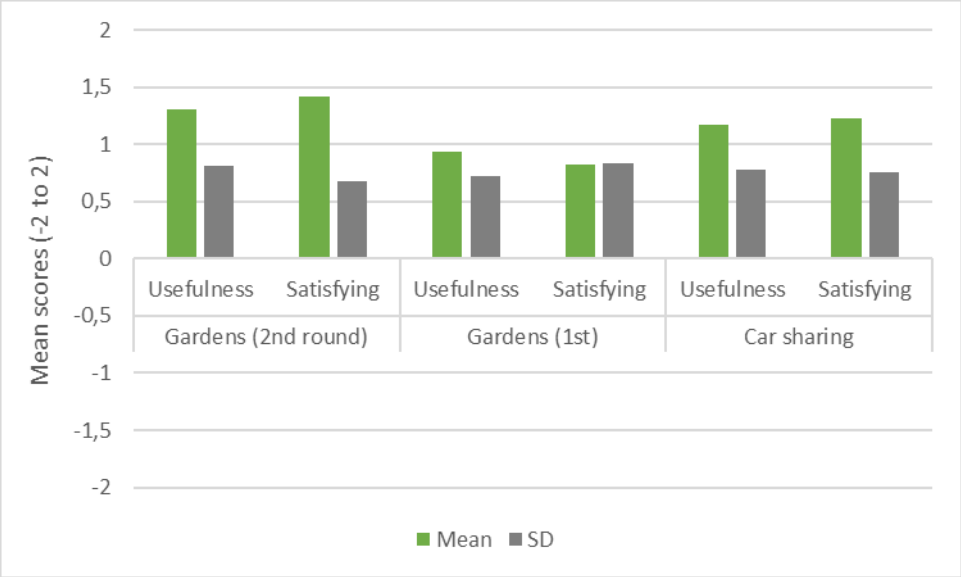


Figure 35. Mean usefulness and satisfaction score per trip part

3.9 Comfort

All trips were perceived as equally smooth with ratings almost reaching 4.5 (out of 5). However,

acceleration was smoother in the automated drives when compared to the manual driving around the city. Braking was better during the second round in Gardens, hence the perception of the VRU detection braking was rated as comfortable. VRU approaching behaviour was rated higher when the detection system was on (i.e. last round in the Gardens). However, variations were higher for both braking and VRU detection in participants' ratings as well as acceleration in the car sharing trip (Figure 36).

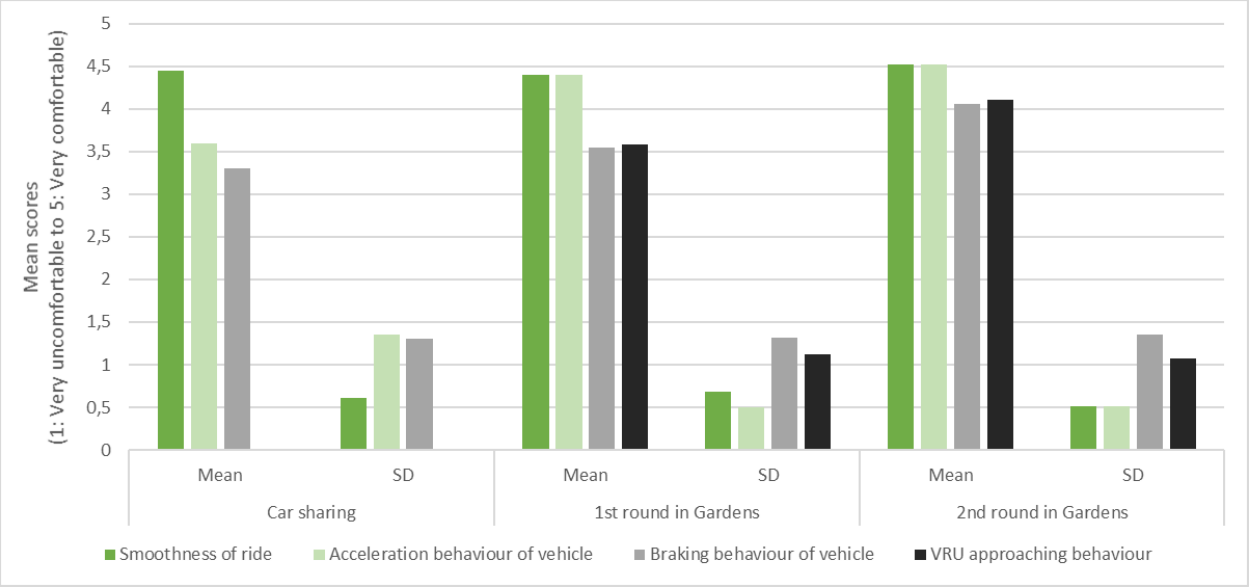


Figure 36. Mean perceived comfort scores (and SDs) across trips.

3.10 Overall experience

Users are very concerned about most aspects but less for data privacy (2.85±1.26) and more for VRUs (4.47±.9) and safety inside other vehicles (4.26±.99) (Figure 37).

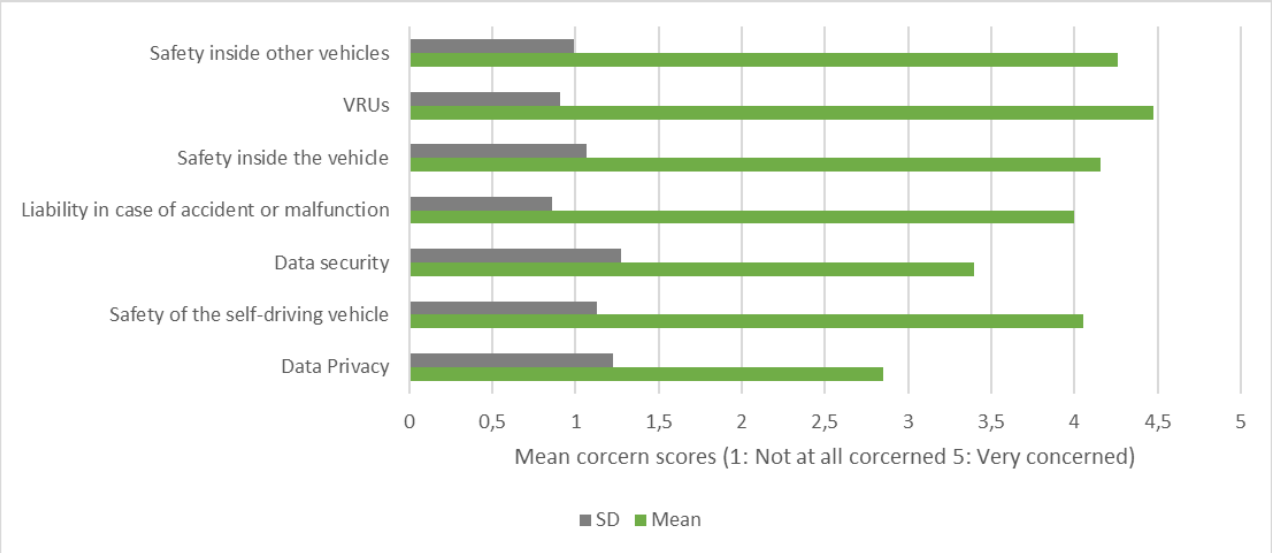


Figure 37. Mean scores (and SD) of primary concerns

Participants were asked which of the three rides they liked most:

- 3 users preferred the manually driving in the city;
- 10 users preferred the first ride in the Gardens;

- 5 users preferred the second ride in the Gardens.

The overall offered service was perceived as useful (4.47± .5) (Figure 38), but although ratings were far above average for understandability (3.2±1.4) and timeliness (3.8±1.3), these received lower ratings compared to others and lower ratings in these dimensions often reveal usability issues.

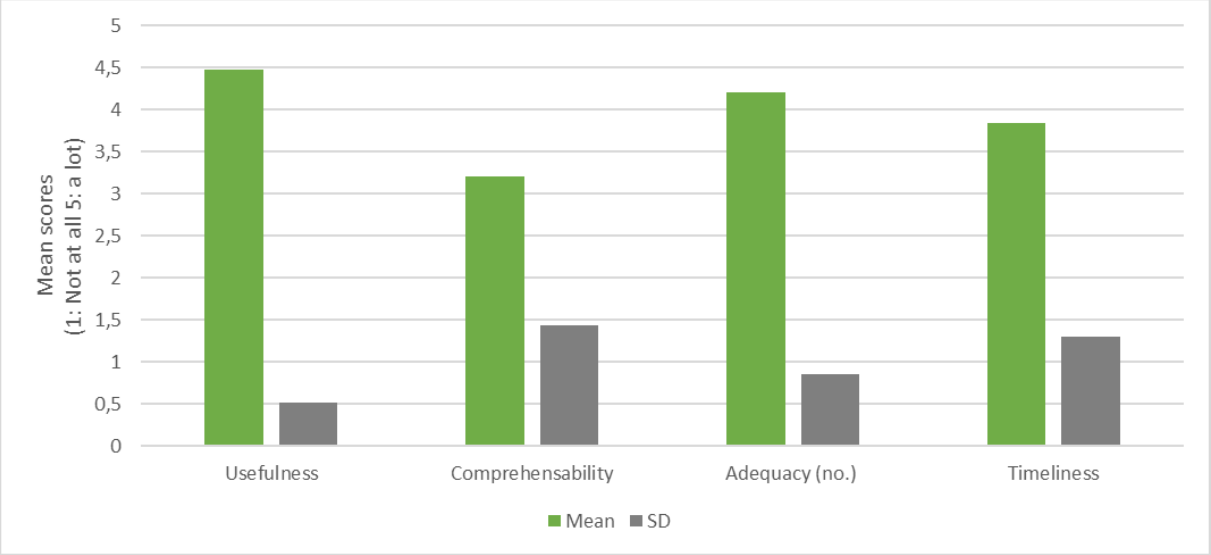


Figure 38. Mean (and SD) scores of perceived usability of POIs notifications

PoIs notifications' related comments:

- Sound problem, difficult to judge the quality of the content.
- We hear very badly the comments, it's unfortunate, we had to stop to hear the voice :(
- Difficulty hearing the notifications, which are not very interesting.
- The notifications could be stronger, the sound of the engine covers the voice.
- Notifications were very difficult to hear.
- The voice is not appropriate but I know it's not the priority.
- The voice of the notifications can be improved.
- The volume was too loud so there were times when I cut it.
- The notification on the sculpture of the king on his horse arrived too late.
- We do not hear them very well with the surrounding noise (the speakers next to the ears would be more practical perhaps).
- I did not always pay attention to the place of interest because did not know where the part that the notification was about was (left, right, in front of me?).

3.11 Future use

63.7% (N=14) of users would be interested to use the service, if it were available now in full operation and 23.7% (N=6) would not.

Reasons for being interested to use the offered services right now if it was in full operation:

- I guess it can be interesting to go around a city and appreciate the environment when you want to go sightseeing. It can also be an interesting means of locomotion in places where it is difficult to drive.
- Discover the city, discover the park in an original way (the trip in autonomous mode if it's the original journey), without worrying about driving.

- The trip would have to be longer in autonomous mode. Explanations of more enjoyable points of interest (background music? + Improved voice and diction)
- As a tourist the service will be a value.
- Interested in this service when you want to visit historical or exceptional places; you are guided for parts of the journey and receive notifications and information on historical sites, heritage, architecture, etc.
- Not interested to repeat the same tour but another itinerary on Versailles would interest me. This can be implemented for local routes, for example.
- Allows freedom with autonomous driving and it can be used to make better use of the landscape.
- I often drive on two wheels.
- No pollution, ease of uses
- Easy to move around Versailles other than on foot or by bike.
- I prefer to walk but I think others might be interested.
- Not enough room for two in the vehicle.
- I would use it only to discover a place, not in my city, hence I would use it only once.
- Interested in the novelty effect to test but will limit the number of vehicles in circulation.
- Regularly, no, but to complete the visit of a city, it can be interesting.
- This allows a first identification before making a choice, on this or that part to visit.
- Yes, for carsharing. No for the points of interest, because the point of interest is communicated but it is necessary to locate it at the same time as one drives, and this distracts the attention ... Some are easier than others to identify.
- It is extremely interesting to have comments on the places around, while remaining free to go where you want (as in a simple self-service car). Delegated driving in a place like the castle park is convenient as you can admire the surroundings. This service is very useful in a city of tourist character, it would be less in your city.
- I appreciated the very comfortable driving of the vehicle and the ease of maneuvering (parking, narrow passage, turn around ...) in view of the small size. The application and the different notifications are very interesting both to better know the city and to keep a constant vigilance along the way.
- Very useful to discover the sights of the city.

19 users mentioned they would use the service and 1 said no. The comments can be found below.
The person who said no, said it because in the car there is no room for another passenger.

Reasons for using the services offered in the future:

- I imagine that it can be interesting on a straight and long road, in addition to a shuttle system.
- For the same reasons as for the park when we do not know the city, it allows to move and discover while being assisted. Attention to the price (cost of the service).
- in Paris for example, this service would allow short trips with a smooth, flexible and sustainable mode of transport. The "bi-mode" (manual + autonomous on some portions) is comfortable and reassuring.
- Pleasant
- Good way to discover a place avoiding the crowd of organized tours
- Maybe my vacation spot to do my shopping or small trips
- Very nice to visit a city
- To make short trips to the city from home
- Discovery the area on a larger geographical radius.

- Not enough room for a passenger
- Discovering a city that I do not know
- Other tourist cities is an original way of visiting or replacing an Uber service
- Being able to visit a city more easily, nevertheless the number limited to 2 in the vehicle poses problem.
- To move around the city at a point (business meetings, for example)
- Altogether, from the moment when one can learn about the architecture and the surrounding history, while allowing oneself to be led. It is still easier to listen to the notifications in a place such as the park than on the open road where it is necessary to focus.
- Using this service in other locations would allow intermodality with the existing TC offer but also facilitate travel while respecting the environment, particularly with the introduction of electric vehicles in car sharing.
- Tour of all areas of the city that have a very different architecture and to know the history of each neighborhood.

Participants are likely to recommend the tested service to friend and colleagues **(4.3±.92)** (Figure 39).

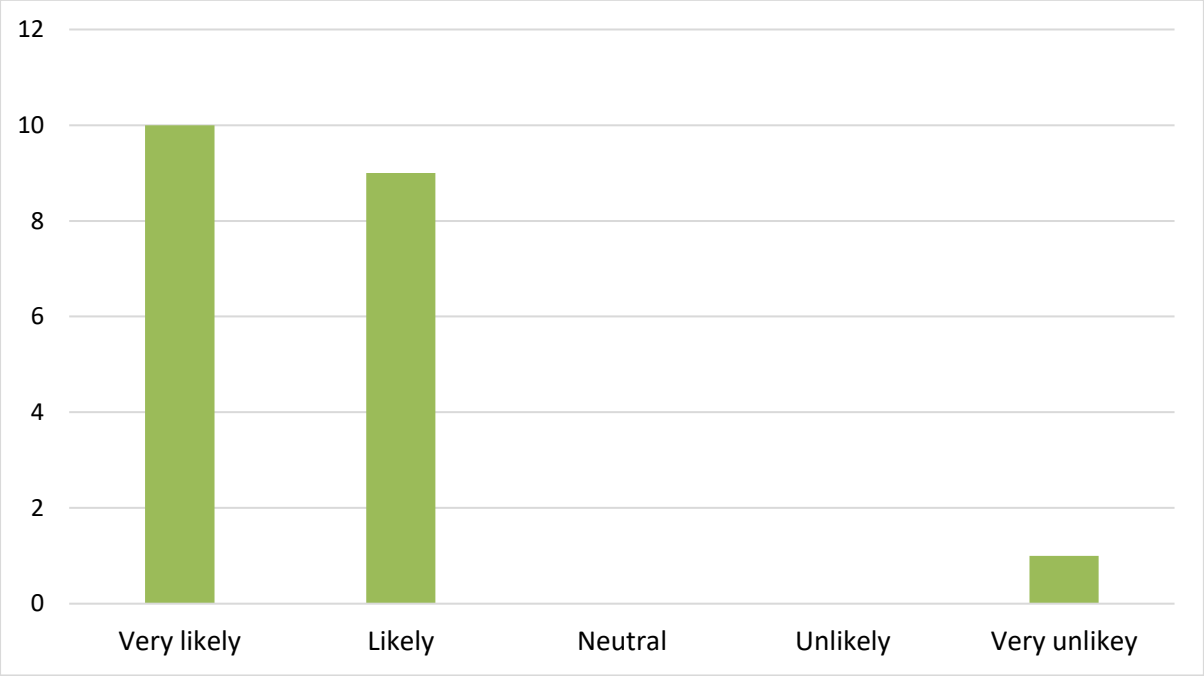


Figure 39. No, of participants recommending the Versailles car sharing app per likelihood level

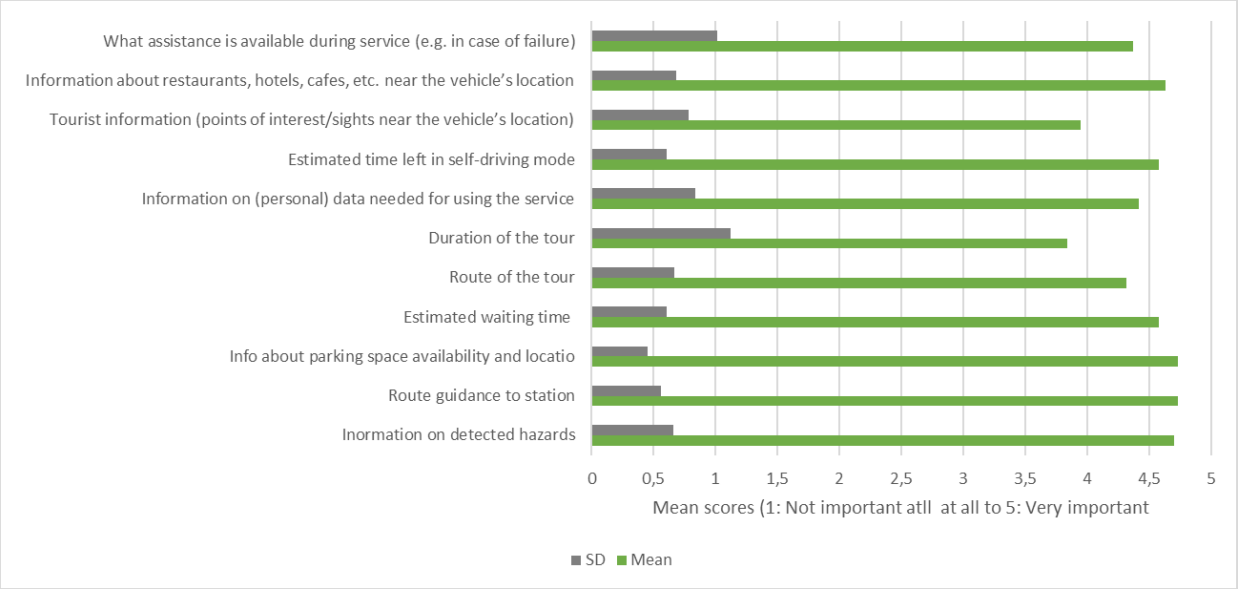


Figure 40. Mean (and SD) perceived importance of information provision

6 users reported additional information they would like to have.

- The maximum time of use of the service (can we take the car for several days?). The number of people "waiting" for the service (= to be able to share). An alert on the level of battery charge and info on local charging points.
- Info on the other tourist circuits in auto mode.
- Time or mileage of electric autonomy.
- Places of visit to go down the car, info on points of interest and to stop.
- Maybe a piece of information on what is happening on the right (car, cyclist).
- The comparison of the carbon cost of the trip compared to a diesel tour bus trip.

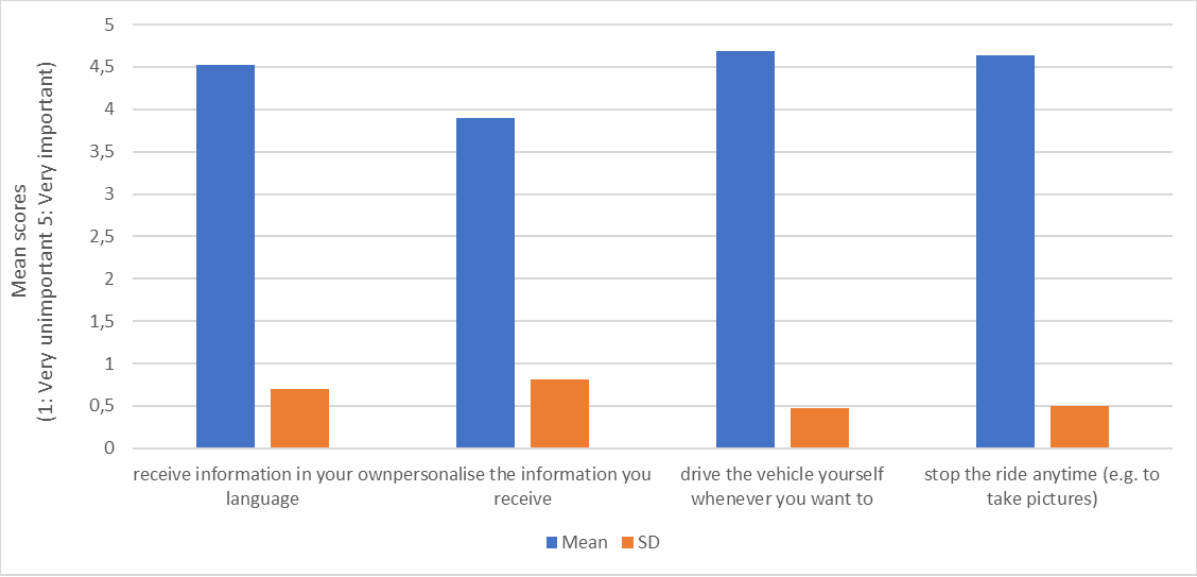


Figure 41. Mean (and SD) perceived importance of offered functions

2 stated that they would like to have additional functions included.

- Voice interaction ... be able to ask for information by voice, for example, estimated time to reach your destination, or search for an alternative route, without having to go through the tablet.
- The available restaurants on the way of my ride.

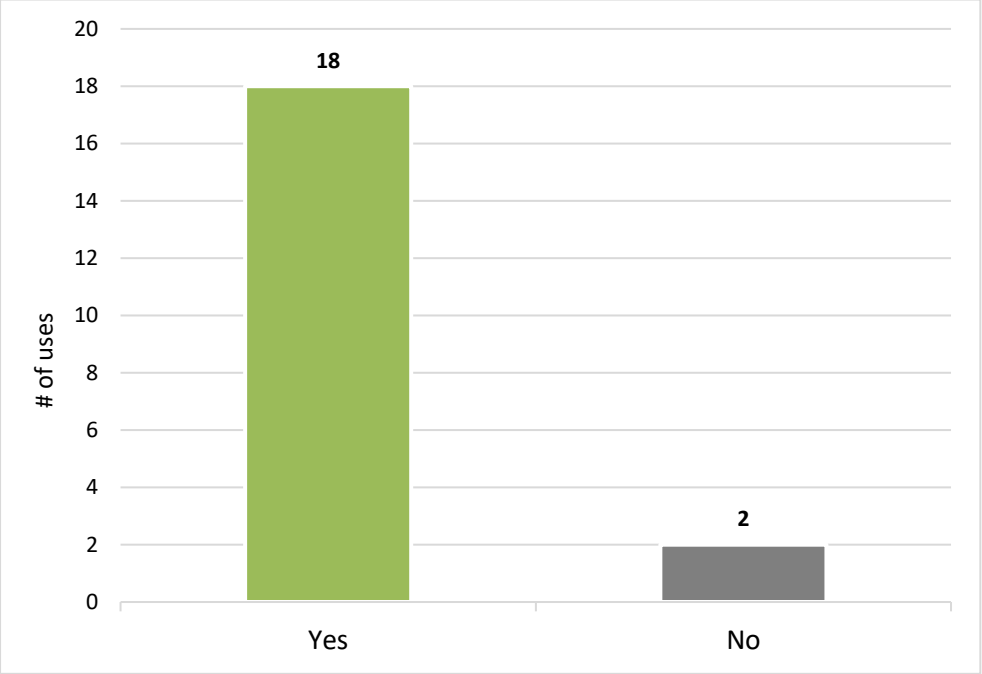


Figure 42. # of users willing to pay to use the UD service

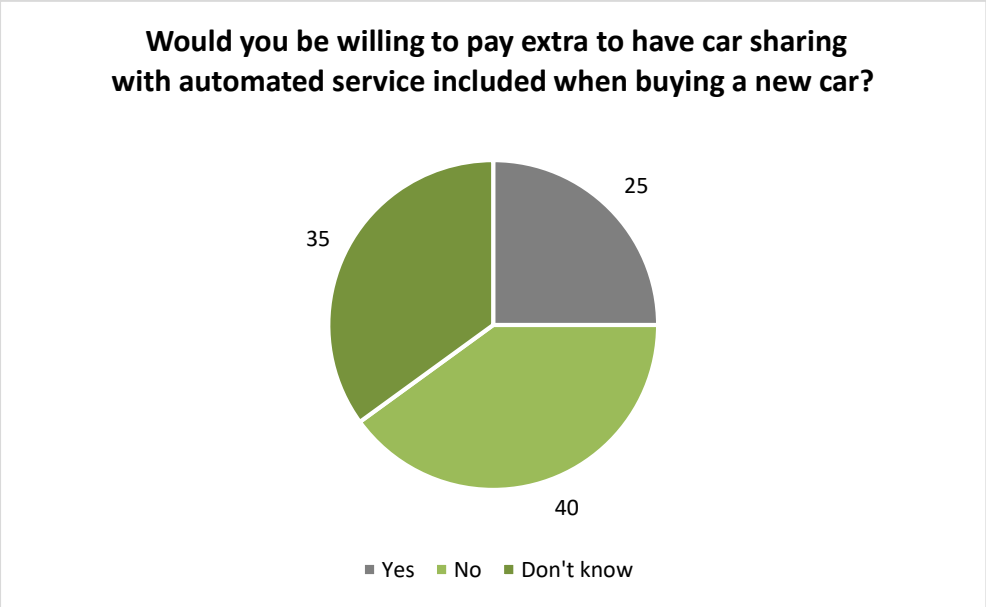


Figure 43. % of users willing to pay extra to have these services integrated to their new car

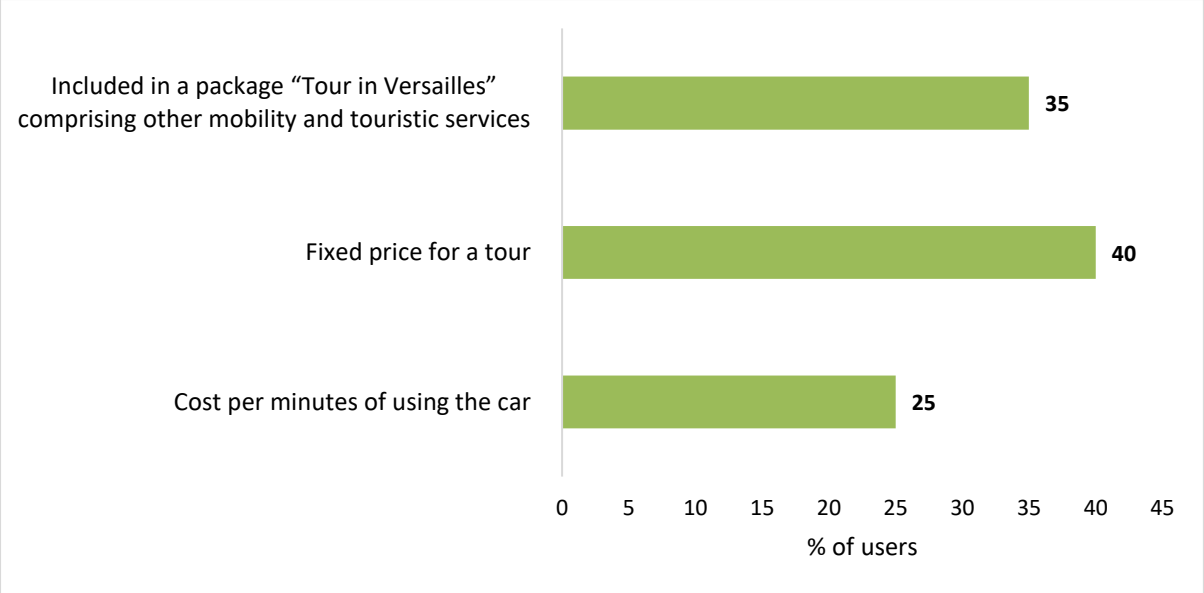


Figure 44. Most convenient pricing basis for UD service

Figure 45. Suitable price selection

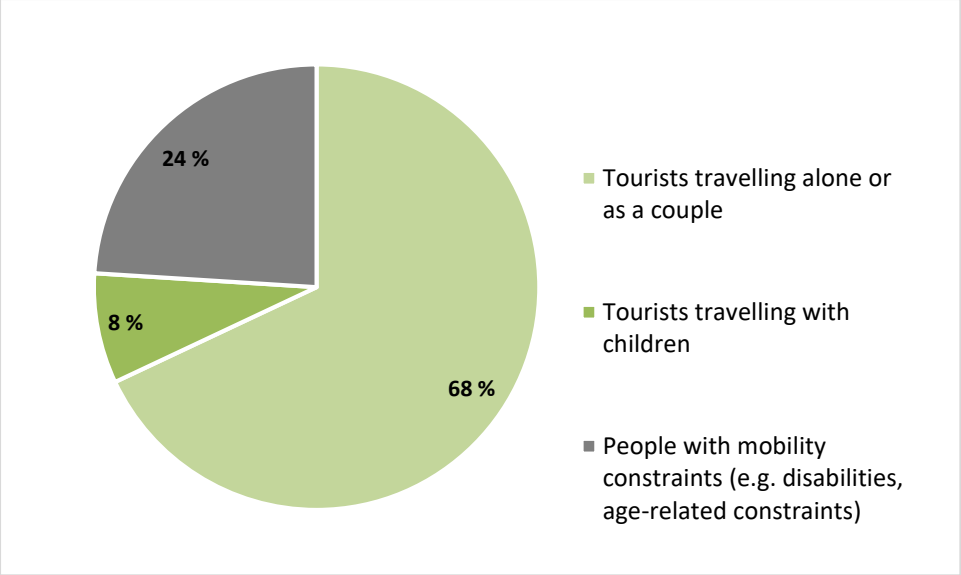


Figure 46. Attractiveness of UD services per user type

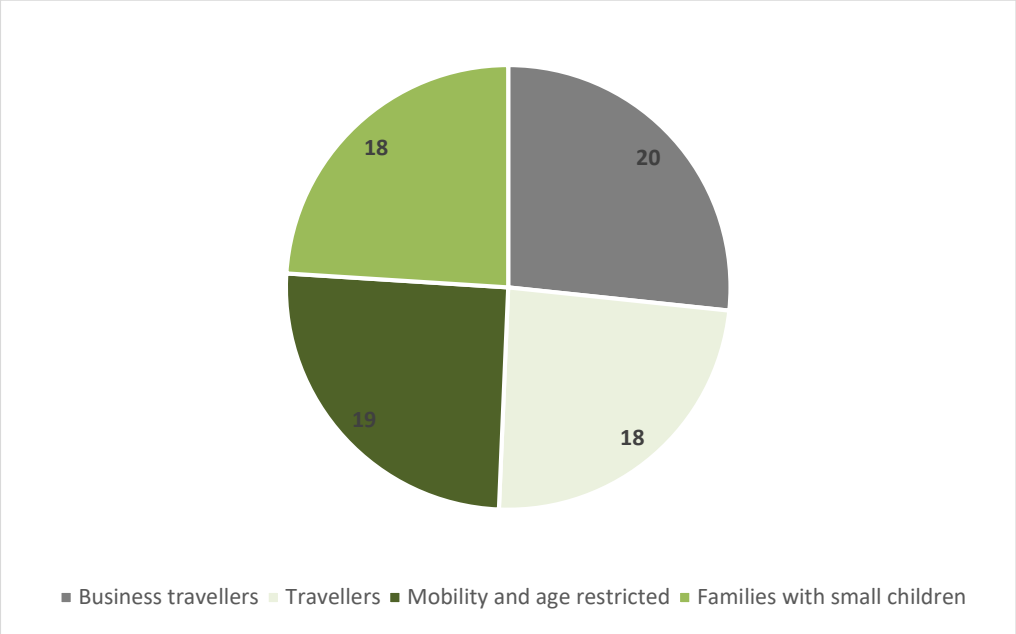


Figure 47. Type of users that the car sharing service would be useful

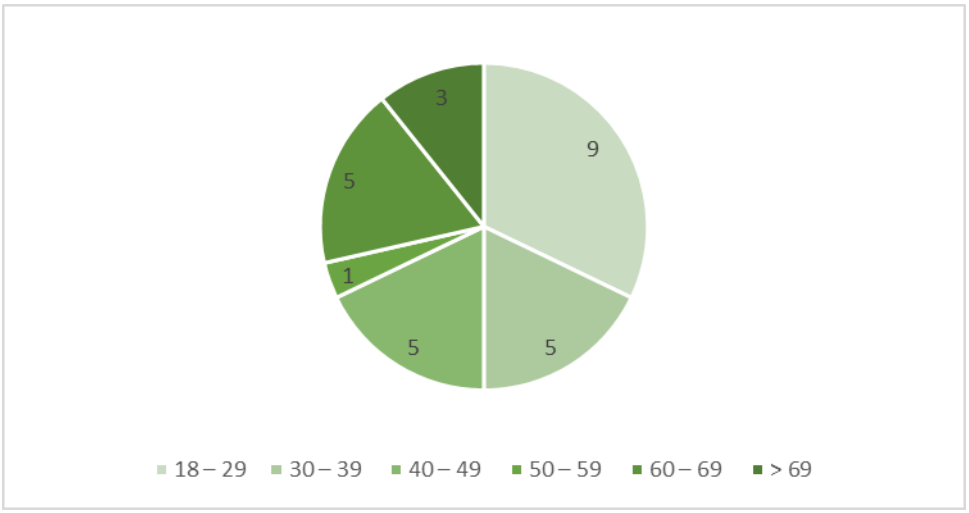


Figure 48. Age group and car sharing app attractiveness

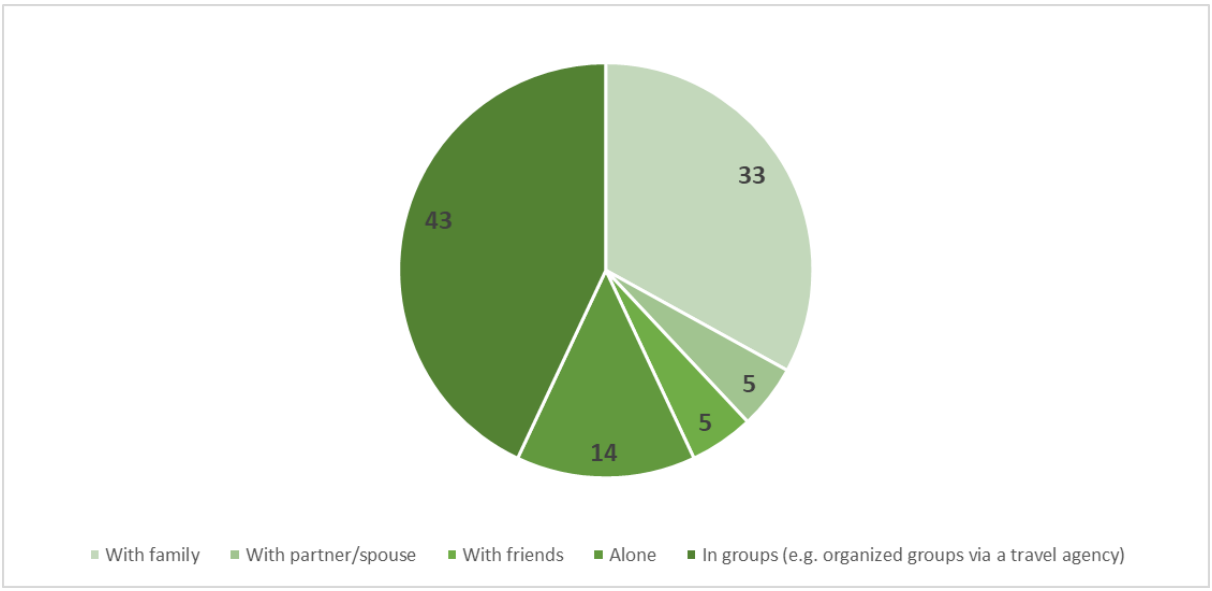


Figure 49. Travelling companions

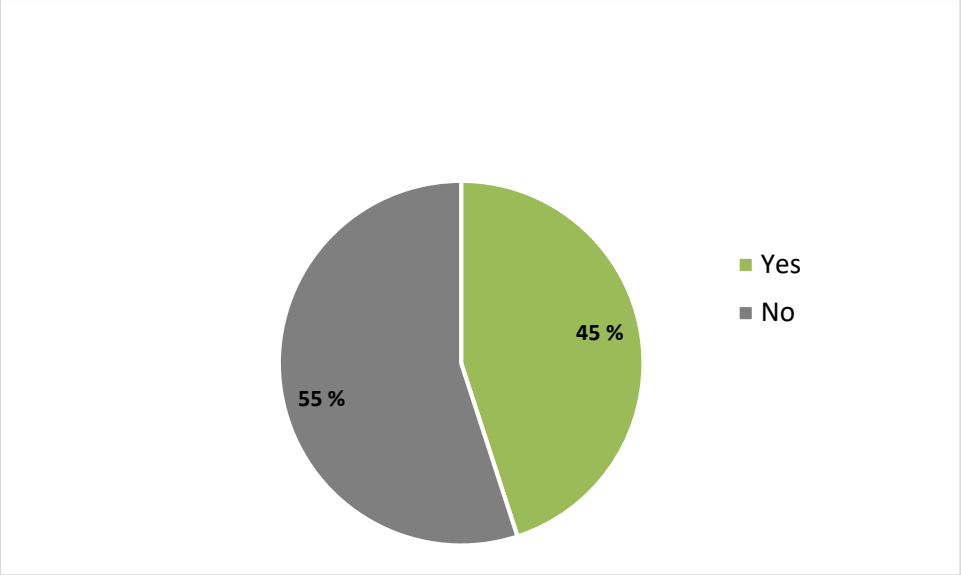


Figure 50. Interest for sales' info

9 users would prefer to receive additional information on shopping places and shops
6 users would prefer to receive additional information about cultural events (e.g. museums, theatre, etc.)
3 users would prefer to receive additional information about restaurants, gastronomy, etc.

Other types of information reported were:

- Station and stops info
- Events in the city: market, sports match

3.12 Recommendations for designers

- A "real" second place at the back
- Increase the areas of autonomous driving. Improve the sound quality of ads.
- The problem for a family with a child is that they have to use 2 vehicles.
- An optional theme to choose from for the visit (for example, for sports fans, points of interest or art lovers) that will make the places of interest appear.
- It would be wiser to think of a larger vehicle template to be more suitable for all types of users.
- Extend the route to propose a visit of the various districts of the city

4 Background information

Most users (N=25) nearly always have an available car to use (Figure 51).

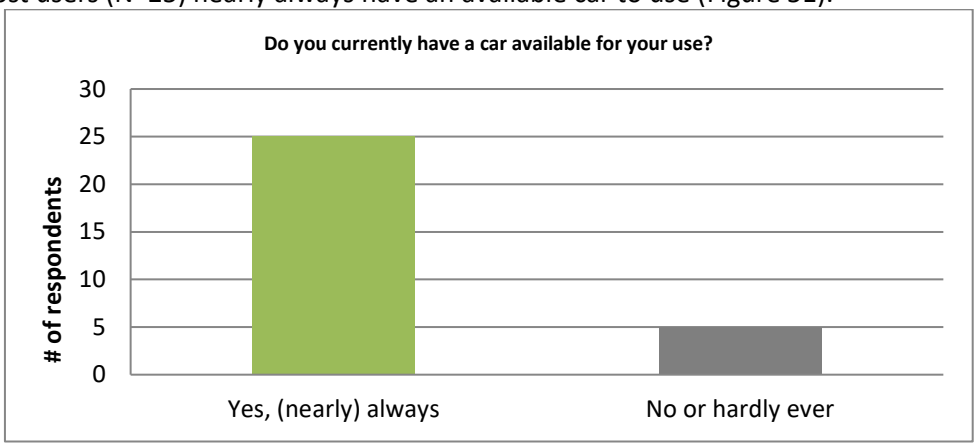


Figure 51. Car ownership

Users most often user their own car and public transport for commuting trips (Figure 52).

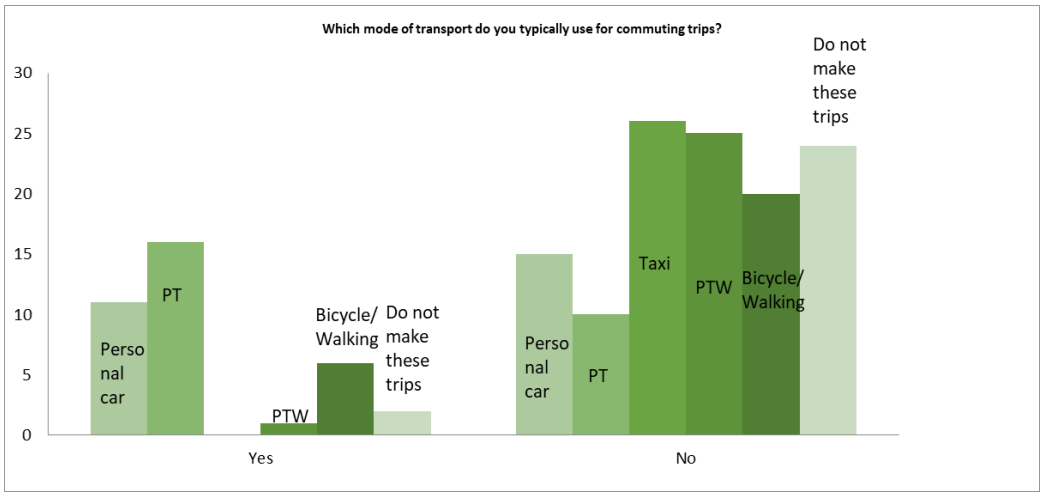


Figure 52. Transport mode frequency of use for commuting trips

The same holds true for short business trips but in this case more user drive their own car than use the PT (Figure 52).

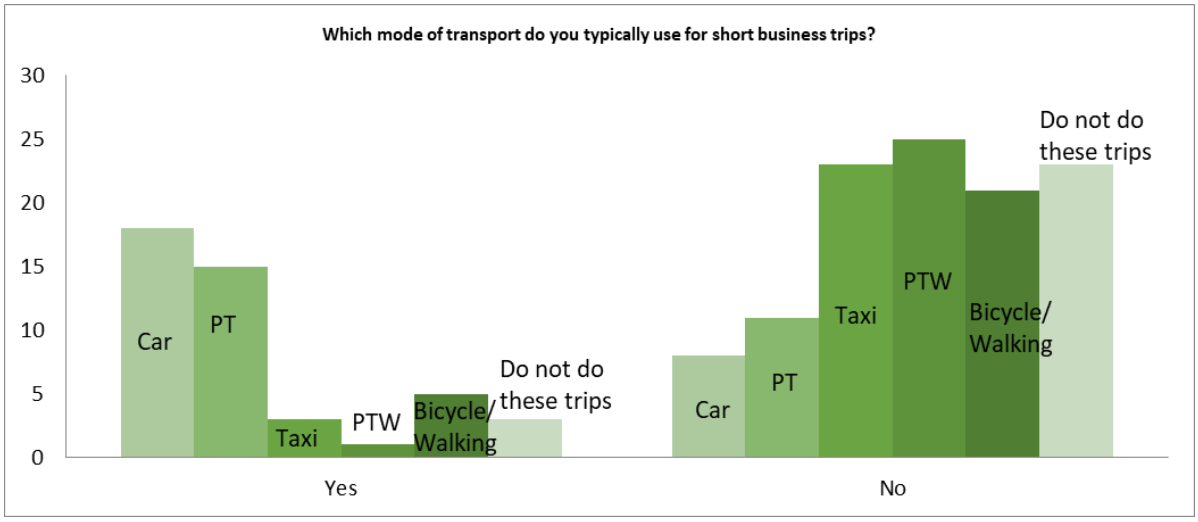


Figure 53. Transport mode frequency for business trips

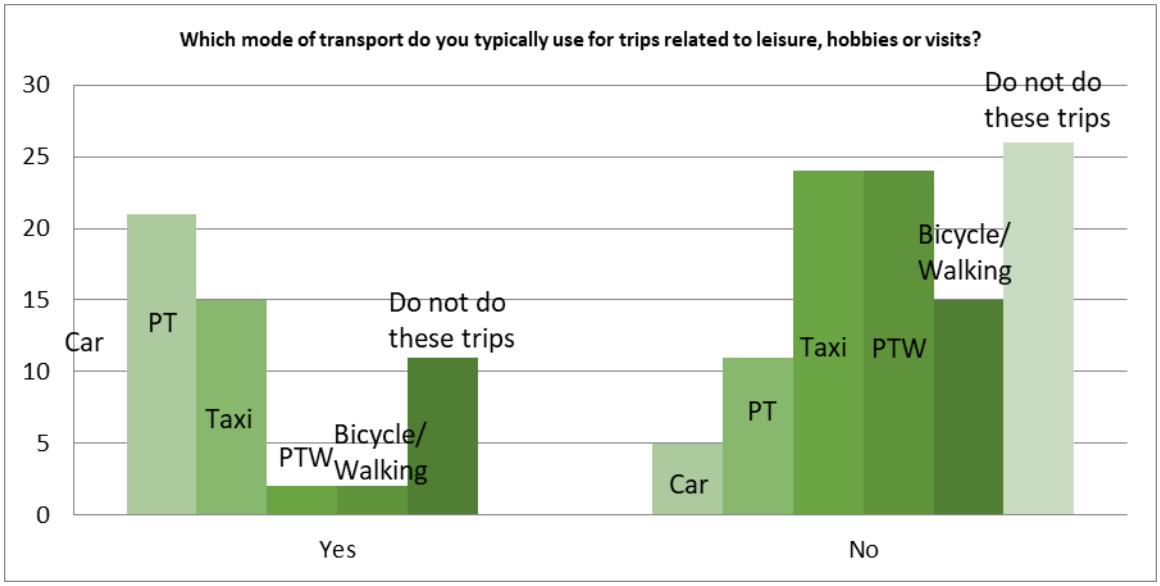


Figure 54. Transport mode frequency for hobbies & leisure trips

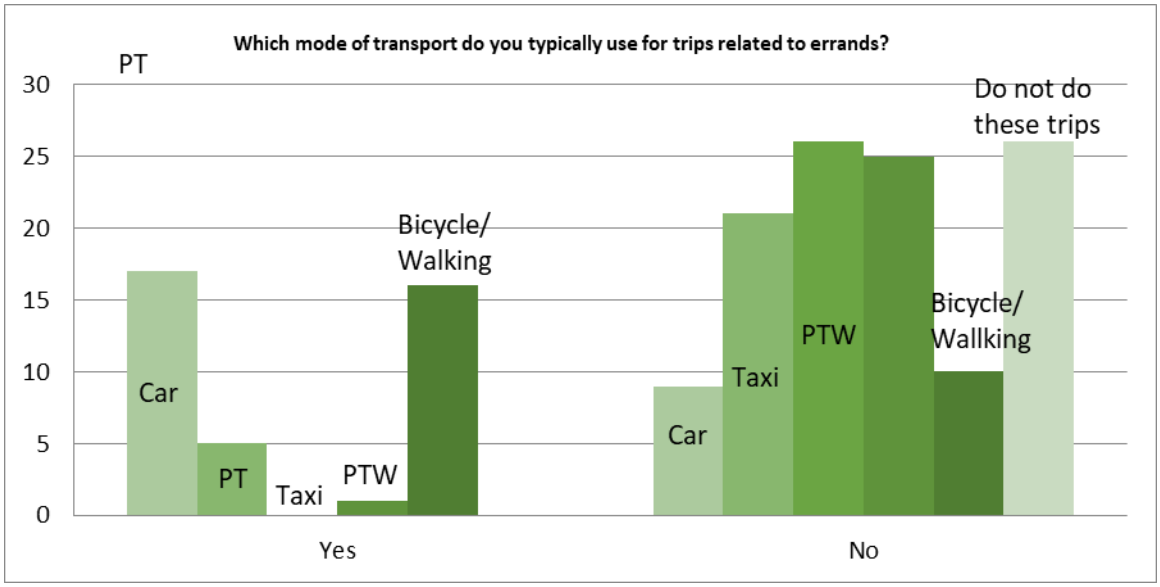


Figure 55. Transport mode frequency for errands' related trips

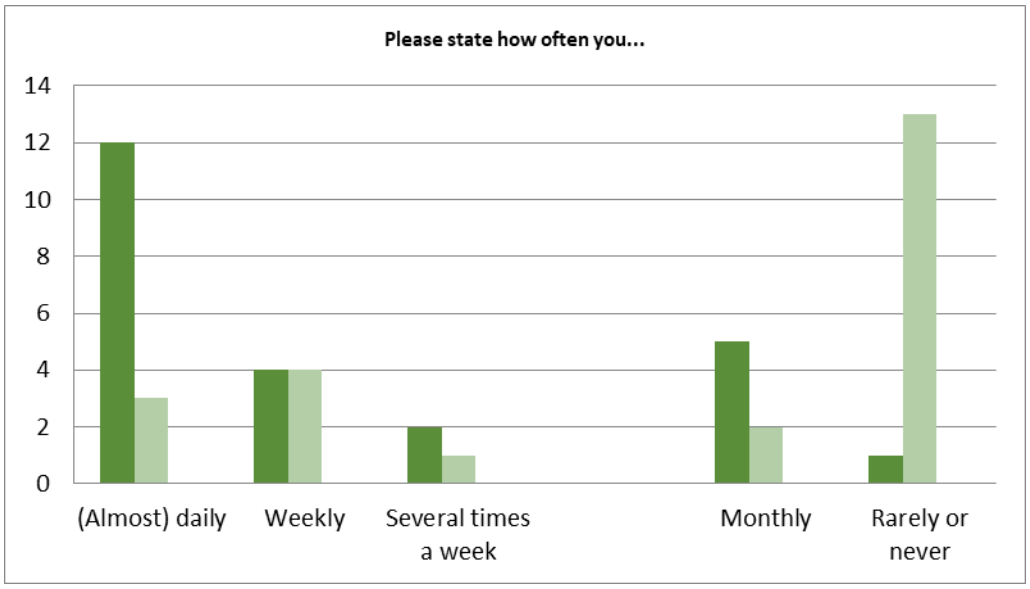


Figure 56. Frequency of driving in a motorway or an urban environment

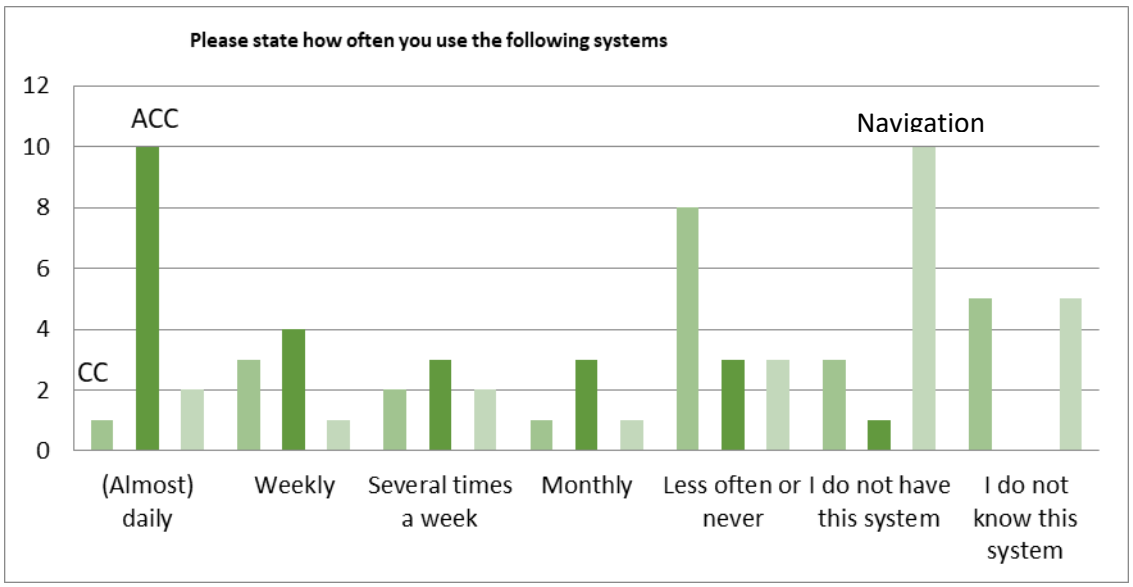


Figure 57. ADAS frequency of use

Figure 58. Frequency of services' use

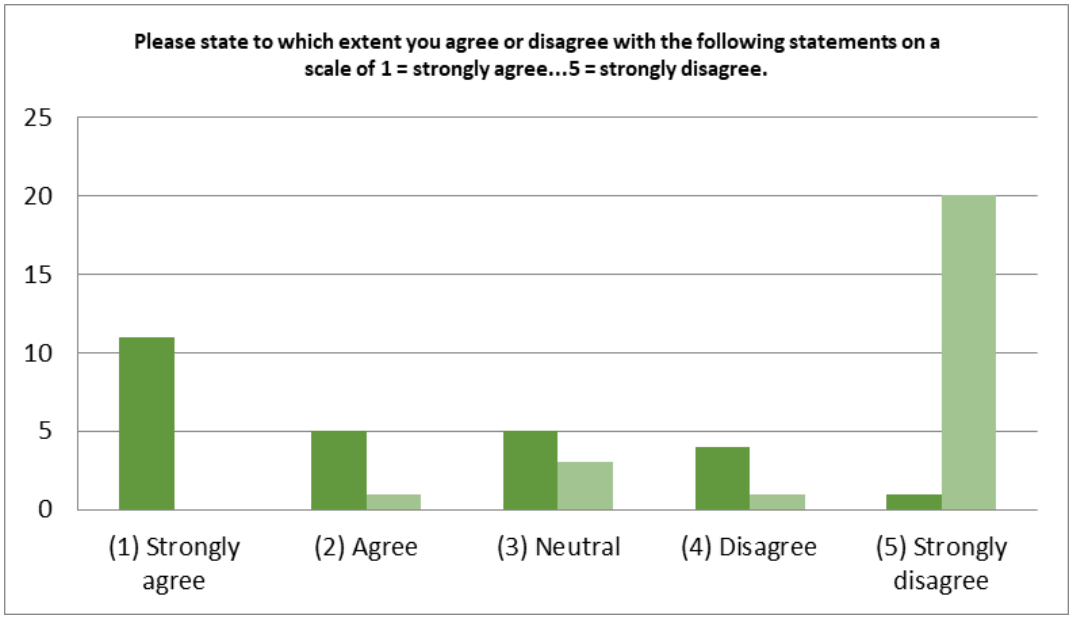


Figure 59. Reasons for driving (just for fun)

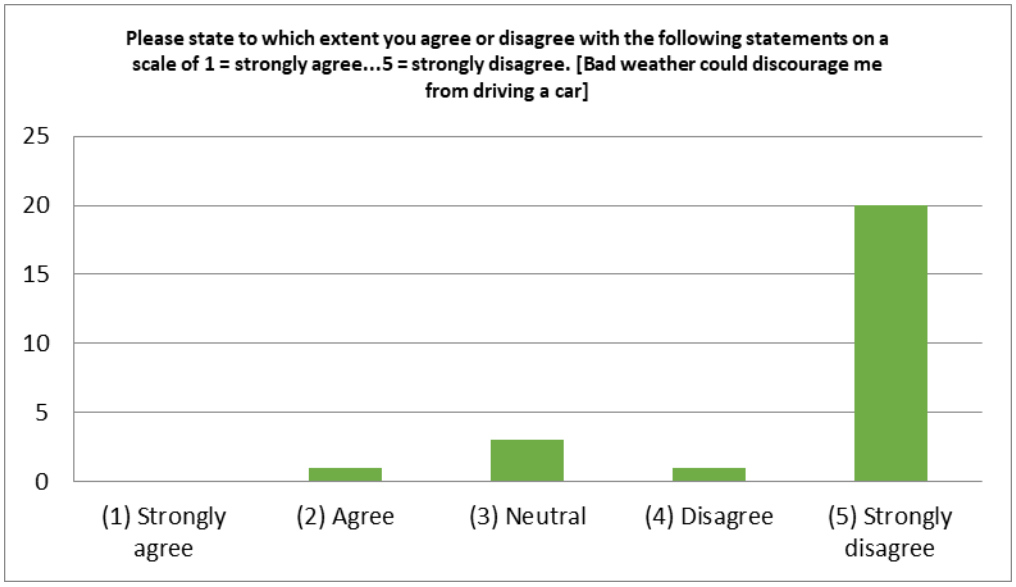


Figure 60. Reasons for driving (bad weather could discourage me from driving a car)

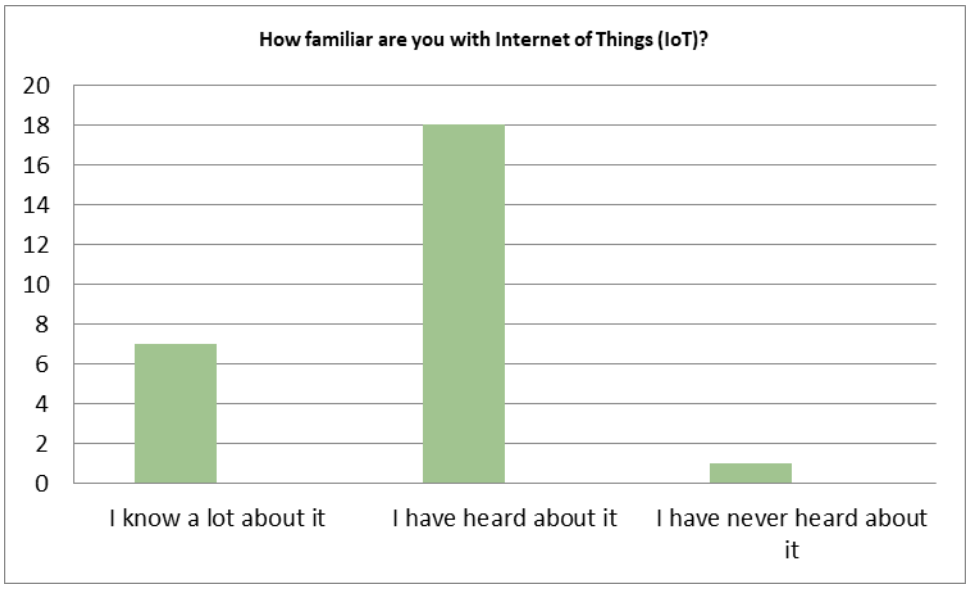


Figure 61. Familiarity with IoT

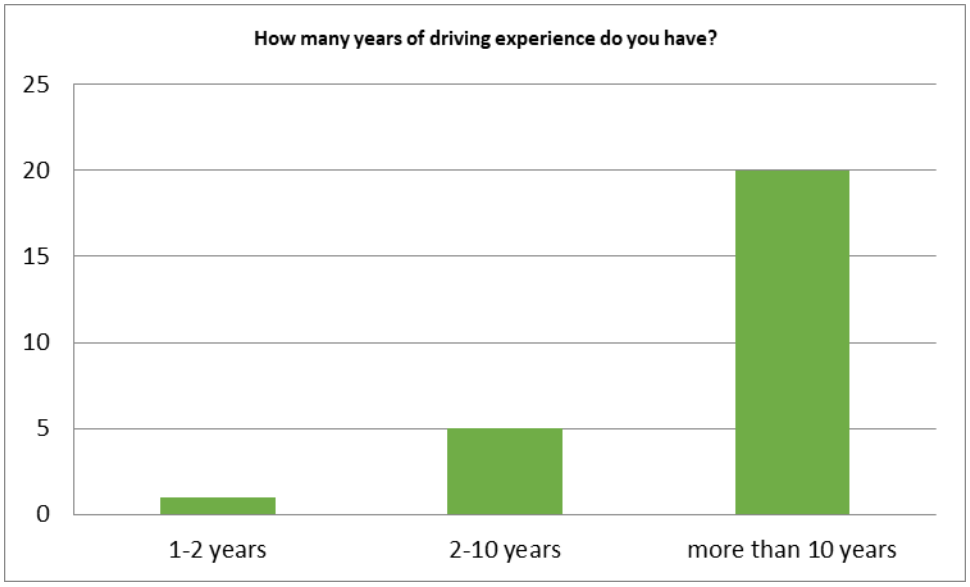


Figure 62. Driving experience (years)

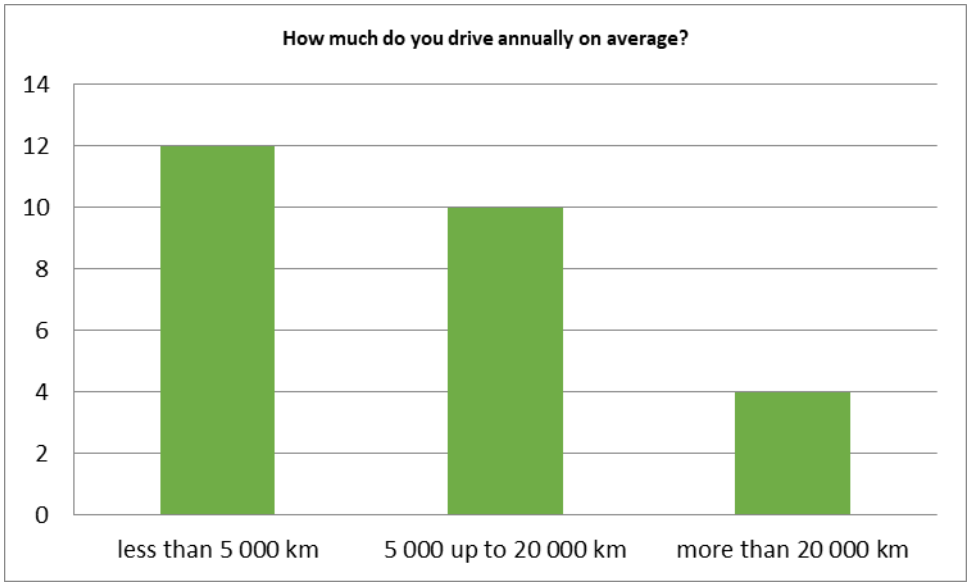


Figure 63. Driving experience (km/year)

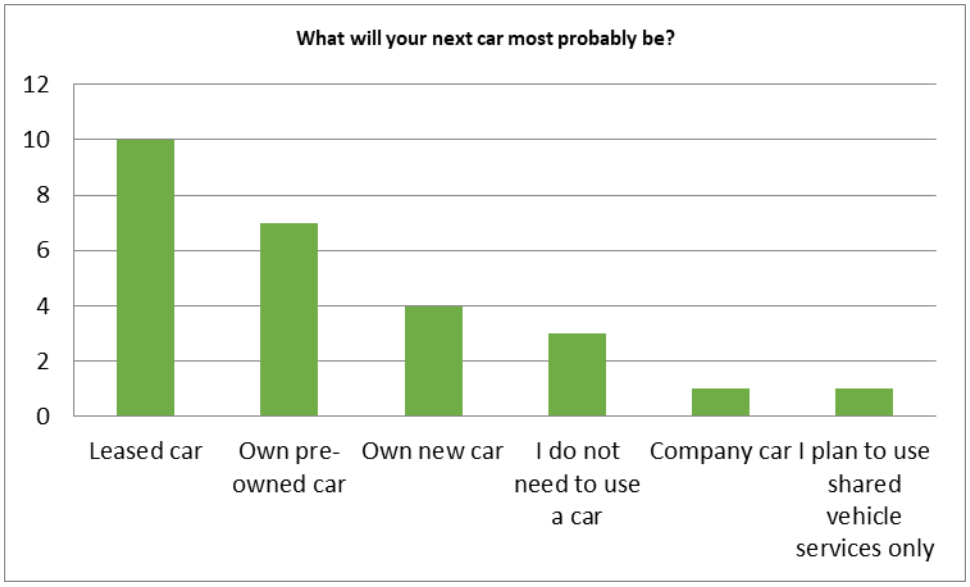


Figure 64. Next car type

Figure 65. Gender distribution

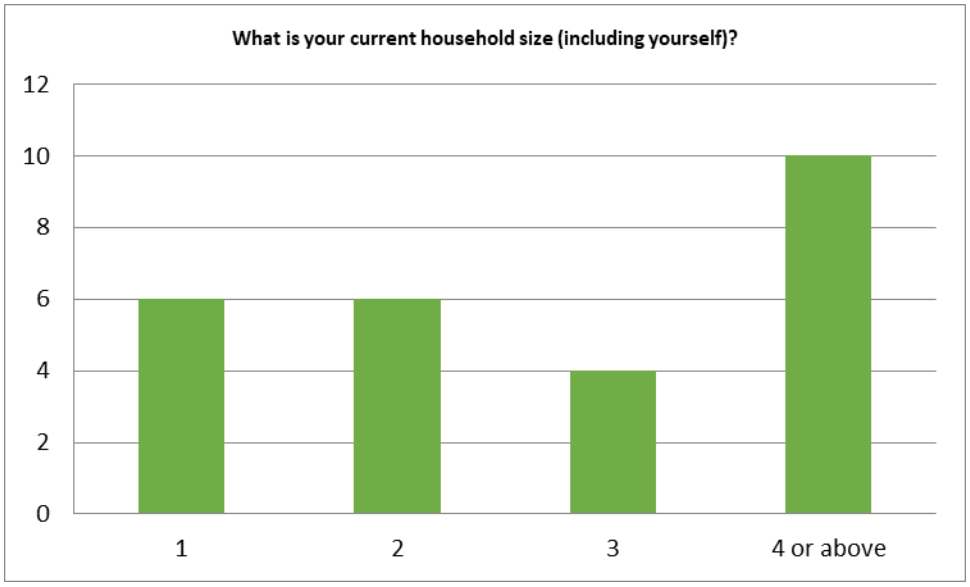


Figure 66. Household size

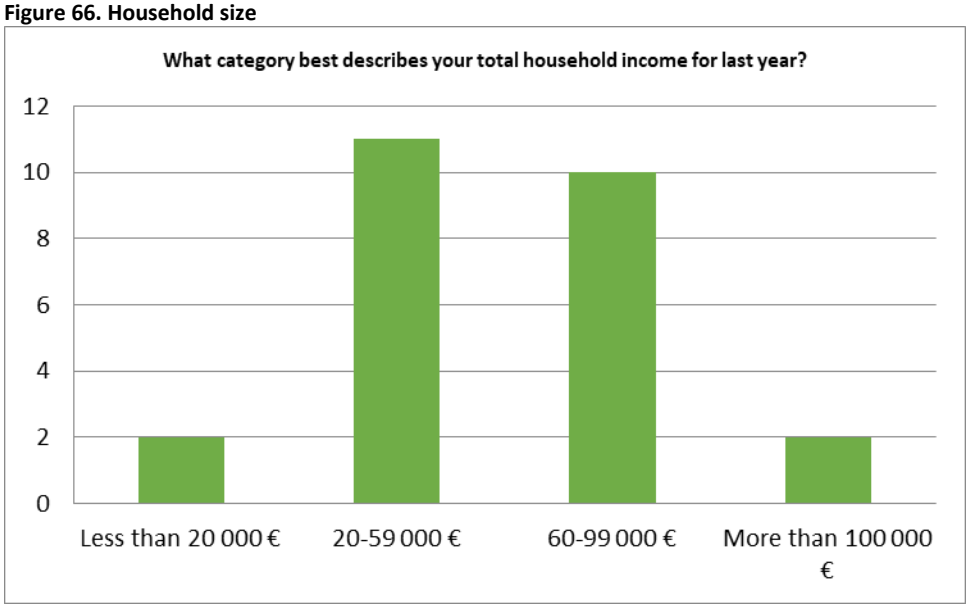


Figure 67. Household gross yearly income

Summary of the user focus group
Versailles, 13 May 2019

The focus group was attended by 6 persons (5 women and one man) who previously performed the iteration. They all accepted to be recorded and informed that the record of this session will be sent to the AUTOPILOT partners for further analysis. The record of the session started after the round table of participants.

Describe the context you wish even in a story, and how you will use it, noting any changes you will make and why

Most of participants mentioned tourism, touristic tour, historical building.

The care sharing application can be used for the last mile trip: it is a way to join two train stations in Versailles, even there are a lot of public transport (bus) or from the train station, to reach home. It can be a complementary offer of transportation for those who do not have a pass navigo (mobility package for the Great Paris Region), or for those who do not want to use public transport and have an individual mean of transport. It can also be used for other purposes like shopping or bring back the kids after school. The offer should be wider than only Versailles in that case. The difficulty then is the obligation to give back the vehicle at the car sharing station. The question of the driving licence has to be examine: this service can be useful to people who do not have / not any more a driving licence.

In rural areas, the main problem is the last mile trip. The care sharing can help, especially with autonomous driving for people without driving licence. Then, the whole trip should be automated.

For tourist, the size of the vehicle is a problem: to small and for only two persons, and too noisy inside to be able to hear properly the audio notifications.

The application should guide the user by geo tracking to the care sharing station.

The sound quality and the voice used for the notifications should be improved, as well as the number of languages available. The notifications should be delivered earlier, not right when the user is on the point of interest. It is dangerous to focus on the audio notifications in an environment you do not know, and at the same time, to drive. Automated driving would be more comfortable / safer at this stage. It could be interesting to visualise the points of interest on the tablet in the vehicle if we do not have to take care of driving.

A tourist would find convenient to be able to park close by any points of interest indicated, in order to visit or have a deeper look. Parking lots should be available also close by chops or restaurants.

The type of vehicle (Twizy) does not feet to tourist (small, with only two seats).

A – QoL & Wellbeing

How concerned are you about the car recognising VRUs?

All participants seem to be concerned by VRUs, but they are wondering how automated vehicle will manage if there are a lot of VRUs and manual cars. It would probably be easier if all cars are automated, the whole zone would be serene. The test was limited (driving only on the straight road with a limited number of VRUs, which is stress-free, so it is difficult to imagine.

Did something happen, where you felt uncomfortable / scared?

The test went well in general, the cyclist was well detected, but some users experienced a

stop of the vehicle without reason. The test was too short to get a clear picture of the service. During the first trip, some users stopped the vehicle manually, fearing that the vehicle will not stop. They felt more comfortable during the second round. Knowing that the cyclist is connected helped to feel more comfortable and safe. The test with the pedestrian is less impressive because the vehicle slow down properly either when the pedestrian was connected or not.

Does it add to well-being if the car display shows a notification when it recognises VRUs?

It could be useful to know that the vehicle detected a bicycle, to have a red point of the tablet showing the detection of VRUs, for example, but in town, in an urban area, if there are too many VRUs, the user could be overwhelmed with notifications.

What kind of notification would you like to get?

Travel time remaining, the itinerary followed, the location of charging stations and the way to reach them. The smartphone application should allow a check of the vehicle before use (is the vehicle in good conditions, without scratch …). It should be possible to choose the kind of notifications to receive: shops, restaurants, and for PoI, it could be personalized regarding the profile of tourists (architecture, culture, kids…), cultural events in the town in the next few days. Be careful not to offer notifications that are already available on google (like restaurants). If the shops and restaurants are paying to appear as a notification, then we have to be careful on their quality. Maybe to allow the connection to other applications?

In the vehicle, the screen for technical purposes was quite disturbing the users. They did not pay too much attention on the notifications on their screen and do not remember too much about it.

Which type of persons would benefit most from this service and why?

This service could be useful for families with young kids, elderly, couples… depending of the kind of vehicle available (a Twizy allows only two persons inside and no place for bags). Automated driving is very attractive, it is a way to introduce people to new technologies, new kinds of mobility. Then people will be more willing to adopt those technologies.

Some tourists have already prepared a detailed planning of the places they want to visit, and others are coming without anything. The application may be more useful to the second category.

Discussion on typical mobility as a tourist: what changes if you use these services and for which groups?

The service would change the mobility of user only as tourist, to follow a touristic itinerary and discover a new town/place. The service is very interesting for tourist visiting a town they do not know. It is an additional visit, helpful to have an itinerary already prepared.

If car is fully automated, tourists will feel more secure and be able to focus on the points of interest rather on driving in an unknown environment.

It would not affect the daily mobility.

What types of benefits could the service have on different types of trips?

The service would optimize a touristic trip and the autonomous driving is fun. The idea of freedom seems very important: it allows tourists to visit at their pace, stopping by where they want (if there is a possibility to park) to visit the points of interest. Then, parking lots should be available close to PoI additionally to the car sharing stations. The vehicle is then booked for a certain time and will be given back at the end, to the car sharing station. Automated driving car reinforce the security of road users, although the driver is still responsible and driving.

What would be the most important impact to touristic service provision?

To have the notifications and explanation in the native language of the user is very important. As of now, the office of tourism of Versailles is working with French, English and Spanish. It is very important for the comfort of the tourist, to have as many languages as possible, even if English is widespread. In particular for kids.
Automated car would greatly improve the quality of experience: it would be more comfortable than to be in a bus with 50 persons, listening to the same information.

What types of drawbacks or risks could the service have?

Download an additional application can be an obstacle, especially a new application that requires registering bank coordinates. The application should be well secured. Downloading the application should be free of charges.
If everybody is connected and there are many people, then the automated car will never be able to move ? Can the automated car bring all road users to share properly the space?
The service may be useful if the service is fully on automated mode. If everybody is connected.
Fear of one user to run out of battery (for the car) without knowing where to charge the vehicle, how many kms the car can still drive. There should be charging stations everywhere in the town.

What kind of personal data would you be willing to share? why?

Age, family size and composition (to book a type of vehicle suitable, to get a personalized itinerary for example), bank coordinates.
The service may be available directly at the car sharing station without registering through the smartphone application. It would help people not too confident with a smartphone, or not willing to download an additional application, or to register bank coordinates in another application.
Geo-tracking: the service should ask permission and limits the geo-tracking for the time the car is being rented.

B – Mental models & Comprehensibility

What would you tell the designers of the system to change to make the system more useful?

The smartphone application does not show the itinerary to the car sharing stations. It just show were they are but does not explain how to reach them.
Notification regarding emergency / breakdown: users did not think about this possibility.
The tablet in the vehicle is connected to internet. It should then allow to go on internet, for example that the kids could play while the parents enjoy the touristic tour. It should also be possible, for example to book a ticket for an exhibition, a show or the visit of a museum described in a notification. In French, car sharing has two meaning: “autopartage” and “covoiturage”. “Covoiturage”, is the possibility if you have free places in your vehicle, to publish them on internet so people going in the same direction, can join. “Autopartage” means to rent a car for a certain time. The application may allow this possibility (not for tourist, only for the car sharing application side). The application clem.mobi is proposing those options (mixing different kinds of car sharing).
The possibility to have access to the electric vehicle without having to touch the charging station could enhance the use of those vehicles by tourists who are not familiar with electric vehicles. Electric bus can be charged by the roof, without a physical link. A notification saying that the vehicle is well plugged to the charging station.

How easy is it to understand what is expected of you as driver/passenger?

It is understandable. Maybe to explain better how to plug the vehicle. People are not yet very

confident with electrical vehicle.

Do you accept sharing your location and information of the vehicle to the service provider?

Yes, it is necessary to get the notifications, to follow the itinerary. But some users are reserved about the tracking of their behaviour, the analysis of their consumption.

C – Wishes and ideas for improvement

What should be improved to make the service more useful to you?

See previous answers.

Having full access to internet through the tablet, in order to play for the kids, of book an exhibition, a museum.

Give access to a vehicle to people without a driving licence. What about the emergency procedure? If an incident on/with the vehicle happened ?

What information do you wish that the service would include?

See previous answers.

Not adding services that already exist in other applications, rather create links

How could your willingness to pay be improved?

The price of the service is of first importance. If the vehicle is fully automated, then it is a service by itself.

The price should be comparable to the price of an exhibition or museum, or of public transport. Depends on the duration of the trip/service.

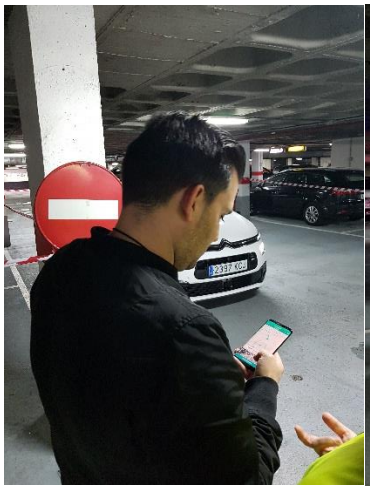
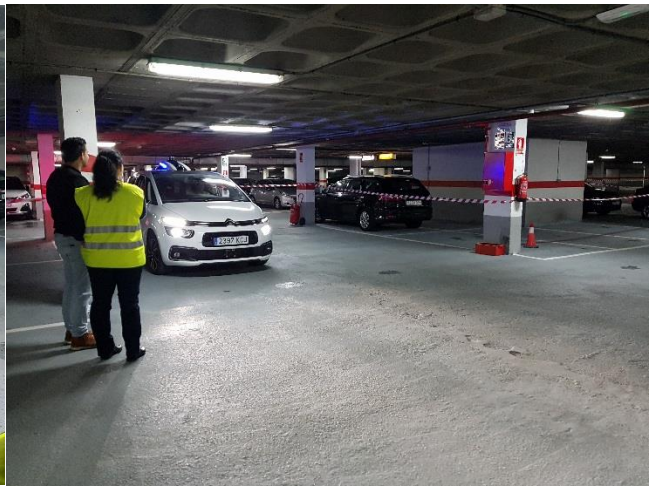
What types of other services would you like for sightseeing and other touristic services?

See previous answers.

Vigo Automated Valet Parking (AVP)

1 Background

The Vigo AVP user testing took place in two iterations: the first one between 06th – 18h February 2019 and the second iteration was performed between 03th – 17th June 2019 at the Vigo City Hall, Spain. Answers from 43 participants are analyzed in this document.

2 Test Protocol

Introductory presentations were given in Spanish, as were most discussions. Description of the technology and test conditions were also carried out in Spanish. Questionnaires were in Spanish and carried out through the online survey tool, 'Surveymonkey'. Before participating all the user signed the consent protocol and all of them wore a reflective vest. The questionnaire used in the second iteration suffered some modifications because a new version was developed in order to enhanced first version. In fact, some feedback from the users of first interaction was provided to the Evaluation Work Package with that objective.

3 Technical problems

There were some minor issues with the technologies during the testing. If in some test there were problems with the technologies and the participant could not run the test, his/her data was not considered for this report. Moreover, it had a problem with the register online for some participants answers, probably regarding the process of saving the answers. That is the reason for not having answers for all the participants.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in four areas and the usefulness of the service on a 7 point Likert scale. This was rated 3 to -3 (eg. Positive = 3, Negative = -3).

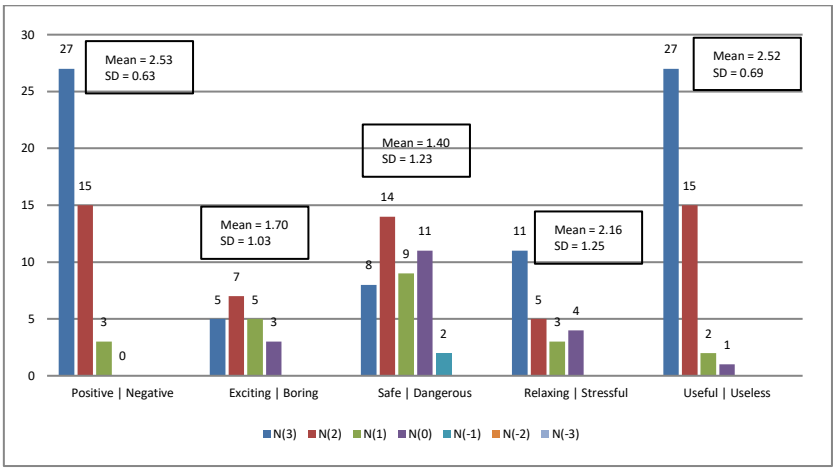
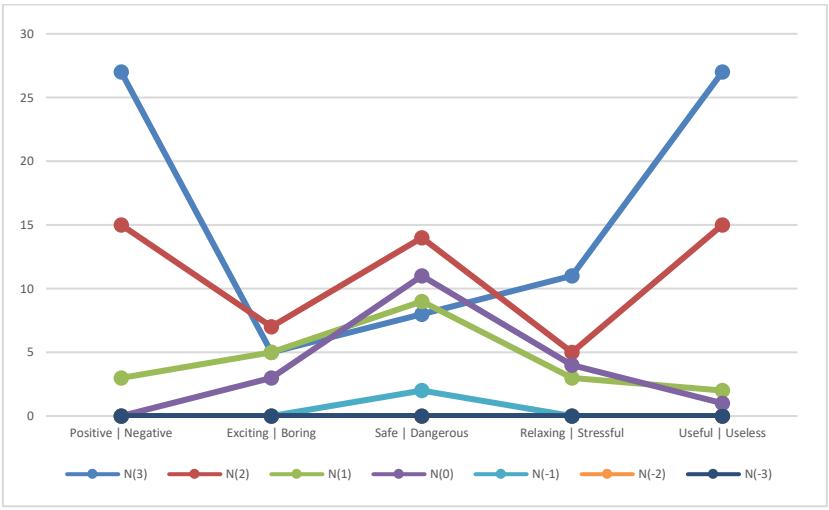


Figure 1: Participants expectations on the test and usefulness of the service[1]



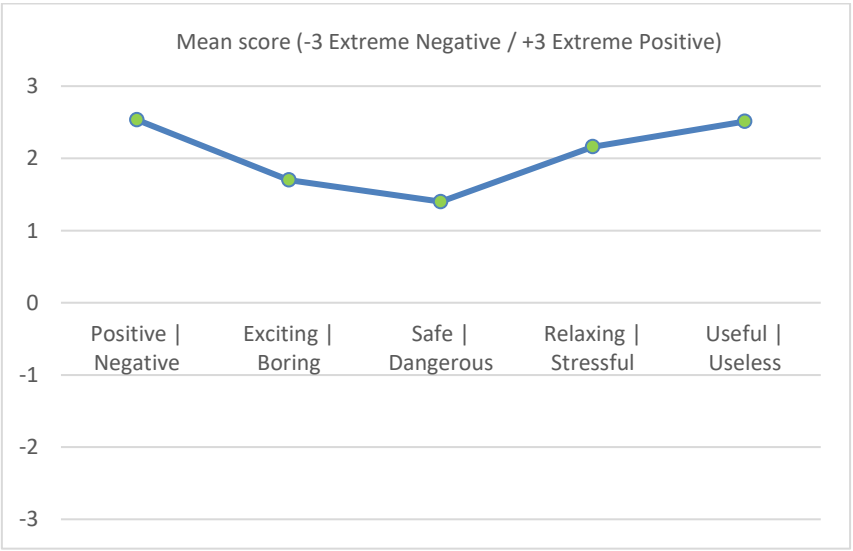


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service[2]

[1] The variable "Exciting/Boring" was calculated with data from 1st iteration and "Relaxing/Stressful" with data from 2nd interation.

[2] Idem that previous note.

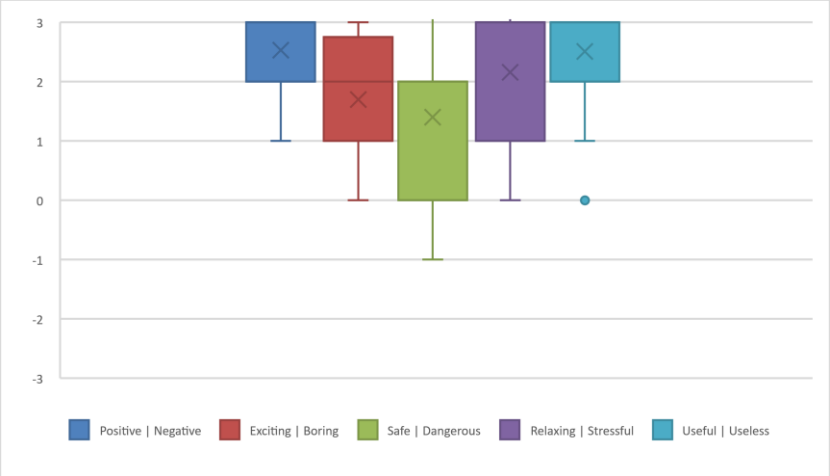


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier[3].

- In general participants considered that the experience was positive and useful.
- It was considered that the experience was also safe, only two participants evaluated it as a bit dangerous. Eleven drivers were neutral regarding the issue of safety.

Main concerns regard to city parking

Participants in this study identified the main concerns regard to city parking. Answers are shown in the table below. Key worries are related with not available parking slots and consuming time and fuel.

I would like to know with anticipation in each area I could park.
Find a place to park in a minimum time as possible.
There is no place to park.
Waste of time \ Don't find place\ Consumption.
Time wasted trying to find place to park.
The time lost and economic expenses that imply.
There is never parking available for the quantity of cars parked, but if it is totally necessary, I park in a blue zone (if there is place available) or in a paid parking.
Difficult to find parking, collapses that forms, the pollution.
Space in proximity.
Find it.
Find a parking place. Don't having difficulty parking because of the size of the place and the size of my car. Don't create too much traffic jam while I am parking.
It is difficult to find places to park in the city, I normally have to leave the car to much far from my destination to be able to park or pay a parking or take a bus.
Lack of parking spaces.
Availability. That damage my car (especially intentionally: broke the windows to steal objects from inside, scratches in the paint ... etc).
Difficulty of finding place to park - The price of parking in the blue zone, and the time that I can leave the car there -difficulty of parking on the slopes - High probability of having my car scratched - Too many times is possible that the park don't have the adequate signalling.
Lack of places to park.

[3] The variable "Exciting/Boring" was calculated with data from 1st iteration and "Relaxing/Stressful" with data from 2nd iteration.

Find parking, free of charge, In a quickly way and close to the destination. Small bumps / damage on your car that were other users that produce when parking.
Difficulty finding a site and making those sites difficult to access.
The possibility of parking, which in many places is almost impossible.
The availability of free places and the space used for park it.

Motivation for taking part of the study

In the next table it is presented the main reasons expressed by participants to take part of this study. Mainly they wanted to collaborate in the car of the future, try an autonomous car and have knowledge and testing of new technologies.

Collaborate with the development of the project.
Try a new technology that you may have on the future.
It is interesting to be able to test projects that will undoubtedly be an improvement in the quality of life and that sooner or later will end up integrating into society.
To know the actual state of development.
The experience and curiosity to do a test of this kind.
Test an innovative proposal in first person.
I'm interested to know what the state of this technology is and see how it really works.
Test the system to see how it works.
Know a new function of parking.
Know new technologies.
Curious to see how the system works
I think that the project is very interesting, technology is a pioneer and I think that in the future it will help improve both efficiency and safety when parking. I'm glad you counted with me to see the demonstration first-hand.
Interest in the operation of the system and to see how the tests work with the users.
Know new technologies and live first-hand the experience offered by autonomous vehicles. In addition to helping a partner.
Taking into account that my car is very old and don't have any technology of today to help parking. Have some feedback with some of them.
I like to test new concepts.
Curiosity to see how it works.
I am interested in everything that has to do with autonomous driving.
Both the interest of seeing how a car parks alone, and the ability “to contribute my grain of sand” to the autonomous car.
Can use this functionality in the first person that is not easy to be possible to try.
Experiment and learn more about autonomous driving, as well as help in its development.
Know the project to see how it works and see the track area.
Test the autonomous driving systems and compare it with the Model S that I tested with autopilot.
Collaborate in the creation of the car of the future.
High taste for new technologies, curiosity.
Knowledge of autonomous driving systems for professional reasons.
I am interested in discovering the advantages of the driver assistance systems with IoT to value them to an upcoming purchase or recommendation to people that I Know/family members.
See operating the current technologies that my car does not have.
In order to experience driving an autonomous car, how advanced is the technology is a field of autonomous driving and above all to be able to serve as an aid to my companions of the company.
Test the experience of the autonomous vehicle and collaborate with the study.

To be able to collaborate in a pioneering service and experience the last technologies before they are released. In addition, the interest I have always had for cars and technology.
Know the systems of autonomous driving and help with their development.
I have not driven any autopilot system. I am interested in its development.
Try new driving systems.
Know the system in which is being practiced the development.
Interested in the progress of autonomous vehicle technology.
To be able to help developing new systems for the future and can test it before they get out to the market.
Try an autonomous car.
I'm curious to see how the system works and how the user feels when driving with the car
I think it is interesting to participate in a study like this.
I am interested in the topic of autonomous driving.
Try new driving assistance systems.
Know the new technologies that are being incorporated in cars.
Learn more about the systems in development at CTAG.

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -3 to 3 (eg. Positive = 3, Negative = -3), in five areas. The scale used for evaluating usefulness was between 1 to 5 (1=not very much useful; 5=too much useful).

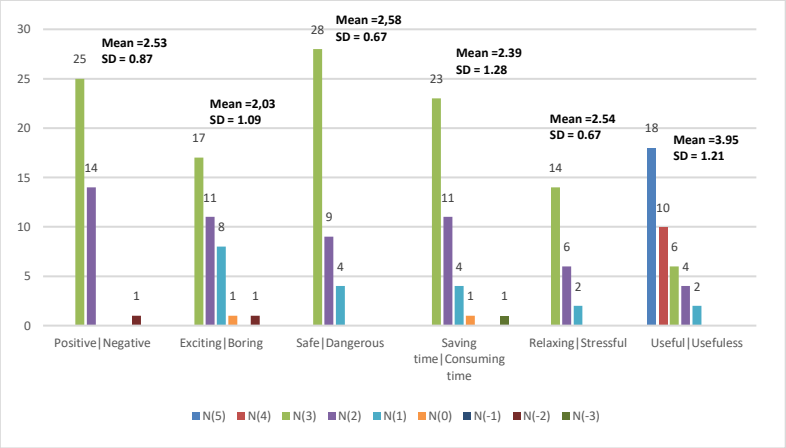
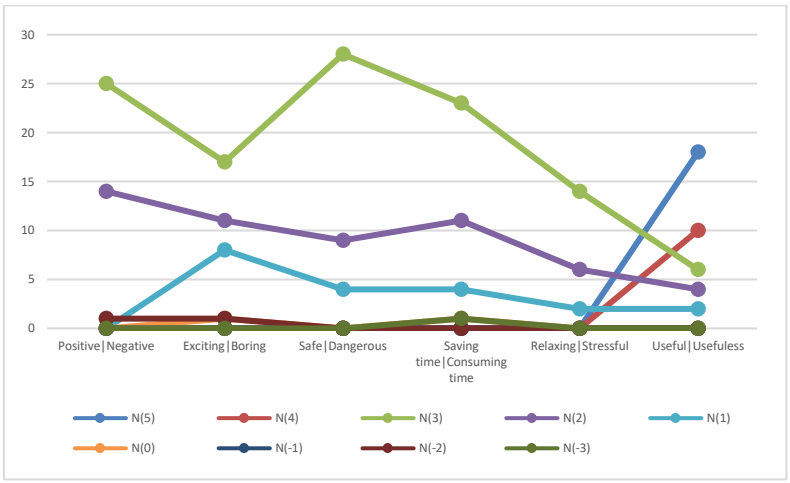


Figure 4: How participants felt about the test and usefulness of the service



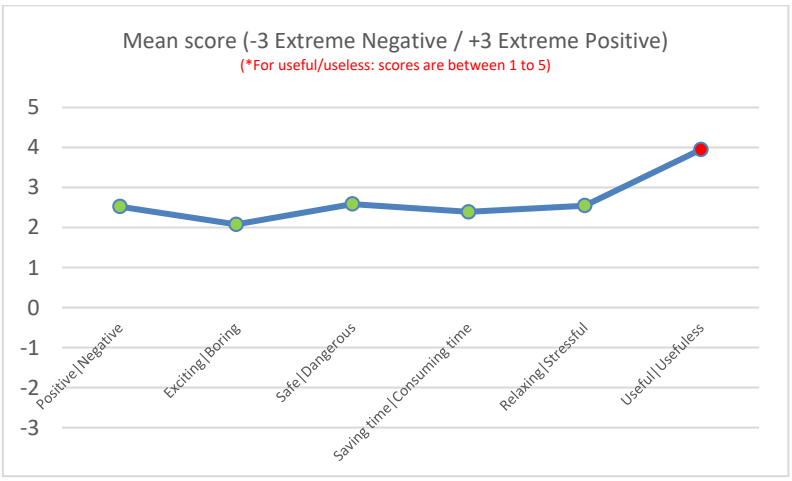


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

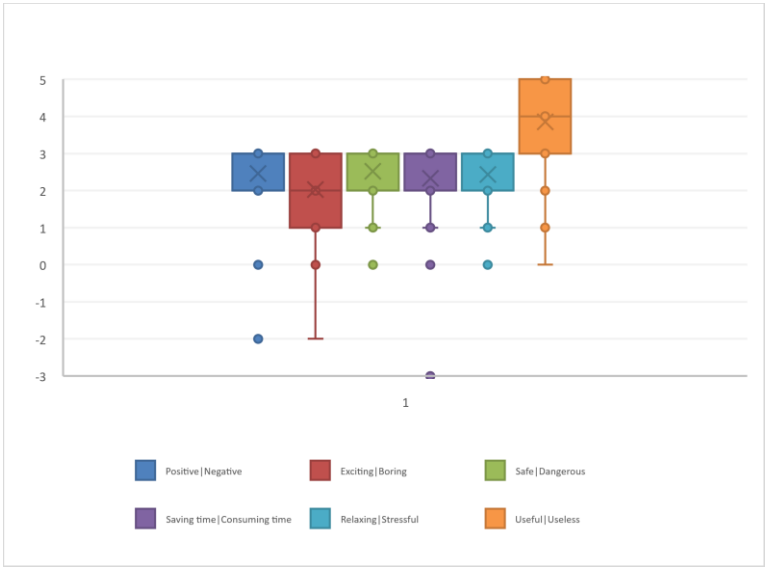
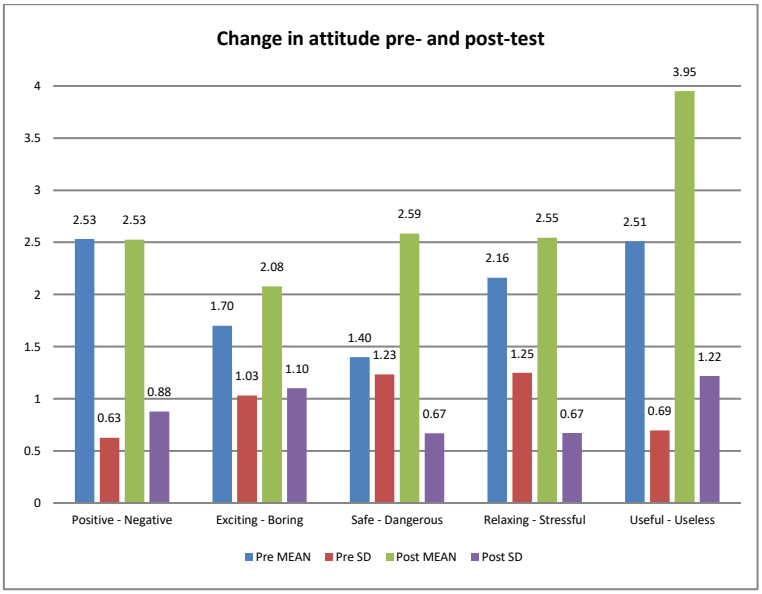


Table 1: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- After testing the AVP function only one participant considered that it was negative.
- Only one participant believed that it was boring.
- Only one participant thought that the AVP consumed time.
- Six participants found the experience boring.
- One driver was neutral about how exciting or boring the experience was.

4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.



Positivity of Experience

- The post-test reactions were similar in the pre-test expectations compared with post-test results.

Excitement of Experience

- The post-test reaction was more exciting than the pre-test expectation.
- This was the biggest change from pre-test to post-test.
- Deviation in responses are similar for both conditions.

Safety of Experience

- There was change between the pre-test expectations and post-test reactions, score was higher for post-test expectations
- Deviation in responses was lower in post-test reactions

Stress of Experience

- Scores for stress was a little higher for post-test reactions, although the deviation was also lower for this situation after testing AVP.

Usefulness of Service

- It is the variable with higher change. The post-test condition was clearly higher than the previous expectations although the deviation is also higher for this condition.
- It was one of the most positive areas

Initial Post-Test Reactions[4]

9 participants reported feeling unsafe or uncomfortable during the test:

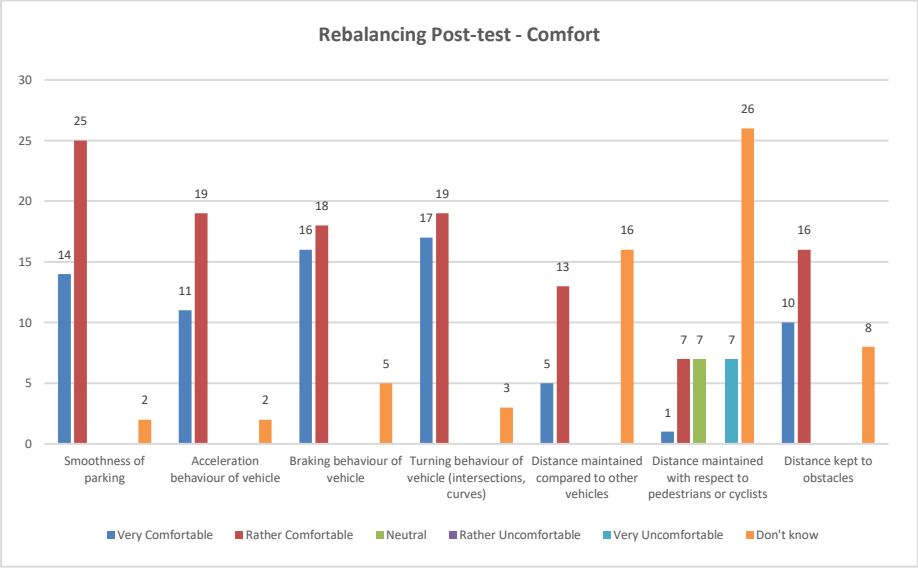
I had two attempts because in the first time the car did not start moving, after closing the mobile application and trying again it worked without problem. But this made me think about the possibility of the car standing stopped in the middle of the parking stopped and the user is not there to see it and solve it, and I think that this can become to be a problem.
How would be its behavior with other cars parked on the side?
He doesn't know where I was going to park.
There were people crossing in the parking area, and I am not too clear about the behavior of the car in this kind of situations.
Nothing.
The lack of habit to drive a automatic car, does that in two moments I pull the brake with my left foot, when I intuitively search for the clutch pedal.
The system failed.
I have put that no, but I was an awkward tad that the car was automatic. And I don't use automatic cars but I defended myself quite well.
Not seeing where the car was parked.
When he parked, he only got very close to the adjoining vehicle.

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 Comfort whilst experiencing service

Participants were asked to comment on the perceived comfort of various aspects of the service. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice (using a Likert scale of 7 points).

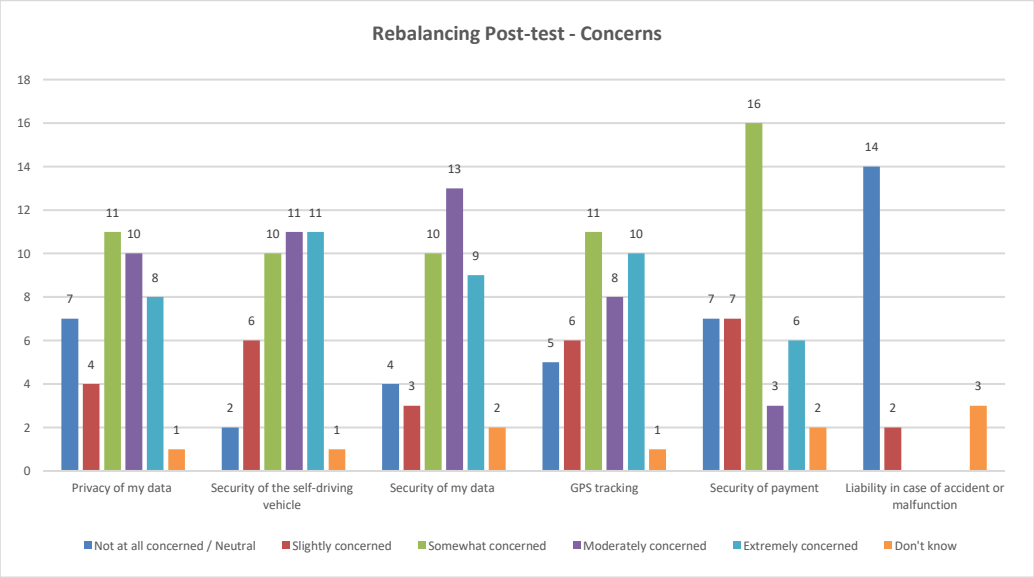


[4] Translated from Spanish

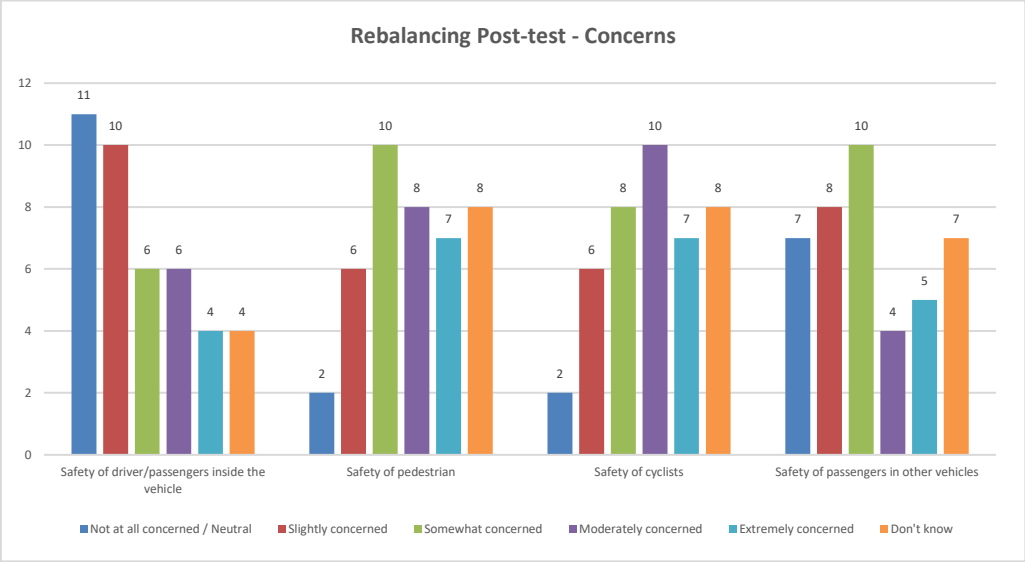
- In general it was very appreciated the AVP regarding smoothness of parking, score in this aspect increased after testing the valet parking.
- Acceleration and braking behavior was positively evaluated and perception about these characteristics also augmented after testing AVP.
- Moreover, turning behavior of vehicle increased a bit after testing the function.
- It seems that some drivers have not clear how to evaluate distance kept to other vehicles, pedestrians and obstacles.
- Although 26 have not clear how to assess the distance about pedestrians or cyclist one participant considered it as very uncomfortable.
- Seven participants thought neutral about distance maintained with respect to pedestrians or cyclists.

4.4.2 Concerns whilst using service

Participants were asked to comment on their concerns regarding various aspects of the service. They were ranked from Not at all concerned / Neutral to Extremely concerned.



- Over half of participants where concerned about privacy of my data, security of the self-driving vehicle, security of their data and GPS tracking.
- Security of payment was other aspect that somewhat concerned 40% of the sample.
- The aspect that had the smallest number of people without concerns was liability in case of accident or malfunction.



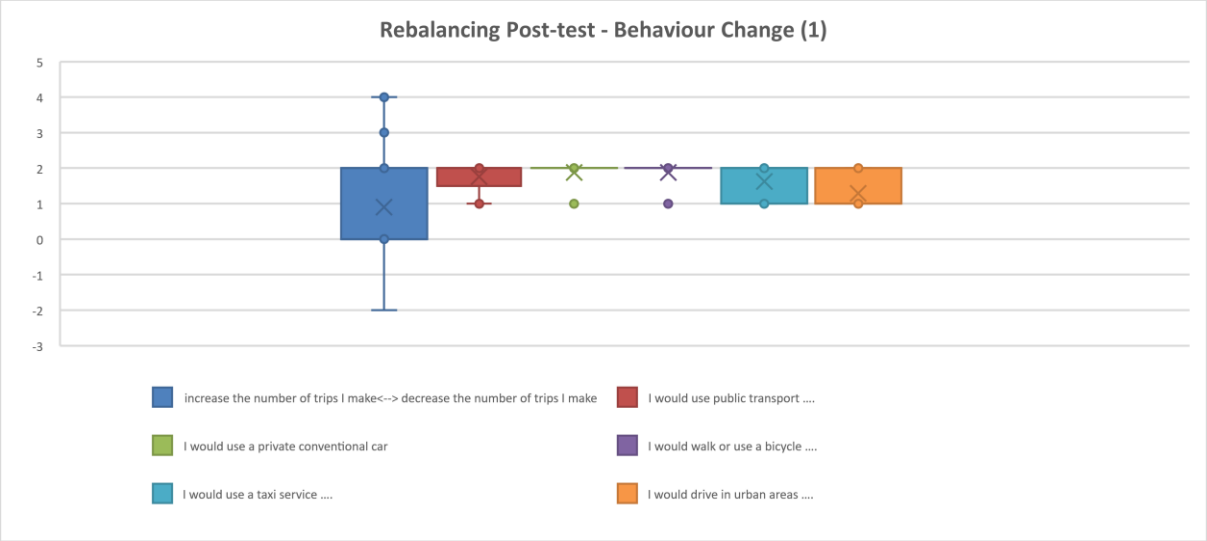
- Regarding safety of driver/passengers inside the vehicle, around 25% is not at all concerned. 4 drivers are extremely concerned about this issue. Other 4 participants don't know how to evaluate it. 10 of them are slightly worried for that.
- If it is considered the safety of pedestrians only 2 participants are not at all apprehensive for that. Six of them are slightly concerned. Most of the sample is worried for this issue. 8 participants didn't know how to asses it.
- Drivers are also concerned about cyclist's safety only 2 participants are not worried about it. 7 of them are really concerned about it.
- About safety of passengers in other vehicles 16 participants were not too much worried about it. Although 5 of them expressed that they were concerned. 7 participants had doubts about how to evaluate it.

4.5 Post-Test Thoughts on Future Use

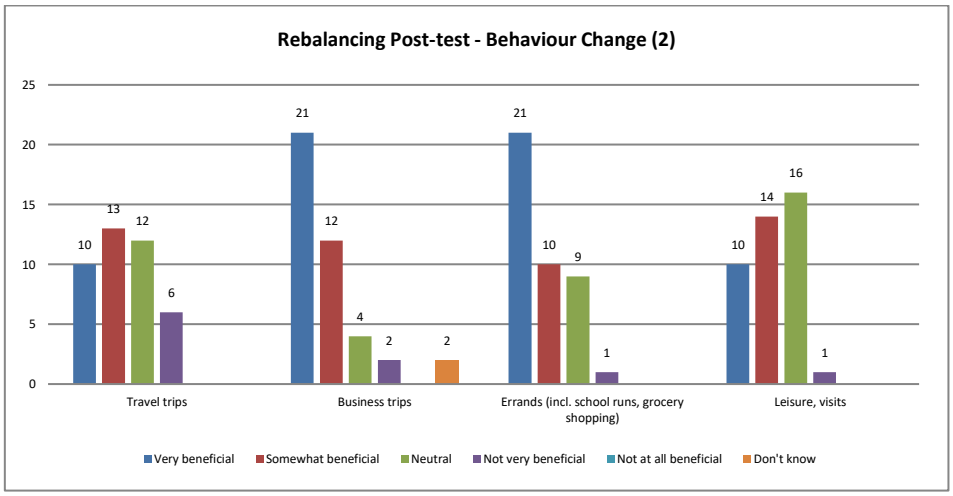
Participants were asked to comment on how they might use the service if it was available.

4.5.1 Behaviour Change

Participants were asked how the service might affect their usual travels. This included how overall number of trips, private car use, walking/cycling, public transport use, taxi use, traffic safety and pedestrians' safety would change (ranked between -2 and 2) and how beneficial it may be to categorized trips. They were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.



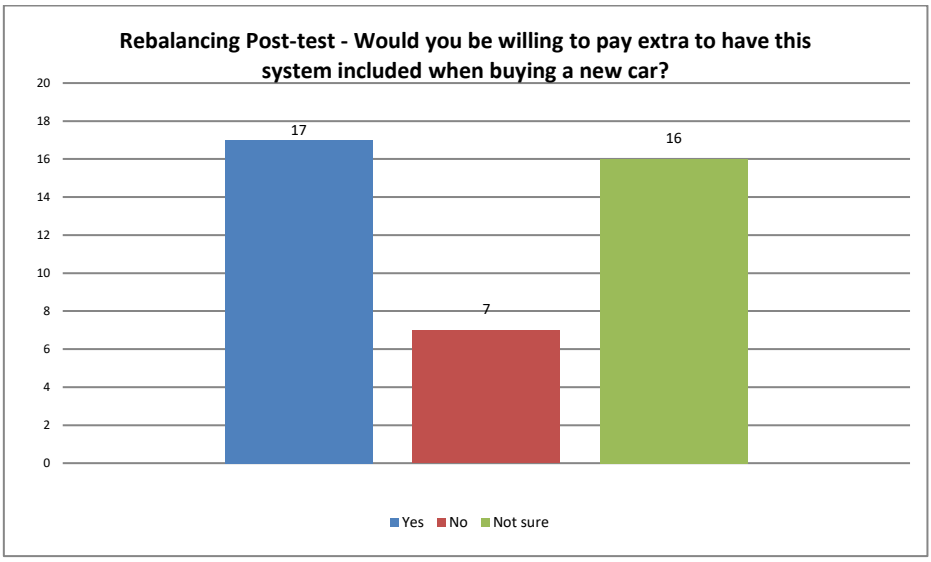
- Only 1 participant thought that the service would decrease their overall number of trips
- None thought that the service would increase their private car use
- None supposed the service would change their walking/ cycling
- None believed that the service would increase their public transport use
- None assumed that the service would increase their taxi use
- None considered that the service would decrease their traffic safety
- None thought that the service would decrease their driving on urban areas



- Most participants felt that the system would be beneficial for all trip types.
- The greatest number of participants who felt this system would be very beneficial was for business and errands trips.
- Six participants felt that this service would not be very beneficial for business trips.
- The highest number of neutral participants was regarding leisure-visit trips.

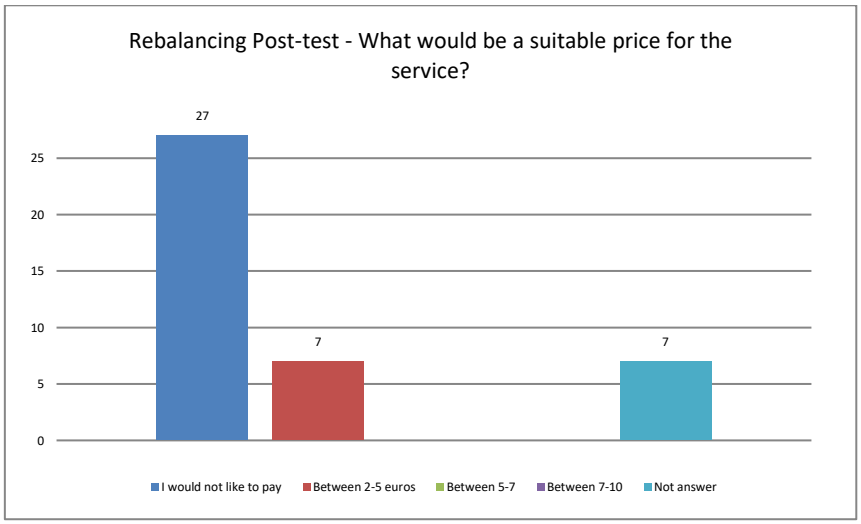
4.5.2 Interest in service

The participants were asked if they would be willing to pay for the service.



- Around half of participants would be willing to pay for this service.
- Seven participants would not pay to use this service.
- Around half of sample were not sure if they would pay for this service.

The participants were asked how much they would be willing to pay for this service compared to a conventional taxi service.



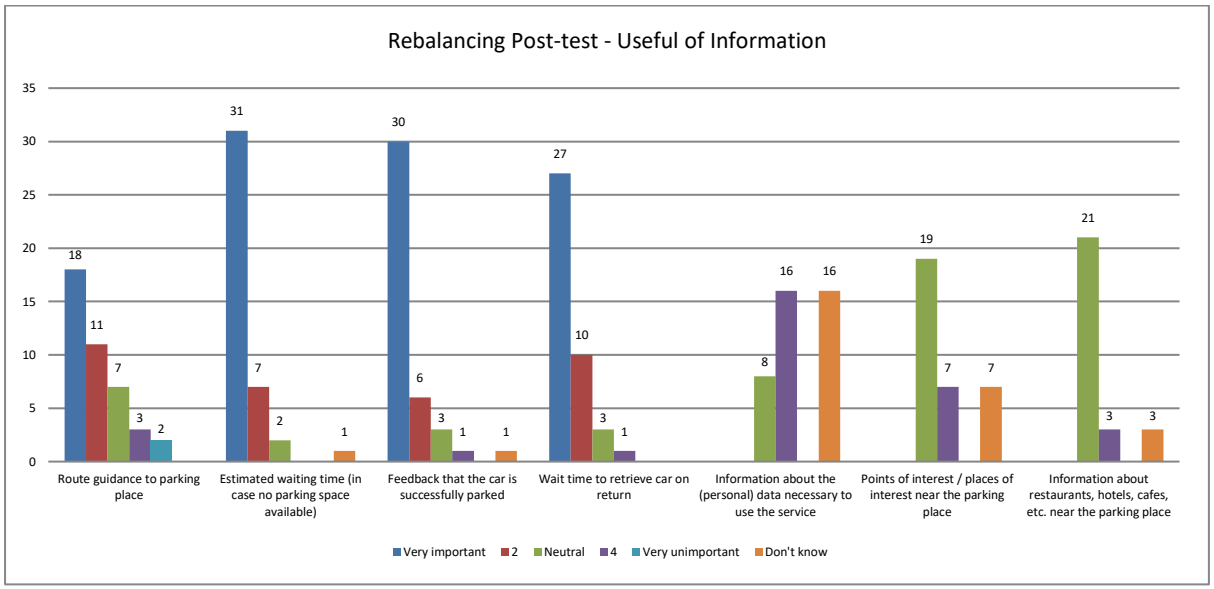
- Although in the previous question more of the half of the sample said they would be willing to pay for the service, after when asking about how much, only 7 participants said that they will pay between 2-5 euros.
- Answers to the next question: “Would you like to have this service with a bonus option?” are presented in the next table:
-

The Ideally were several types of bonus, to be chosen by the user (weekly, monthly, by number of times parking).
Number of times parking.
Weekly.
Determined number of times parking.

Weekly, monthly or a certain number of parkings , depending on how often the service will be used
I would like to be able to choose a different type of bonus depending on the needs, for example if I park in a parking place to go to the work it would be nice to be able to make an annual bonus.
Determined number of times parking.
x number of times parking (30 for example).
With a prepaid card with a certain number of parkings since the times I use the parking is situational.
Determined number of times parking.
Of all kinds to adapt to the needs of each moment. But I do not think you should pay more to the parking for this service, when buying the car yes, but in the parking no more than any other car.
A bonus with a specific number of parking times that does not expire, and that reduces the usual price of the service.
All, but if I have to choose one, the number of time parking.
Determined number of times parking.
Regular bonus.
Annual.
By times parking.
Determined number of times parking.
Monthly
Monthly
With a reduced price and making recharges.
Monthly.
Determined number of times parking.
Monthly.
If you are going already to pay the parking for leaving the car, I do not understand why you would have to pay an extra bonus to use this service. If in addition, you already pay for it to be incorporated into your car when you buy it. I do not understand. Although I would see the best way, monthly and annual.
Annual.
Weekly bonus.
In the case that there is bonus, I would be interested in the bonus per number of parking times.

4.5.3 Usefulness of Information during Service

Participants were asked about the usefulness of various aspects of information that could be provided through the service. These were ranked from Very useful to Very useless, with Neutral as a central choice.



- Around 45% of participants thought that the information regarding route guidance to parking is very important. Only 2 persons considered that it is not significant.
- Three quarters of participants believed that it was essential to have information about the estimated waiting time for parking in case no parking space available.
- About three quarters half of participants thought that the feedback that the car is successfully parked would be useful.
- 65% of participants thought it would be advantageous to have information about wait time to retrieve car on return.
- Most of drivers did not considered useful provide information about personal data necessary to use the service.
- Around 60% of participants were neutral about the idea of having points of interest near the parking place. 7 drivers did not know if it was important.
- Three quarters of respondents considered as neutral to have information about restaurants, hotels, cafes, etc., near the parking place.

Other information that participants would like to see are[5]:

In case that there is saturation of the resource; that mean, to arrive at the parking and there is traffic for the drop off zone, to know how much that wait is. If conventional parking is allowed and in case that time waiting is high or that the user does not want to use it, or his car does not have such service.
No.
Proximity of public organisms.
Send photo to my mobile as it has been parked.
The parking space in which I am parked. I may run out of battery in my mobile and have to recover my car manually. That this generates other doubts to me, such as if I recover my car manually, how does the app know that the car has left and that it is not there parked 3 days later; I could had a conflict if I request a new space in the same space without having confirmed the drop off.
1)If my car had been hit or raped while already parked 2) Able to check at any time the time that has been parked and the cost up to that moment.
The service error rate in the previous month.

[5] Translated from Spanish

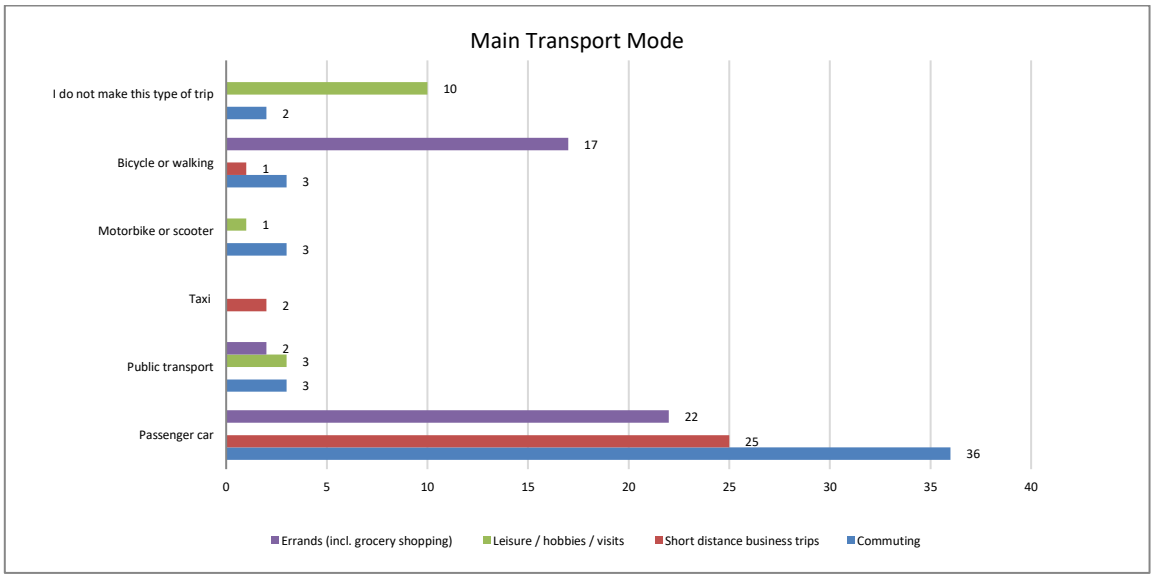
How would be the integration of the system in the new vehicles. It will work with integrated cameras. Since the vehicles will not have the cameras on the roof.
Yes. I may seem silly, but how would all this work without introducing the car key? how would that be safe? because most of the time you can't steal a car because you don't have the key, and many of the cars have anti theft security. But in this case, without the key... I don't understand how it will be.
Estimated time of arrival at the parking depending on the traffic conditions at each moment. (Something similar to the signs that mark the estimated time of arrival of public transportation)
Receive information about the exact location of the parking space: plant number, and parking space number.
I can't think of it right now.
I don't know right now.
That the car parked perfectly without any problem.
Have marked and indicated on a map, the place assigned to my car. It would be nice to receive a photograph of it once parked.
In the test I have not received the information of the parking space where the car has been parked. I consider it important in case you need to access the car.
Photo of the slot when it is already parked.
Information related to adjacent vehicles between which cars my vehicle is parked.
No.
I would like to indicate the place where the vehicle is parked in case the mobile fails to pick it up and know what place where it is.
Number of parking places.
A countdown from when you choose the pickup until the car arrives in the zone to pick up of the driver.
About any incident that could happen during the parking process.
I would like to know up to date each minute how much the parking is costing to me. I would also like to know the condition of the vehicle, if it has suffered any blow or anything. Perhaps it would be nice if the application indicated to me my most common parkings, differentiate those occupied on the map, that the icon changed in relation to: free parking, occupied parking, my reserved place and my parked car.
The parking place where my car is parked, as well the map. In case of any problem with my car, I was notified in the same way.
No.
Time that the car takes parked in the parking. About this, information about how much money I have spent since I parked it.

5 Background

Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

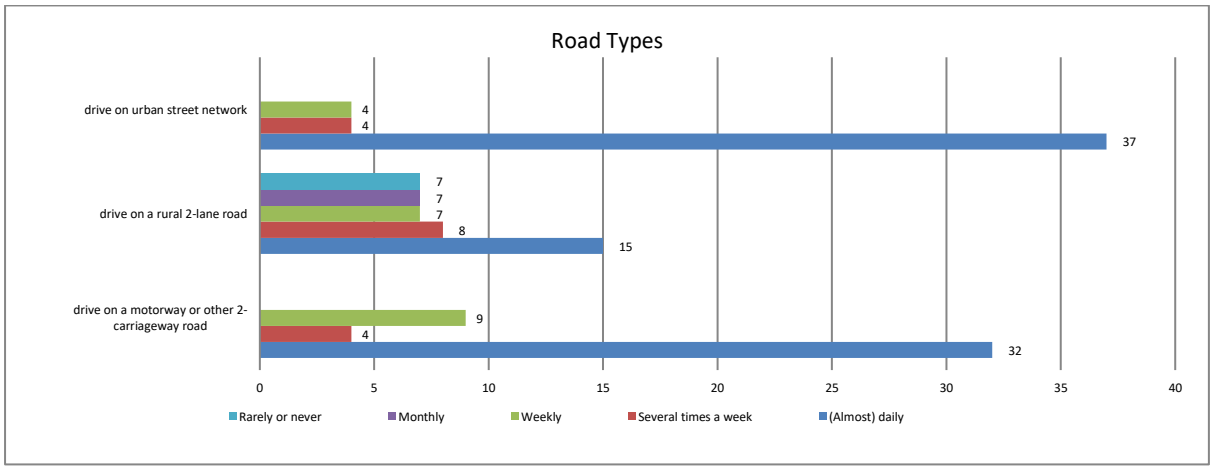
5.1 Travel Habits

Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.



- For shopping (including grocery shopping) most of participants walk.
- The most used transport mode is the passenger car (it is used for errands, for short business trips and mostly for commuting.
- A small number of participants use public transport, motorbike or bicycle for commuting.
- Taxi is used only for short distance business trips.
- For leisure a small number of respondents use public transport or motorbike or scooter.
- Small numbers of participants use public transport as their main mode, most commonly for short business trips
- Two participants use scooter/motorbike as their main mode for commuting

Participants were asked how often they drove on different road types.

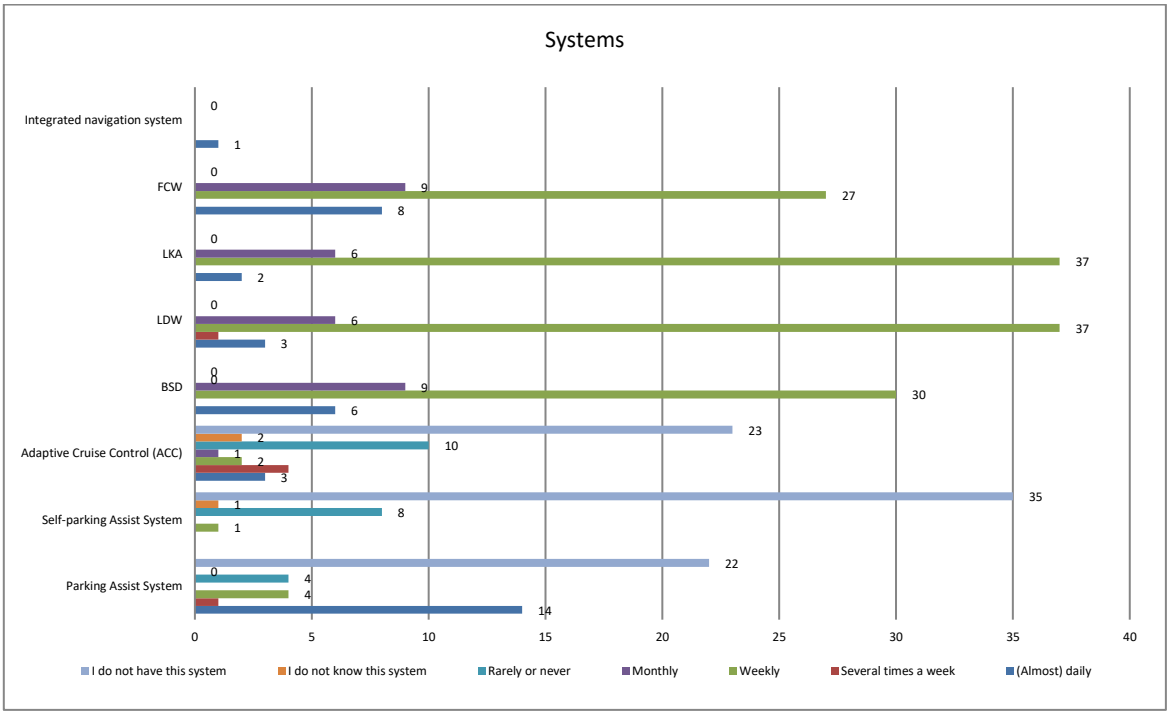


- Most of participants drive on urban network almost daily.
- Only a small number of participants (n=8) drive on urban network at least weekly and less than weekly.
- driving on urban roads is more variable among the participants: 15 of them used it daily, 8 of drivers run several times a week, 7 of them drove weekly, 7 run monthly and other 7 persons rarely or never use this kind of road.

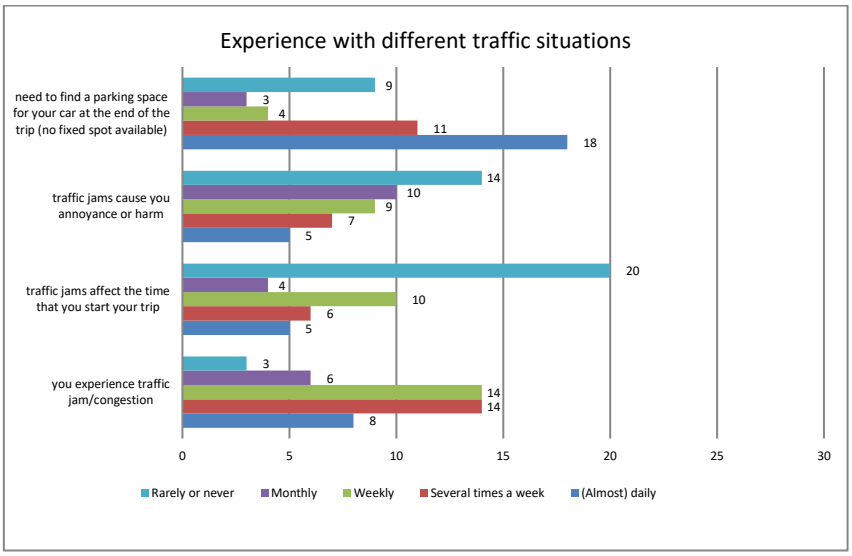
- Most of participants also drive daily on a motorway or other 2-carriageway road (32 expressed to drive in this kind of road). Nine participants run weekly and only 4 do it several times a week.

5.2 System and Service Acceptance

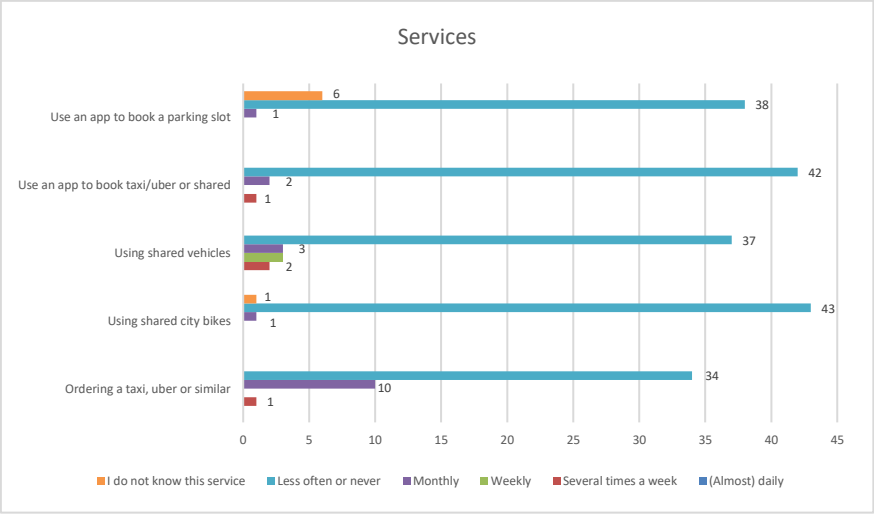
Participants were asked how often they used advanced driving systems and shared mobility services.



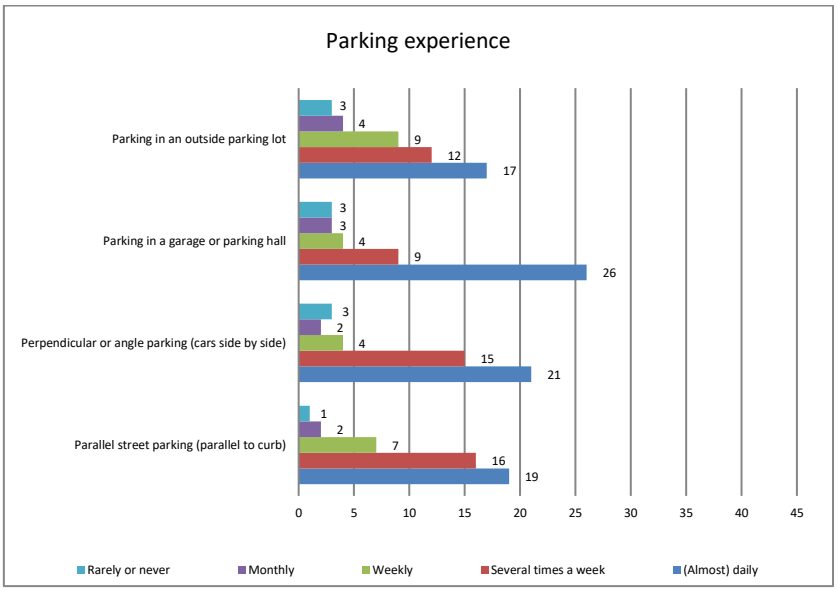
- The system most used is the Parking Assisted System (14 use it daily).
- Systems used weekly for most of the participants are the following: FCW (60%), LKA (82%), LDW (82%) and BSD (66%).
- Around or over half of participants do not have ACC (51%), self-parking (77%) or parking assist systems (48%)
- Only one participant uses monthly an integrated navigation system.
- Two participants do not know ACC system and only one do not have knowledge about self-driving system.



- 40% of participants (almost) daily need to find a parking space for their car at the end of the trip, a quarter of participants need to find for it several times a week.
- It seems traffic is not a problem for 30% of the sample. Only 5 participants are annoyed or harmed because of traffic jams. For 40% of drivers traffic jams rarely or never affect the time they star their trips. For 10 respondents it is a problem weekly.
- Over half of the sample experience congestion several times a week or weekly. 8 participants experience traffic jam (almost) daily.



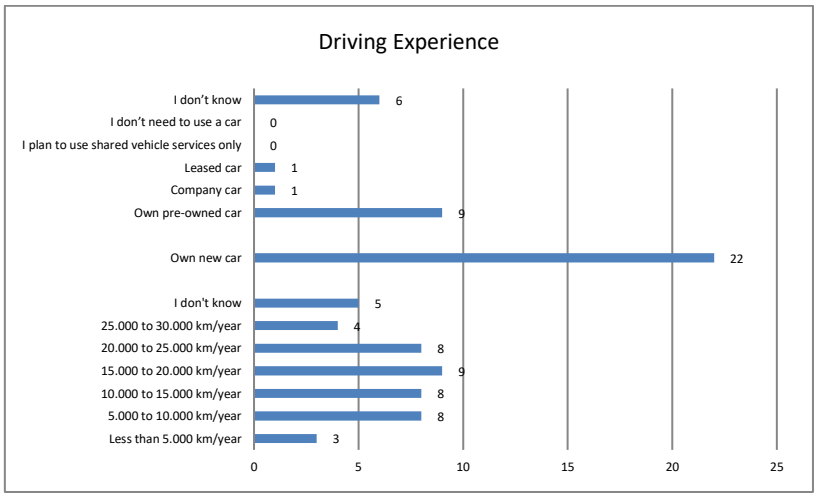
- Only 10 participants order a taxi, uber or similar monthly.
- Only one person uses an app to book a parking slot.
- Only 2 persons use monthly an app to book taxi and only one do that several times a week.
- Almost half of participants do not have access (or know of) shared bikes or cars.
- It seems that this sample is not get used too much to share vehicles or bikes.



- Around 60% of the sample park in a garage or parking hall.
- 37% of drivers park in an outside parking slot.
- Only one person run a parallel street parking.
- Around 80% of respondents perform a perpendicular/angle parking or parallel street parking several times a week or (almost) daily.

5.3 Driving Experience

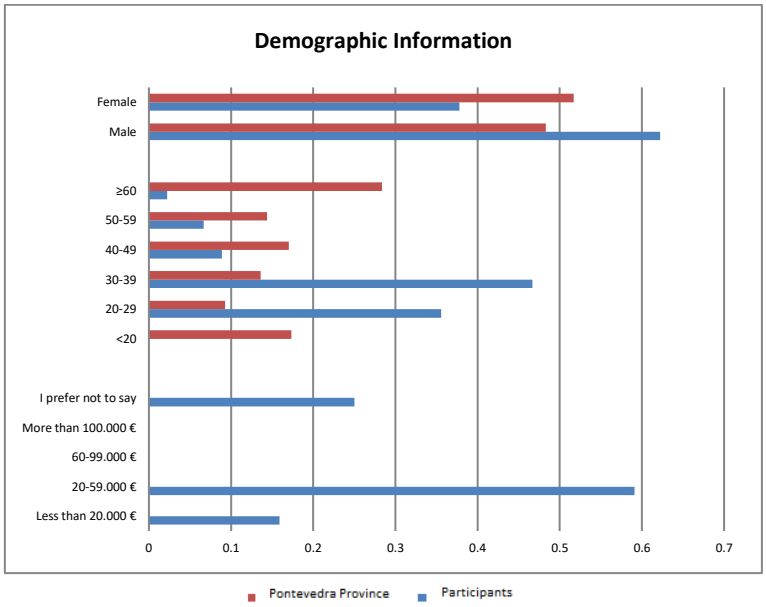
Participants were asked about their attitude and experience towards driving.



- Nearly half of participants (48%) plan to buy an own new car.
- Around 40% of participants drive less than 15.000 km a year.
- Nearly half of participants (48%) drive more than 15.00 km but less of 30.000 km a year.
- 5 participants do not know how many kilometers they run in a year.

5.4 Demographic Information

Participants were asked about their background to establish representation of the test group.[6]



- The percentage of male participants was lower than the Pontevedra region.
- The 20-29 and 30-39 age groups were over-represented.
- The ≤60 age group was under-represented.
- Most of the sample has a salary between 20-59.000 €/year.

[6] https://www.citypopulation.de/php/spain-admin.php?adm2id=36

Vigo Urban Driving (UD)

1 Background

The Vigo UD user testing took place in two iterations: the first one between 07th – 16h May 2019 and the second iteration was performed on 03th July 2019 at the CTAG test track facilities, Spain. Answers from 49 participants were analyzed in this document.

2 Test Protocol

Introductory presentations were given in Spanish, as were most discussions. Description of the technology and test conditions were also carried out in Spanish. Questionnaires were in Spanish and carried out through the online survey tool, 'Surveymonkey'. Before participating all the user signed the consent protocol and all of them wore a reflective vest. Participants in first iteration tested the next use case: Glosa+Event information and the second iteration: VRU+Glosa information. All the participants in this study were CTAG workers, all had not knowledge about AUTOPILOT project.

3 Technical problems

There were some minor issues with the technologies during the testing. If in some test there were problems with the technologies and the participant could not run the test, his/her data was not considered for this report. Moreover, it had a problem with the register online for some participants answers, probably regarding the process of saving the answers. That is the reason for not having answers for all the participants.

4 Results

4.1 Pre-Test Expectations

Participants were asked to rate their expectations of the test in five areas and the usefulness of the service on a 7-point Likert scale. This was rated 3 to -3 (eg Positive =3, Negative = -3).

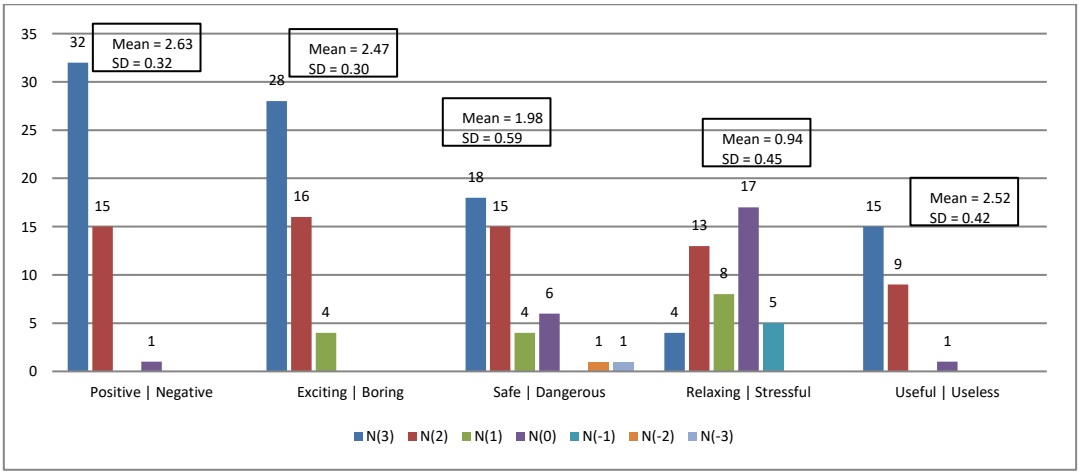
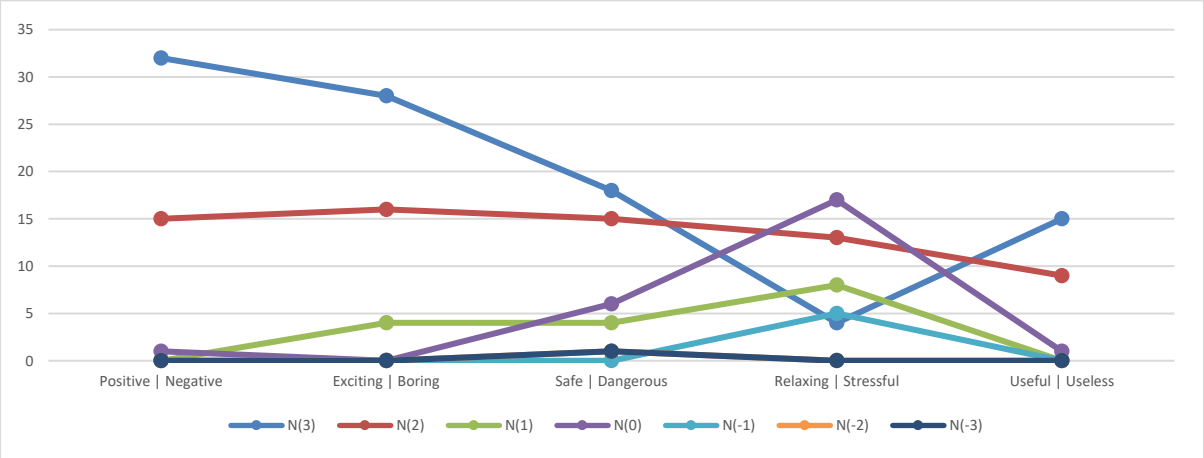


Figure 1: Participants expectations on the test and usefulness of the service[1]

[1] The variable "Useful/Useless" was calculated with data from 2st iteration (n=25).



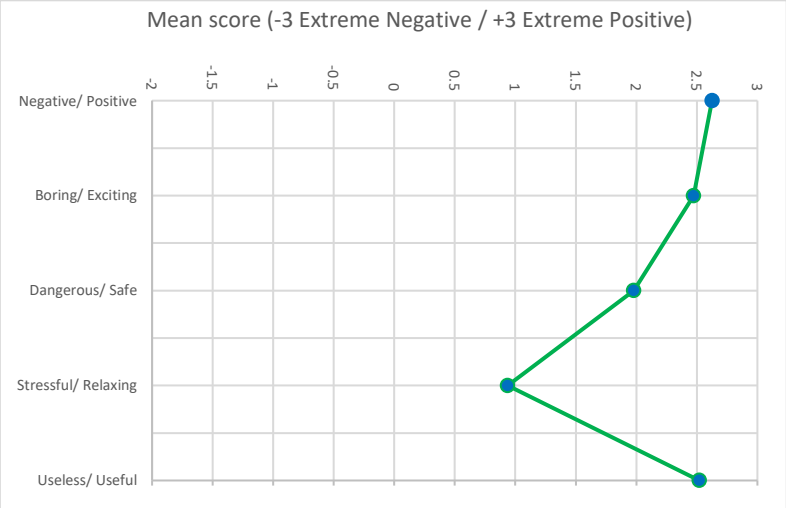


Figure 2: Semantic differential of participants expectations of the test and usefulness of the service

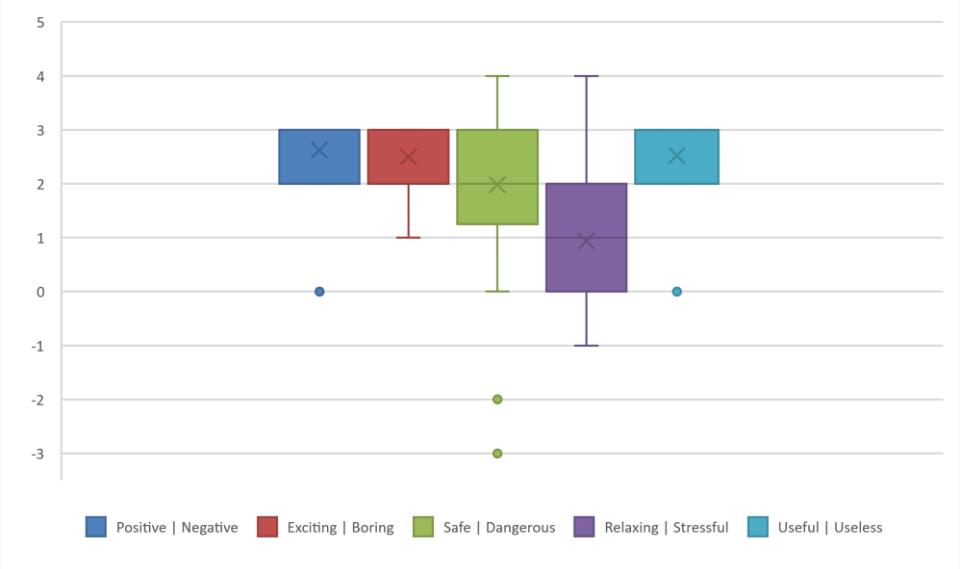


Figure 3: Boxplot showing the spread in expectations. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- No participants thought that the experience would be negative, boring or useless.
- Only two participants thought that the experience would be negative or very negative.
- Seventeen participants were neutral about how relaxing or stressful the experience would be.
- Mean scores are positive for all the variables, the highest are for positive (2,63), exciting (2,47) and useful (2,52).

4.1.1 Motivation for taking part of the study

In the next table it is presented the main reasons expressed by participants to take part of this study. Mainly they wanted to collaborate in the car of the future, try an autonomous car and testing new technologies.

To be able to collaborate in a pioneering service and experience the leading technologies before they are released. In addition to the interest I've always had for cars and technology.
Know the new technologies that are going to be incorporated in cars.
Collaborate in the creation of the car of the future.
In order to experience or behave in an autonomous car, as advanced technology is not a field of autonomous driving and above all to be able to serve as an aid to my companions of the company.
Knowledge of autonomous driving systems for professional reasons.
I have not driven any autopilot system. I am interested in its development.
Test the autonomous driving systems and compare them with the Model S that I tested with autopilot.
Experiment and learn more about autonomous driving, as well as help in its development.
Know the project to see how it works and see the test track area…
Test the experience of the autonomous vehicle and collaborate with the study.
See operating current technologies that my car does not have.
Know the system in which development is being practiced.
I am interested in discovering the advantages of IoT-related driving assistance systems to assess them in an upcoming purchase or recommendation to acquaintances / relatives.
I'm curious to see how the system works and how the user feels when driving with the autonomous mode.
Try new driving systems.
Try an autonomous car.
Try new driving assistance systems.
Be able to help developing a new system for the future and be able to test if before it go out for the market.
I am interest in the subject of autonomous driving.
Knew the systems of autonomous driving and help at the development.
Knew better the systems of development in CTAG.
I think that it is interesting to participate in a study like this.
I am interest in progress of the technology of the autonomous vehicle.
High level of interest in the new technologies and curiosity.
Test new technologies.
Passion for motor racing and development of new technologies.
I never rode in a self-driving vehicle and I would like to try the experience and see how it works and help as much as possible in the project.
Try new technologies in the automotive world.
Curiosity about the system.
Curious about the operation of the autonomous system.
Meet new systems.
Pay a visit to the future.
Knowledge of the systems on which future driving is based.

I want to start or state the technology in this field and also contribute to the development of the project that is in my country.
Test the systems that are developed in the company.
Interest in the technology to be tested.
I am interested in knowing the current status of the work carried out by the CTAG internal development team in the field of autonomous driving in urban environments, as well as the importance of the information received from the infrastructure for the execution of the route.
Be able to help in the improvement of driving assistance systems and road safety.
Interesting news.
Curiosity.
I strongly believe that autonomous driving will be very useful, both to prevent accidents and to make medium and long-distance trips more bearable. I think it will be great to take advantage of travel times in a private vehicle.
value the system and experience sensations in the absence of total control of the vehicle.
Be able to collaborate for the future development.
Get in touch with cutting-edge driving technologies.
Discover first-hand the possibilities of autonomous driving.
Try new driving assistance systems.
Interest in the Autopilot project.

In general drivers had not too much comments or expectations about the test, some of the commented that they hope it will be pleasant and nice experience and an opportunity to learn a bit more how the Autopilot function works.

4.2 Post-Test Reactions

Participants were asked to rate how they found the test and usefulness of the service between two extremes rated -3 to 3 (eg. Positive = 3, Negative = -3), in five areas. The same categories were used as in the Pre-Test.

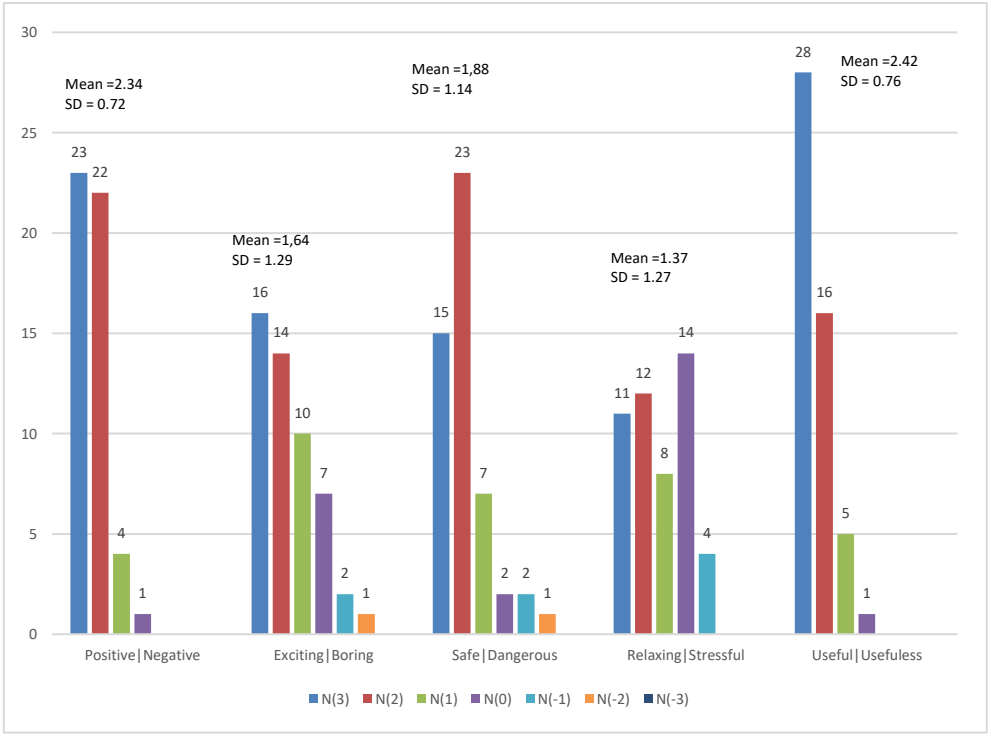


Figure 4: How participants felt about the test and usefulness of the service

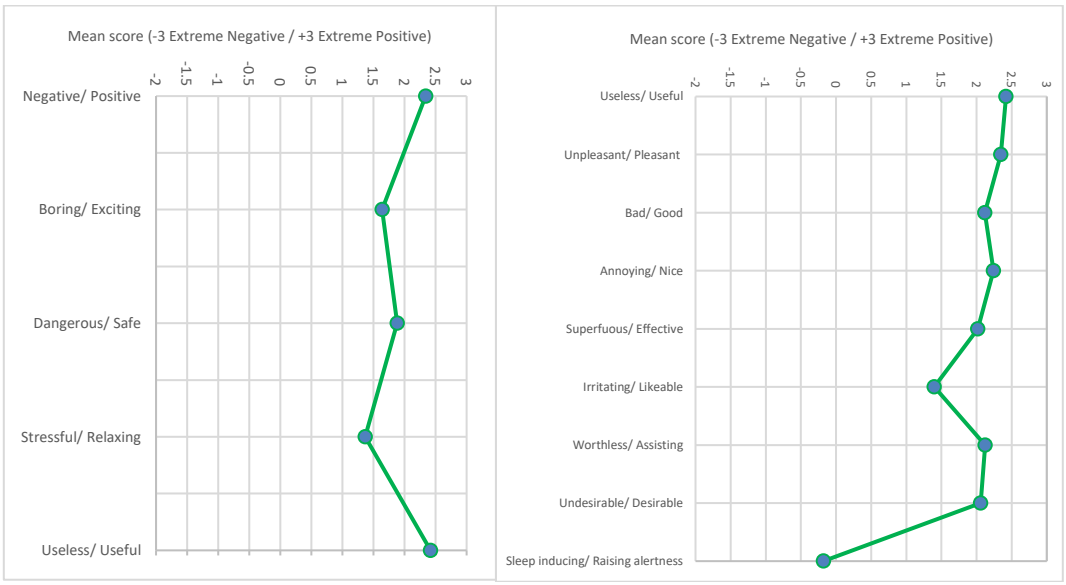


Figure 5: Semantic differential of participants feelings about the test and usefulness of the service

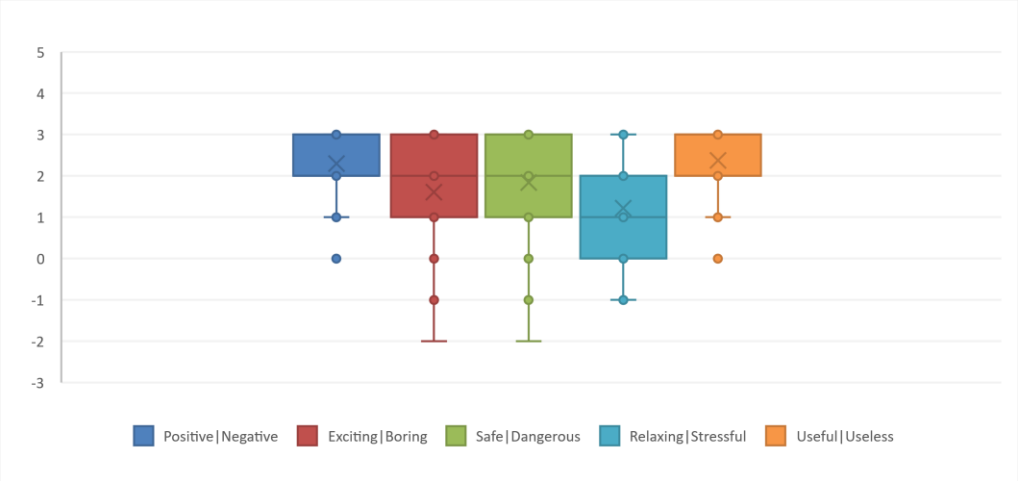


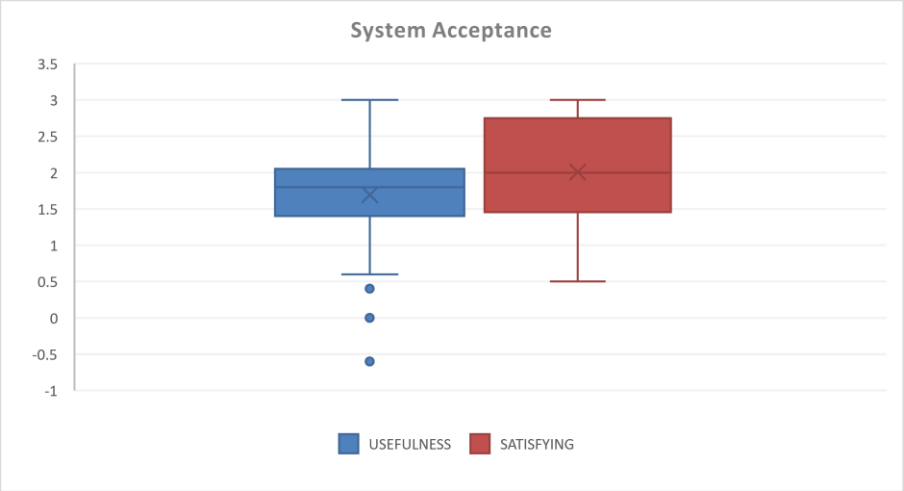
Table 1: Boxplot showing the spread in feelings about the test and usefulness of service. The mean average is illustrated with an 'x', median average with a thick horizontal bar, the coloured boxes represent the upper and lower quartiles, thin whisker and bar show observations outisde the quartiles and a dot is an outlier.

- No participants thought that the experience was negative or useless.
- Three participants thought that the experience was boring. Moreover, other three participants believed that it was dangerous.
- 23 participants considered that the UD test was very positive and 28 valuated it as very useful.
- Fourteen participants were neutral about how relaxing or stressful the experience was.
- All mean scores for the 5 variables are positives. The highest values are for positive (2,34) and useful (2,42).

Additional questions where participants were asked to measure system acceptance, in terms of 'usefulness' and 'satisfaction' as per the Van der Laan scale.[2] Both the average usefulness and satisfaction across all participants were positive, and the system was viewed to be more satisfying

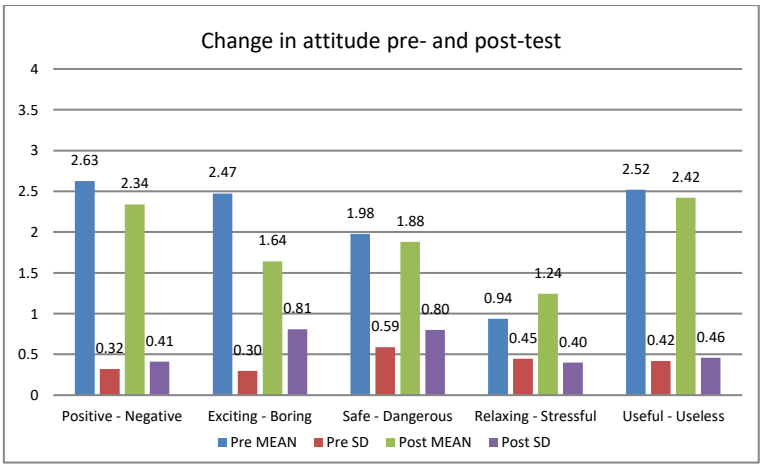
[2]Van der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research - Part C: Emerging Technologies, 5*, pp. 1 - 10.

than useful.



4.3 Comparing Pre-Test Expectations and Post-Test Reactions

The mean Score and Standard Deviation across all responses to Pre-Test Expectations and Post-Test Reactions for the 5 areas are below.



Positivity of Experience

- The post-test reactions were less positive but with a higher deviation than the pre-test expectations.

Excitement of Experience

- The pre-test expectation was much more exciting than the post-test reaction.
- This was the biggest change from pre-test to post-test.
- Post-test reactions had the biggest deviation in responses (although the deviation is very similar to safe-dangerous variable).

Safety of Experience

- The post-test reactions were like pre-test expectations and the deviation was bigger (from 0,59 to 0,80).

Stress of Experience

- This area had the largest positive change from pre-test to post-test. Deviation is pretty similar.

Usefulness of Service

- There was little change from the pre-test expectations to post-test reactions
- It was one of the most positive areas

Initial Post-Test Reactions[3]

Over half of the sample had good impression about the fact the car could drive by itself. 20 participants were unsafe or worried how it could run mainly because it was a new experience for them.

Expectation to know how it will be, but at any moment I felt nervous or worried.
It is strange that the steering wheel turn alone. I guess it's a matter of getting used to that kind of driving. Mainly, it is strange when do such close turns and the steering wheel turns until it reaches to the top.
Have the foot above de brake
Don't having the vehicle control I felt a little uneasy and insecure
Uncertainty.
Have the foot above de brake pedal
Don't touch nothing for the vehicle do not give back the control
Surprise and confusion. I knew the car was going to take control, but I didn't expect the steering wheel to move so much.
Very good
Insecure by lack of use
Sensation of novelty
Good sensation, the product seems that is well done.
At the first moment I still alert and with my feet closer to the pedals
The immediate was to check if the autonomous function is activated.
Fascinating
Look at the steering wheel as it turns alone when making the curve
Fix in the controls (specially the steering wheel and velocity)
Surprise me be able to use 100% without hands
Tranquility
At the moment to activate, take the hands out and feet and observe the car I did not do it well, and I need to react.
Take attention to the evolution of the system operation taking respect to the road
Safety
Be alerted to take the control of the steering wheel at any moment
Any / Calm / Complacency
Well, I felt comfortable
Feeling strange when not taking control of the car
Amazed
Want to grab the steering wheel
No one in particular, like it was a passenger
Curiosity about the performance
I will work?
Comfort
Inconvenience

[3] Translated from Spanish

Normality, that you have participated in autonomous parking projects in which the coach appears autonomously
Worry / anxiety
Surprise
Curiosity for trying a new prototype in more complex scenarios.
Impression that the steering wheel moves by itself
Very interesting
The transition is natural, but with quite normality
Check the information that was transmitted to the vehicle
Observe, being at alert, the evolution of autonomous driving
... for being the first time that the car drives alone
Being the first time I drive in an autonomous car it is strange to release the steering wheel and let the vehicle make the decisions.
Insecurity
Expectation
Release the steering wheel
Good reaction, I like the system

In the next table it is presented some comments regarding the issue if something happened during the drive that made participants feel unsafe or uncomfortable. Mainly participants provided comments about how the car deal with curves in autonomous mode, for some of them was not a very natural movement. Moreover, it was strange for then the unexpected AUTOPILOT deactivation.

When it took the curves, left at the end of it.
Low visibility of the on-screen warning system (yes, even if you understand that it is a prototype).
If I deactivated the autonomous system.
When the connection failed and did not brake and had to be manually stopped.
It seemed to me that the vehicle did not leave enough safety distance with the pedestrian, possibly also due to the differences in the vehicle used for the test and the vehicle itself. The sensation of acceleration of the vehicle to cross the traffic light in green seemed a bit abrupt.
Good conditions, etc ...
Autonomous mode was switched off when starting after stopping at the traffic light. But I understand that this fault is due to the fact that it is in the testing phase.
Unexpected AUTOPILOT deactivation.
The layout that the car makes of the curves is not as natural as it would be desirable and makes me feel a little uncomfortable with it.
Let the steering wheel make so many turns. Since the curves are very closed, the steering wheel turns all its turns. That makes me feel like I'm going to lose control
Failures in the route in autonomous driving
After a road works road section, car accelerated quickly next to the curve and it caused that I had to break hardly, and I had the sensation I lost the lane.
I didn't feel anything insecure, but I was bothered by the fact that the speed up and down buttons were on the steering wheel, as this made them very difficult to press.
A little insecure when the car lost the signal that we left the road lines.
We pass very close to the traffic light (it seems that the car left the preset route)
Not having the control makes that in a bit of insecurity at the beginning and not knowing the use of controls also creates insecurity.
In the second turn, the car left the sideline too much.
The movement of the steering wheel was not the normal movement that I would do if it were in manual mode.

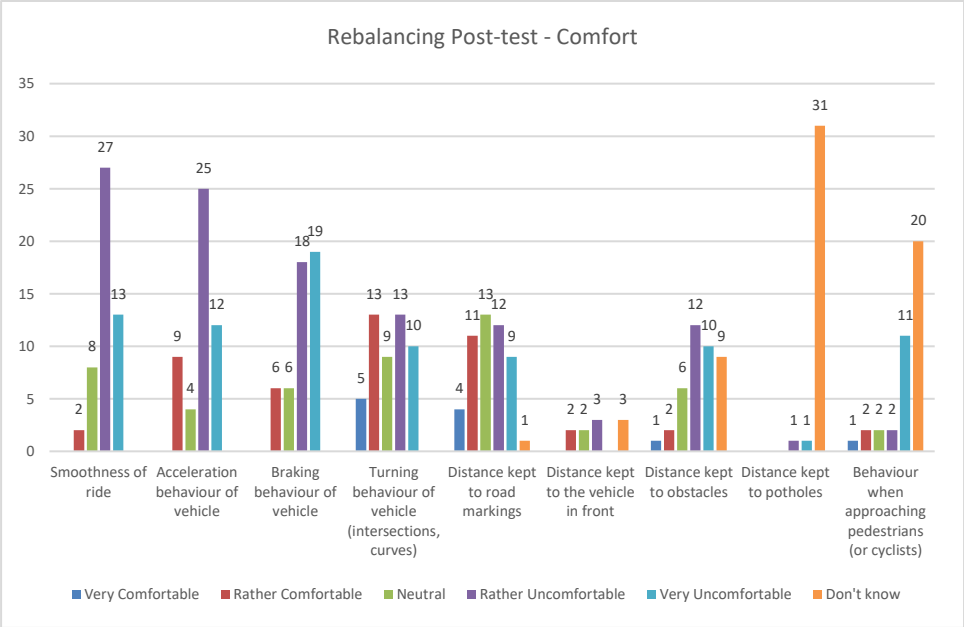
The first time I took the curve, I had the impression that I wasn't going to be able to take it and it scared me for a moment.
When turning it seemed that the car got too close to the outside of the curve.
The steering wheel was not very stable during the straight.

4.4 Post-Test Thoughts on Experience of Use

Participants were asked about their experiences during the test.

4.4.1 4.4.1 Comfort whilst experiencing service

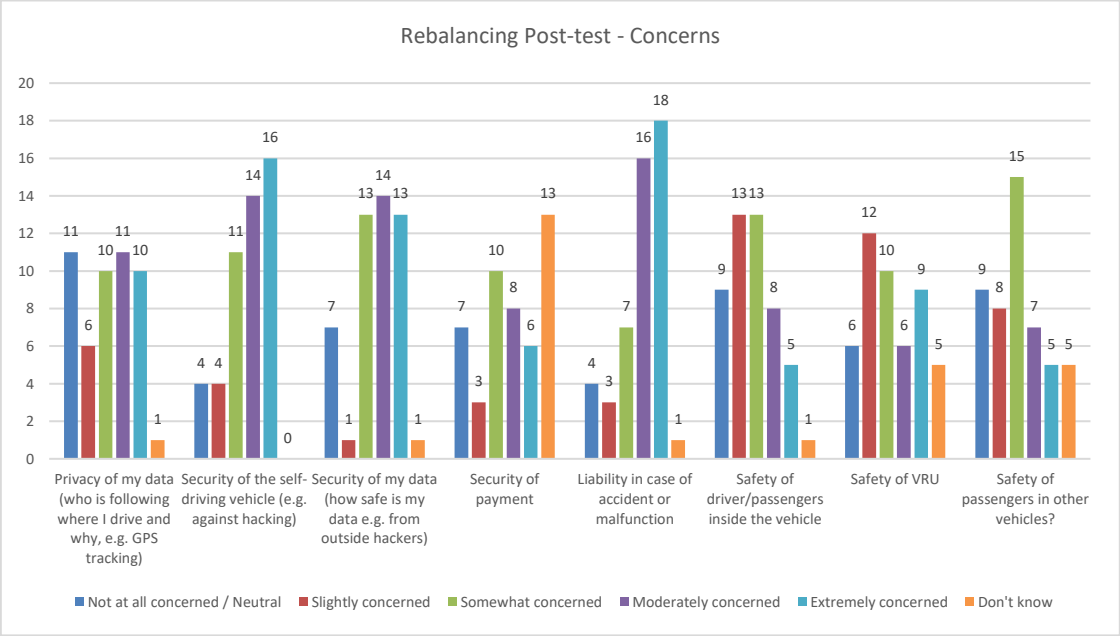
Participants were asked to comment on the perceived comfort of various aspects of the service. They were ranked from Very Comfortable to Very Uncomfortable, with Neutral as a central choice.



- Participants had doubts about how to evaluate comfort regarding distance kept to potholes and behavior when approaching pedestrians (or cyclists).
- 27 participants felt rather uncomfortable regarding smoothness of ride and 25 felt the same taking into consideration acceleration behavior of the vehicle.
- Best scores regarding comfort were for turning behavior of vehicle (intersections, curves) and distance kept to road markings.

4.4.2 4.4.2 Concerns whilst using service

Participants were asked to comment on their concerns regarding various aspects of the service. They were ranked from Not at all concerned / Neutral to Extremely concerned.



- Issues which participants are more concerned are related with security of the self-driving vehicle and liability in case of accident malfunction.
- Participants are less worried about safety of driver/passengers inside the vehicle, safety of VRU and safety passengers in other vehicles.
- Anyway, it seems there is great variability into the participants answers.
- 13 have no idea about how to evaluate security of payment.

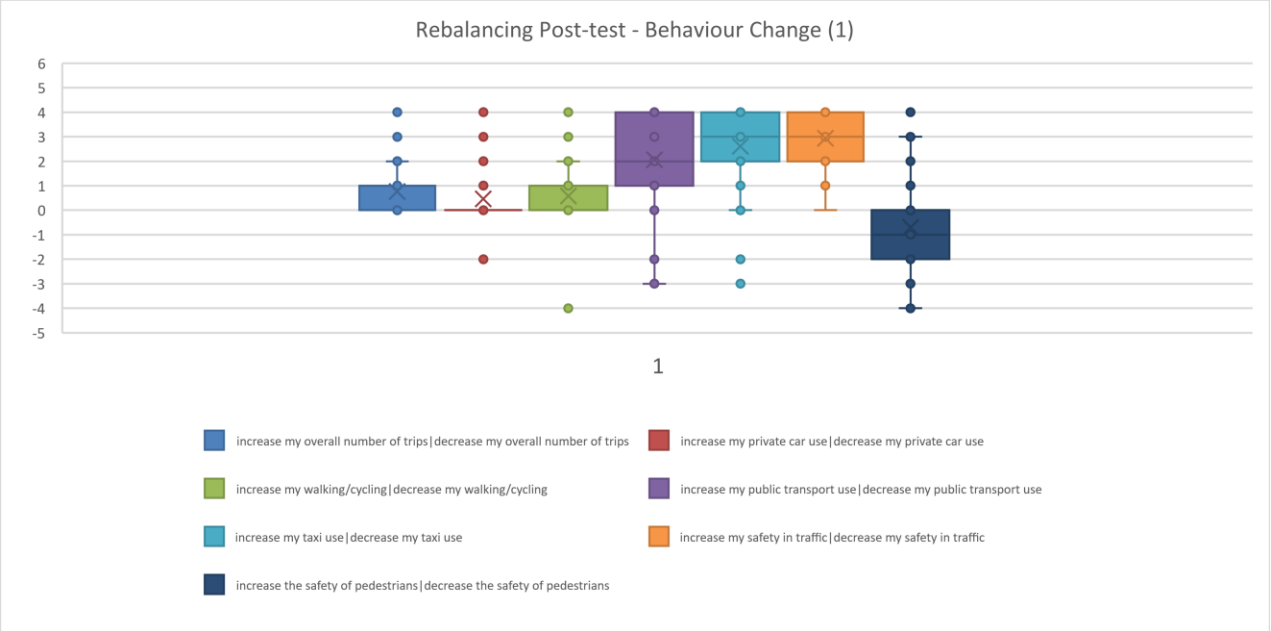
4.5 Post-Test Thoughts on Future Use

Participants were asked to comment on how they might use the service if it was available.

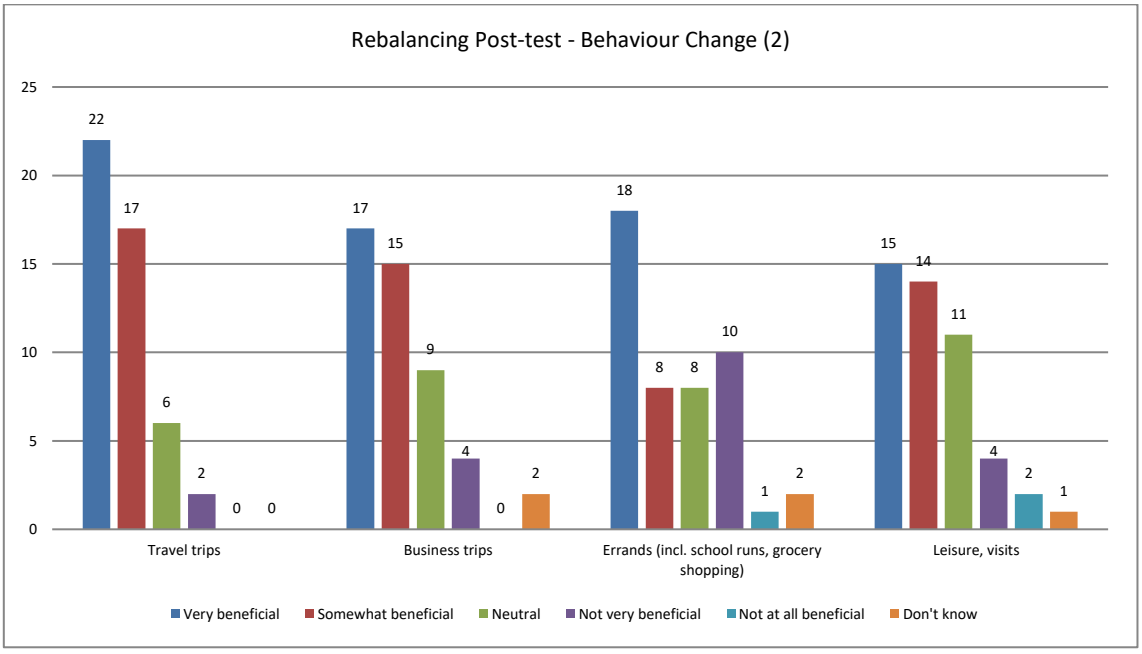
4.5.1 Behaviour Change

Participants were asked how the service might affect their usual travels. This included how overall number of trips, private car use, walking/cycling, public transport use, taxi use, traffic safety and pedestrians' safety would change (ranked between -4 and 4[4]) and how beneficial it may be to categorized trips. They were ranked from Very beneficial to Not at all beneficial, with neutral as a central choice.

[4] Score of 6 points were used for the answer: "I don't know".



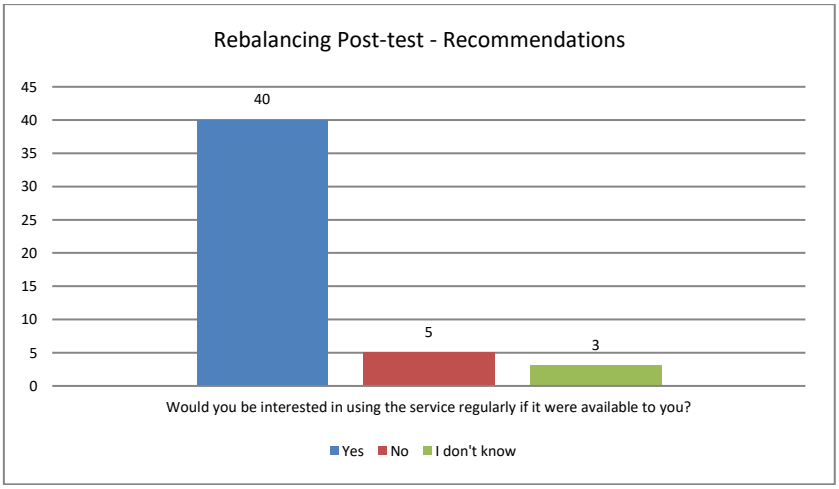
- It seems that this function would increase the use the taxi and public transport, but it would increase their safety in traffic.
- It appears that it would not be differences in the use of their private car.
- It looks like participants had the sensation that UD could decrease the safety of pedestrians.



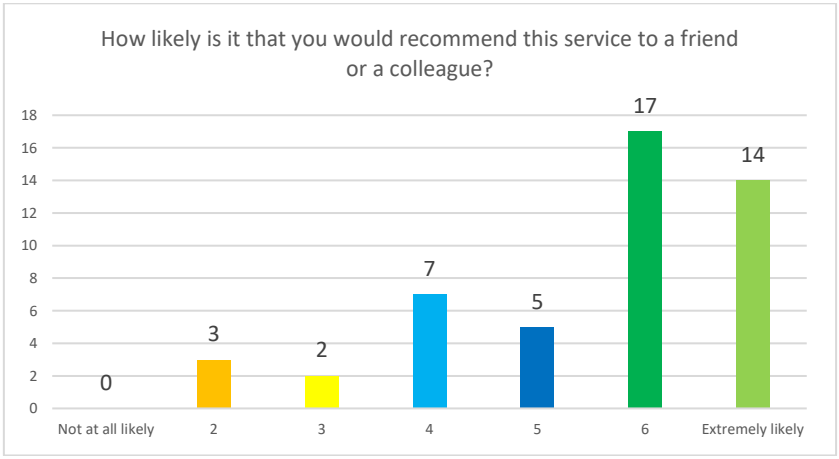
- Most participants felt that the system would be beneficial for all trip types.
- The greatest number of participants who felt this system would be very beneficial was for travel trips.
- Only one participant felt that this service would not be at all beneficial for errands.
- The highest number of neutral participants was regarding leisure, visits.

4.5.2 Interest in service

Participants were asked how likely they would use the service or recommend to a friend.

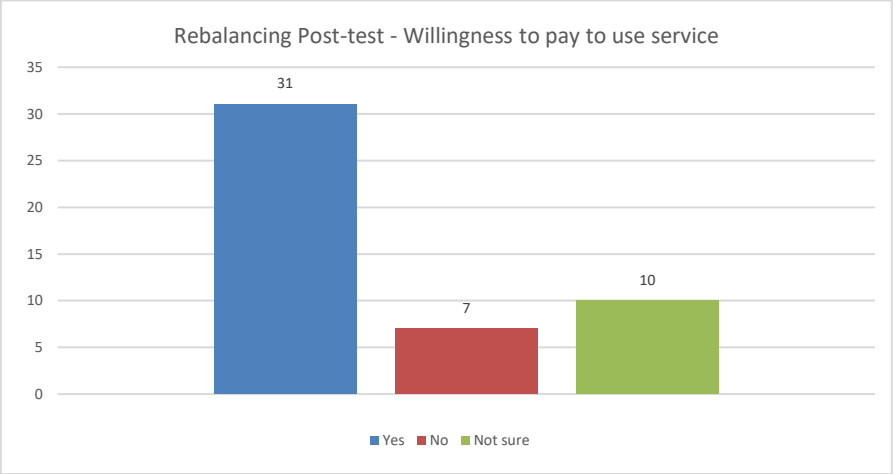


- Forty participants would use the service regularly if it would be available to them.
- 5 participants would not be interested in using the service.
- 3 participants have doubts about their interest in using UD service.



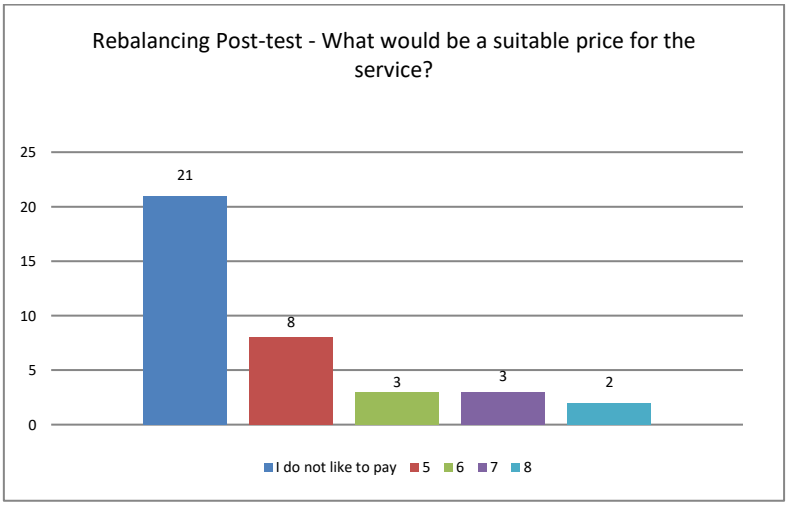
- Most participants would recommend the service to a friend or a colleague.
- 5 people were not convinced to recommend the service to a friend/colleague.

The participants were asked if they would be willing to pay for the service.

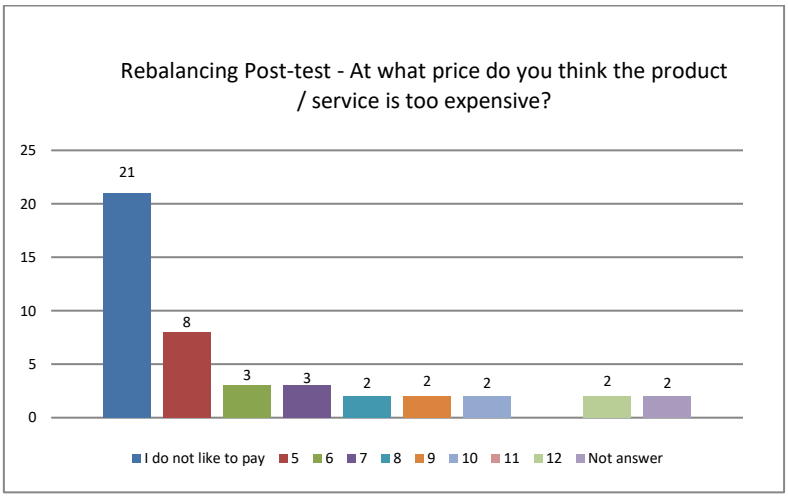


- 65% of participants would be willing to pay for this service.
- Seven participants would not pay to use this service.
- Ten participants were not sure if they would pay for this service.

The participants were asked about a suitable price for the service and what price would be they think the service is too expensive.



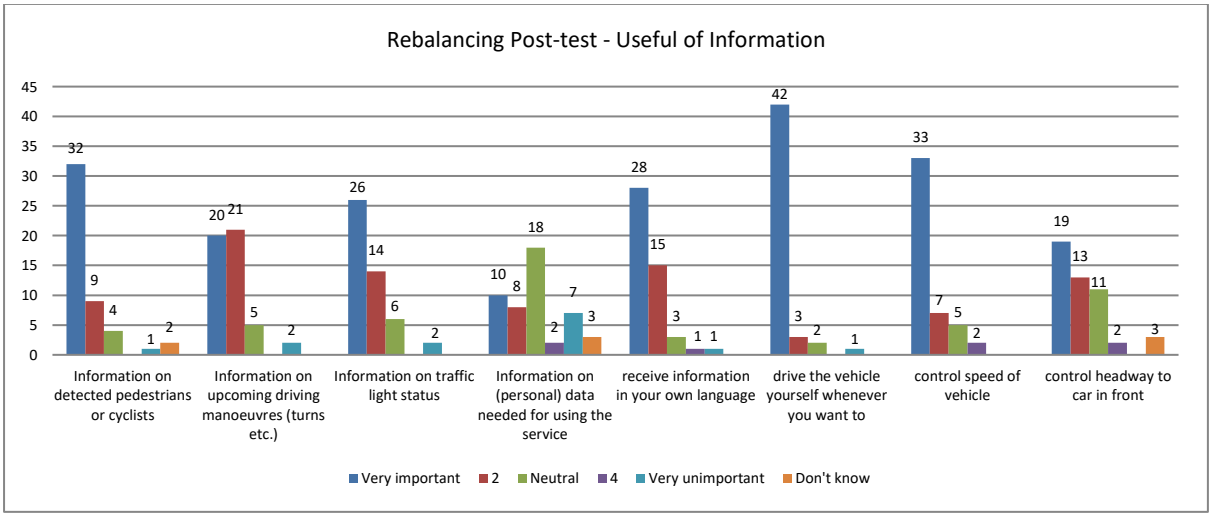
- Although in the previous question, 65% of participants would be willing to pay for this service, 21 participants answered that they do not like to pay.
- Eight participants considered that the suitable price would be 5 euros.
- Three participants believed that the suitable fee would be 6 euros and other three of them established 7 euros would be the right price.
- Only two participants estimated 8 euros as the appropriate price.



- Once more, 21 participants stated that they do not like to pay.
- Around 20% of participants quantified that 5 euros would be too expensive for this service.
- Three persons considered that 6 euros would be too expensive. Another three persons expressed that 7 would be the expensive price.
- A couple of persons estimated eight as the expensive price. Other two said nine euros and another couple considered 10.
- The highest price considered as expensive was 12 euros and this number was chosen for two participants.
- Only 2 persons did not provide an answer to this question.

4.5.3 Usefulness of Information during Service

Participants were asked about the usefulness of various aspects of information that could be provided through the service. These were ranked from Very important to Very unimportant, with Neutral as a central choice.



- Around 67% of participants thought that the information on detected pedestrians or cyclist is very important. 19% of respondents considered that it was important.
- Around 87% of participants believed that information on upcoming driving manouvres was very important or important. 5 respondents were neutral about this kind of information.
- Over half of sample in this test though that the information on traffic light status is very important.

- Eighteen persons were neutral about information on (personal) data needed for using the service.
- For 68% of them is very important to receive information in their own language and 31% of them considered it as important.
- Most of the sample considered that drive the vehicle by their self whenever they want to be very important.
- 70% of participants believed that is very important to control de speed of vehicle.
- Around 70% of respondents considered that control headway to car in front is, at least, important (for 19 persons it was considered as very important).

Other information that participants would like to see are[5] or other function they would like to have:

Traffic status, type of traffic (heavy or light), road status
Information about the traffic state and estimated time arrival
Information about Improvement of Route
At tight curves without visibility have the possibility to know if another vehicle come on the other lane
One that could provide other autonomous cars that run in the same way I drive or the route I have set up.
Weather along the route followed.
If it is possible, I would like to be advise of the advances of the project.
No.
Sound alert coming closer of roadworks or traffic lights.
No.
No.
If I am contributing to energy savings or not with these systems.
The weather and relative information about parkings and etc.
No, I can remember any about this service.
If I am in autonomous mode the car the car that take care of the necessary information to control, if not, I do not need this information. Having in mind that service is reliable.
State of the vehicle, turning system, detection of the different elements
Accidents, works, cut roads, traffic jams, etc.
No.
Real-time data to see the operating status of the electronic system (something like a way of knowing the stress of the system).
Know in real time what type of signs the vehicle is recognizing. As well as additional information that the Spanish General Direction of Traffic or other users can offer.
I think it is enough with showed information.
Possible accidents on the marked path and that generates an alternative route with confirmation
No.
Traffic information about the closer vehicles.
No.
Atmospheric conditioning and traffic conditions (traffic jams, accidents, etc.).
Estimated time of arrival at destination.

Answers to the next question: “Is there anything additional you would like to tell the designers of the system, to change to make the service more useful to you?” are presented in the next table:

No.

[5] Translated from Spanish

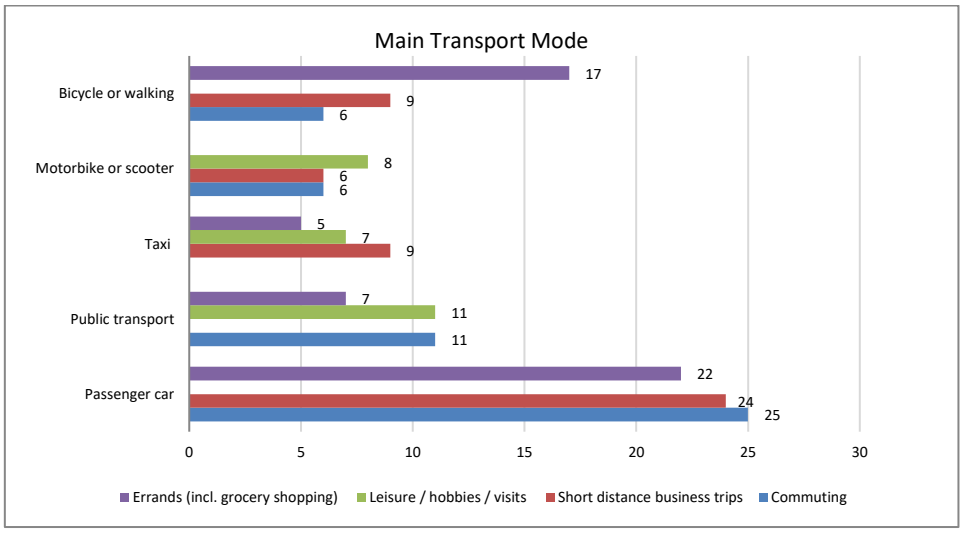
I would add information about of the emergency vehicles (ambulances, police) that interfere with us on the road, informing the driver and responding appropriately by braking and letting it pass, moving away to the shoulder. Etc…
Nothing more.
Change location of the control buttons during autonomous driving, on the steering wheel it is uncomfortable.
Add information about the environment, nearby vehicles or traffic jams.
The controlled of the vehicle must not be integrated in the steering wheel, since this is turning and makes access difficult.
No.
The system should capture the pilot's attention by means of some sound or vibratory stimulus so that he pays attention to the important warnings, if he does not exist.
Make the steering wheel turn more constant and without much staggering.
Open too much at the curves.
No.
I suppose they will take it into account, but the fact that the speed control and autonomous mode buttons are on the steering wheel becomes very uncomfortable, because in autonomous mode the steering wheel turns only and you have to chase those buttons.
I would like the speed to be to 10 in 10 and not to 5 in 5.
Improve at smoothness for turn management to be less abrupt.
The HMI in the work detection part looks too small. It should be larger for a few seconds flashing in the center of the screen.
I had trouble knowing at what speed I had autonomous driving set. Besides, the speed went from white to gray and I didn't know why. I would also like to see how works on the map approached the event. Finally, the screen behind the wheel often did not see it because the wheel was spinning. It should be placed in another position (in the right IC or in an elevated IC above the steering wheel).
No.
The setpoint speed in gray was not visible.
The icons in the upper left or right are not visible for tall people.
Be more striking when the car is autopilot mode.
The indication on the red traffic light board is almost imperceptible if you are not paying attention to the frame. It has less visibility than the green traffic light indication and I think it should be the other way around.

5 Background

Participants were asked some background questions about their current travel habits and demographic details to set context for the findings.

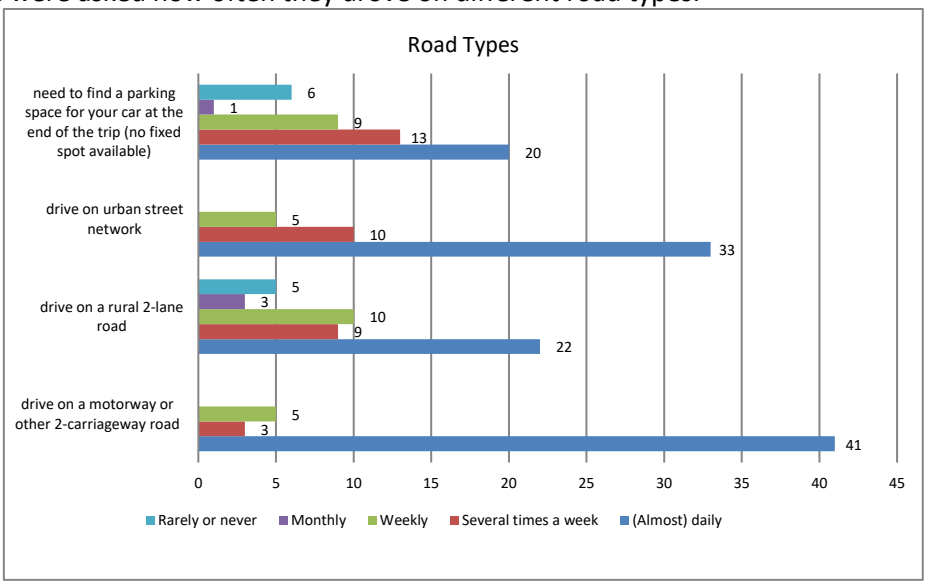
5.1 Travel Habits

Participants were asked which mode was their main transport mode for various trip types, and how often they used all transport modes for various trip types.



- Passenger car is the main transport mode, mainly for commuting, short distance business trips and errands.
- For commuting also 11 persons use public transport.
- Bicycle or walking is used mainly for errands.
- For leisure/hobbies/visits participants use motorbike/scooter, taxi or public transport.

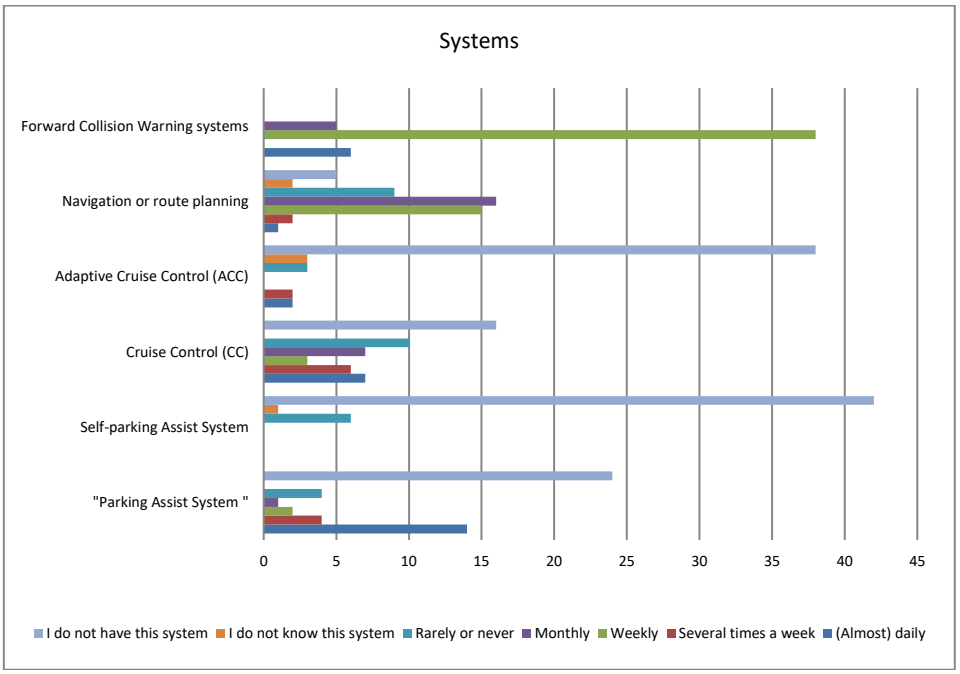
Participants were asked how often they drove on different road types.



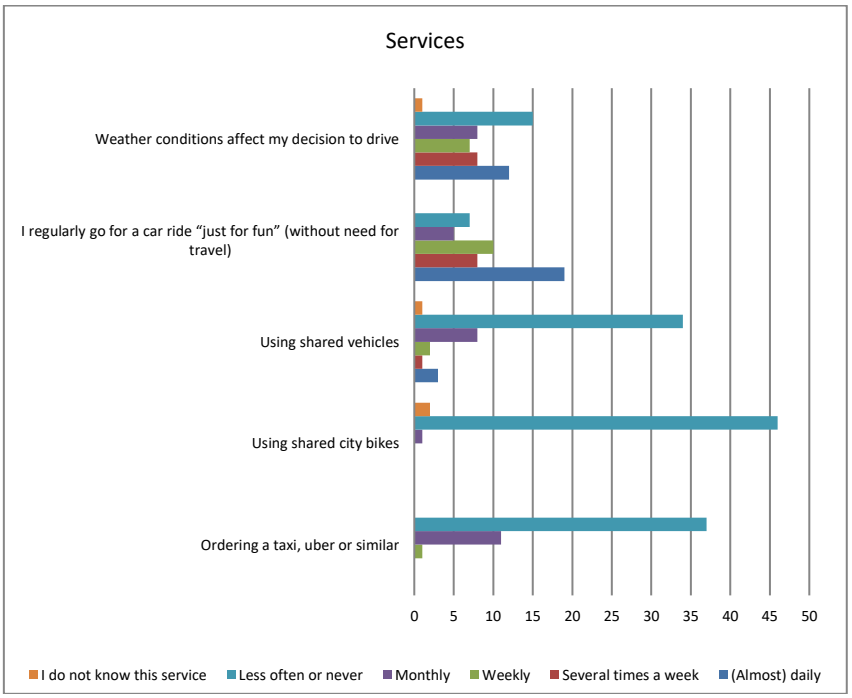
- Most of participants drive on motorway or another 2-carriage road (almost) daily.
- Moreover, around 70% run on urban street network (almost) daily. 20% of them do it several times a week.
- Around 40% of drivers drive on a rural 2-lane road (almost) daily. 18% of them run several times on week in this type of road. And 20% do it weekly. 10% of respondents do not drive in this kind of road.

5.2 System and Service Acceptance

Participants were asked how often they used advanced driving systems and shared mobility services.



- FCW is the most used system for the participants who take place in this test.
- Navigation or route planning is the other system used weekly or monthly for most of participants.
- Most of participants have not in the car ACC or assistant to help them to park. Although around a quarter of them use parking assist system to park (almost) daily.

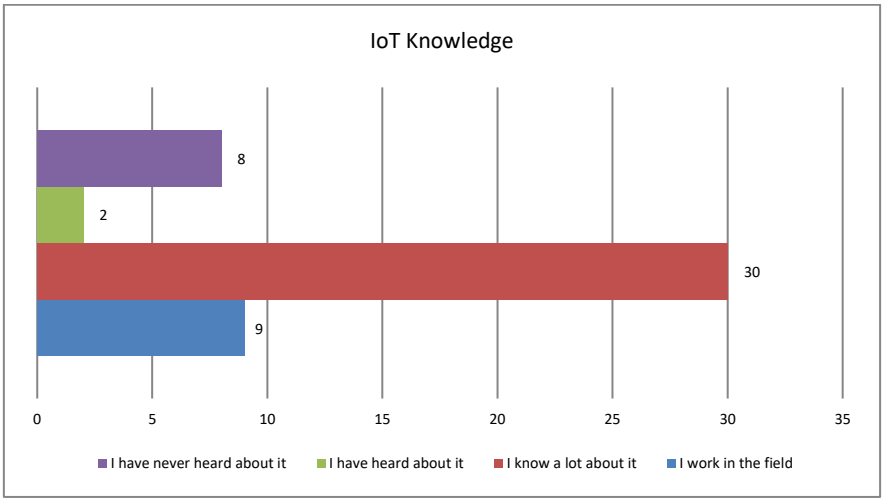


- Over half of participants do not share city bikes, shared vehicles or order a taxi, uber or similar.
- Around a quarter of sample order a taxi, uber or similar monthly.
- Around 35% of them regularly go for a car ride "just for fun" (without need for travel)[6].

[6] "Weather conditions affect my decision to driver" and "I regularly go for a car ride "just for fun" are not services but it was included in this graphic for their relation about reasons with influence in the car use.

5.3 IoT Knowledge

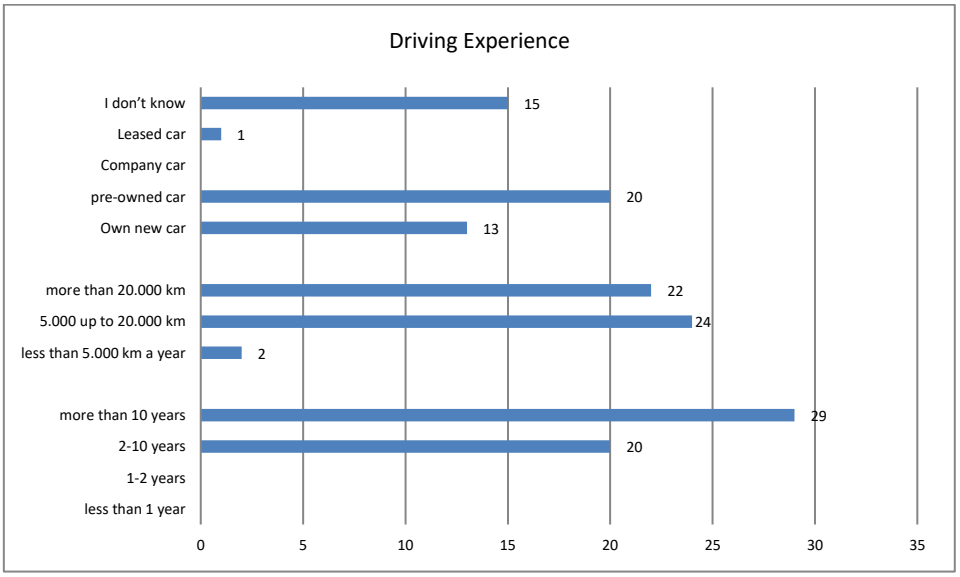
Participants were asked how aware they were of Internet of Things.



- Over half of participants (61%) know a lot about IoT. 18% of them works in the field.
- 16% of respondents have never heard about it.

5.4 Driving Experience

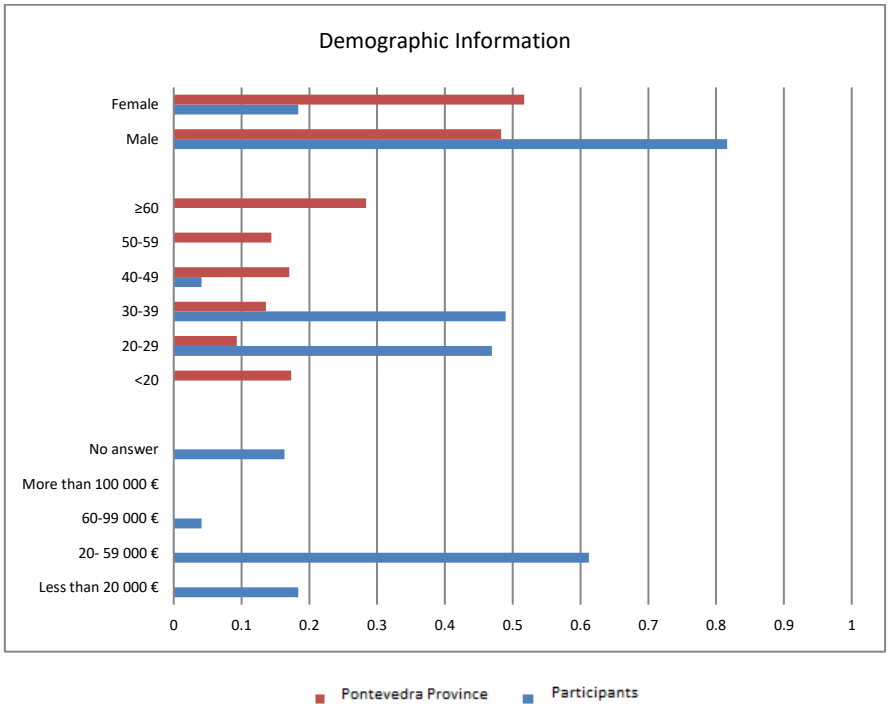
Participants were asked about their attitude and experience towards driving.



- Around 60% of participants are very experienced drivers with more than 10 years of practice. The other drivers of this sample have an experience between two and ten years.
- Around half of sample drive between 5.000 up to 20.000 km/year. A similar percentage run more than 20.000km/year. Only two participants drive less than 5.000 km/year.
- About 40% of sample plan to buy a pre-owned car. 30% of them do not know what their next car would be. Around a quarter of them consider that it would be a own new car.

5.5 Demographic Information

Participants were asked about their background to establish representation of the test group.[7]



- The percentage of female participants was lower than the Pontevedra region meanwhile the percentage was higher than the local reference data.
- The 20-29 and 30-39 age groups were over-represented.
- The <40 age group was under-represented.
- Over half of the sample have an income between 20-59.000 euros/year.

[7] https://www.citypopulation.de/php/spain-admin.php?adm2id=36

AUTOPILOT

Appendix 3: Detailed survey summaries

User Acceptance – Requirements

	Hazard Detection	Platooning	Urban Driving	AVP
Brain-port	- Importance of Information during the Service ○ Almost every participant rated information on detected hazards (36 out of 38) and on what the car will do about the hazards (35 out of 38) as (very) important ○ No participants thought that either the information on detected hazards or what the car would do were unimportant ○ 2 participants were neutral about the information on detected hazards ○ 3 participants were neutral bout what the car would do ○ Other information that participants would like to see: ▪ Acoustic/tactile signal ▪ Information on traffic jams, unexpected road lane changing users, moving objects, alternative routes, speed cameras, police, fire brigade, ambulance ▪ Hazards like ghost riders, slow riders, unreliable road	- Importance of Information during the Service *(as a Leader)* ○ No participants thought that the information in all aspects were very unimportant as a leader ○ No participants thought that the information in aspects of route guidance, estimated waiting time to form platoon, estimated time to final location, and what assistance is available during service were unimportant ○ All participants thought that the information about estimated waiting time to form platoon was important or very important ○ 8 participants were neutral about the information on (personal) data needed for using the service ○ Information on road guidance was ranked as (very) important by all 20 participants (15 "very important", 5 "important") ○ Information on headway kept to car behind is (very) important for 16 participants, but there are 3 respondents who perceive this information as unimportant - Importance of Information during the Service *(as a Follower)* ○ No participants thought that the information in all aspects were very unimportant as a follower ○ No participants thought that the information in aspects of estimated waiting time to form platoon, (personal) data needed for using the service, estimated time to final location, what assistance is available during service, and receive pre-warning about manual driving were	- Usefulness of Information during the Service ○ 70% of participants thought that the information on crowds of pedestrians that could affect the route of the car was useful or very useful ○ Around half of participants thought that the information on crowds of pedestrians for other reasons and having access to the information would be useful ○ Nearly half of participants did not think that crowd information for other reasons was useful. - Other information that participants would like to see are: ○ Information about weather conditions ○ Information about time (waiting time, time the ride will take, time of arrival) ○ Information on what the car does and why ○ The app could be more user friendly (more colors, more clear images) ○ Information about the route	

	users, large water ponds, upcoming emergency services, unusual crowds on fixed routes ▪ → From the above, participants would like to see a join between this service and existing traffic systems, and would like audio signals	unimportant ○ Half of participants were neutral about the information on (personal) data needed for using the service ○ The majority of participants (over 50%) thought that the information in all aspects were important or very important as a follower ○ Nearly everyone (95%) thought that the information about estimated waiting time to form platoon and receive pre-warning about manual driving were important or very important ○ Route guidance seems to be slightly less important as a follower than as a leader - <u>Other information that participants would like to see:</u> ○ Information about traffic and about the chances of platooning not working out ○ How many followers you have behind you. And a notification when someone quits on their own initiative ○ As a follower, be warned in time for unexpected events on the road which the leader can see ○ Information on other users - <u>Importance of Features of the Service *(as a Leader)*</u> ○ No participants thought that the features of adjust/choose the distance between cars and stop the platooning anytime were very unimportant as a leader, on the contrary, those information were assessed as (very) important by 17 and 19 out of 20 respondents. ○ 2 participants thought that communicate with other drivers were unimportant or very unimportant ○ 8 participants were neutral about feature of communicate with other drivers as a leader during service ○ Nearly everyone (95%) thought that the feature of stop the platooning anytime was important or very important, and no one thought it was		

		unimportant. - Importance of Features of the Service *(as a Follower)* ○ No participants thought that the features in all aspects were very unimportant as a follower ○ 4 participants thought that adjust/choose the distance between cars was unimportant ○ 8 participants were neutral about feature of communicate with other drivers as a follower during service ○ All participants thought that the feature of stop the platooning anytime was important or very important ○ Nearly everyone (95%) thought that the feature of drive the vehicle yourself whenever you want to was important or very important and no one thought it was unimportant. ○ Communicating with the driver of the lead vehicle was (very) important for 15 out of 20		
Li-vorno	- Importance of Information during the Service ○ No participants thought that any type of information were unimportant, except of one person who stated that information on personal data would be very unimportant ○ All 12 participants found one of the main feature of the system – providing information on detected hazards – as very important ○ 7 to 9 participants found also information about what the car will do about the hazards as well as personal data needed for using the service as very important ○ Information about service			

	fees and what assistance is available during service use were both rated only by 4 to 5 participants as very important one - <u>Importance of Features during the Service</u> ○ All participants rated the option to drive the vehicle by oneself whenever one want to as (very) important ○ The option to control speed of the vehicle was found to be (very) important by 9 out of the 12 participants; 3 were neutral about it ○ The option to control headway to car in front was rated only by 3 participants as very important; 5 found it (somehow) important, and 3 chose "neutral"			
Tam-pere			- <u>Importance of Information during the Service</u> ○ A majority (23 to 26) of participants found it important to get the following information: route monitoring, estimated arrival time, information on detected pedestrians and cyclists and information on traffic light status ○ 17 participants found it important to get information on upcoming driving maneuvers, but 9 participants felt neutral about this information ○ 11 to 12 participants found it important to get information on points of interest or sights near the route and information about restaurants, hotels, cafes etc. near	- <u>Importance of Information during the Service</u> ○ A majority (25 to 28) of participants found it important to get the following information: route guidance to parking place, estimated waiting time, confirmation that the car is successfully parked, wait time to retrieve car on return and parking fees ○ 12 to 15 participants found it important to get information on points of interest or sights near the parking place and information about restaurants, hotels, cafes etc. near the parking place while 8 to 9 participants rated those information as (very) unimportant

			the route while 8 participants rated those information as (very) unimportant - Other information ○ Information about congestions, accidents, alternative routes, (free) parking spots, weather, animals ○ Target speed for driving in green wave in consecutive traffic lights - Importance of Functions of the Service ○ 19 participants found it important to get information in their own language ○ 15 participants found it important to personalize the information they receive ○ 23 participants found it important to drive the vehicle themselves whenever they want to ○ 24 participants found it important to control the speed of the vehicle ○ 23 participants found it important to control the distance to car in front - Other functions ○ Autonomous parking ○ View nearby objects ○ Speed adjustment	- Other information ○ Information on the parking situation and parking space ○ Waiting time for car to return from parking ○ Pictures or videos while/ where the car drives - Importance of Functions of the Service ○ 23 participants found it important to get information in their own language ○ For the aspect "choose where the car should park", 12 participants found it important and 10 participants found it unimportant ○ 22 participants found it important to be able to stop the process and park themselves - Other functions ○ Customer service, payment in the same app ○ Information on weather ○ Remote control of heating during parking ○ Complete trip planning ○ Choose from multiple drop-off/pick-up points, even if they differ from the original drop-off point
Ver-sailles			- Importance of Information ○ Most important information (M > 4,5): information about parking space availability and location, route guidance to station, information an detected hazards, information about restaurants, hotels, cafes etc. near the vehicle's location, estimated time left in self-	

			driving mode, estimated waiting time ○ Less important ($M < 4$): tourist information (point of interest/ sights neat the vehicle's location), duration of the tour - Other information ○ Maximum time use of service, number of people waiting for service, info on charging points ○ Info on other touristic circuits in auto mode ○ Time or mileage of electric autonomy ○ Comparison of carbon cost of this trip to diesel tour bus trip - Importance of Functions ○ On average, all functions (receive information in your own language, personalize the information you receive, drive the vehicle yourself whenever you want, stop the ride anytime)are assessed as relevant - Other functions ○ Voice interaction	
Vigo			- Importance of Information ○ Around 86% of participants thought that the information on detected pedestrians or cyclist is (very) important. ○ Around 87% of participants believed that information on upcoming driving manouvres was very important or important. 5 respondents were neutral about this kind of information. ○ Over half of sample in this test though that the information on traffic light status is very important.	- Importance of Information ○ Around 45% of participants thought that the information regarding route guidance to parking is very important. Only 2 persons considered that it is not significant. ○ Three quarters of participants believed that it was essential to have information about the estimated waiting time for parking in case no parking space available. ○ About three quarters half of participants thought that the feedback that the car is

			○ Eighteen persons were neutral about information on (personal) data needed for using the service. ○ For 68% of them is very important to receive information in their own language and 31% of them considered it as important. ○ Most of the sample considered that drive the vehicle by their self whenever they want to be very important. ○ 70% of participants believed that is very important to control de speed of vehicle. ○ Around 70% of respondents considered that control headway to car in front is, at least, important (for 19 persons it was considered as very important). - <u>Other information/functions</u> ○ Traffic status, road status, accidents ○ Estimated arrival time ○ Function that informs about other vehicles on other lanes ○ Weather conditions ○ Sound alert coming closer to roadworks or traffic lights ○ Information on energy savings ○ State of the vehicle ○ Information on what the car "sees" (e.g. signs)	successfully parked would be useful. ○ 65% of participants thought it would be advantageous to have information about wait time to retrieve car on return. ○ Most of drivers did not considered useful provide information about personal data necessary to use the service. ○ Around 60% of participants were neutral about the idea of having points of interest near the parking place. 7 drivers did not know if it was important. ○ Three quarters of respondents considered as neutral to have information about restaurants, hotels, cafes, etc., near the parking place. - <u>Other information</u> ○ Waiting time ○ Photo when car has been parked ○ Information on parking space ○ Information on service error rate of the previous month ○ Up to date info about costs