5GMOBIX

5G for cooperative & connected automated MOBIlity on X-border corridors

D5.4

Report on user acceptance

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Control sheet

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ABBREVIATIONS

Abbreviation	Definition
ACC	Adaptive Cruise Control
AD	Automated Driving
ADAS	Advanced Driver Assistance Systems
AV	Average (case scenario)
ATI	Affinity for Technology Interaction
BE	Best (case scenario)
BSD	Blind Spot Detection
CBC	Cross Border Corridor
CCAM	Cooperative, Connected and Automated Mobility
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CoopAutom	Automated Shuttle Driving Across Borders: Cooperative Automated System
DoA	Description of Action
EC	European Commission
FCW	Forward Collision Warning
GA	General Assembly
HD	High Definition
HDMapsPublicTransport	Public Transport: HD Maps
HDMapsVehicle	Complex Manoeuvres in Cross-Border Settings: HD Maps
HLS	HTTP Live Streaming
HUD	Head-Up Display
LaneMerge	Complex Manoeuvres in Cross-Border Settings: Lane Merge for Automated Vehicles
LDW	Lane Departure Warning

MediaPublicTransport	Public Transport: HD Media Services
Overtaking	Complex Manoeuvres in Cross-Border Settings: Automated Overtaking
RCCrossing	Automated Shuttle Driving Across Borders: Remote Control
RMSEA	Root Mean Square Error of Approximation
RMSR	Root Mean Square Residual
STEM	Science, Technology, Engineering and Mathematics
TAM	Technology Acceptance Model
TS	Trial Site
TSL	Trial Site Leader
UAAD	User Acceptance for Automated Driving
UC/US	Use Case/User Story
VRU	Vulnerable Road User
WP	Work Package
WPL	Work Package Leader
WO	Worst (case scenario)
X-border	Cross-border

EXECUTIVE SUMMARY

The present document constitutes deliverable D5.4 – "Report on user acceptance" of the 5G-MOBIX project. Its main objective is to report on Task 5.4 – user acceptance, which aimed to assess the acceptability of the different Connected and Automated Mobility (CAM) use-cases (hereby referred as user stories). The purpose of this task was 1) to evaluate the user acceptability regarding the different user stories and 2) to understand how 5G connectivity issues (the CAM enabling technology addressed by the project), such as service interruptions and degraded quality of service may impact said acceptability.

The user evaluation was focused on the use cases trialled at the cross-border corridor (CBC) between Spain and Portugal. These included three advanced driving manoeuvres: (1) lane merge, (2) overtaking and (3) driving with reliance on a High Definition Map, (4) a passenger shuttle remotely driven through the border, (5) the same passenger shuttle receiving information from external sensors about the presence of nearby Vulnerable Road Users (VRUs) and (6) a multimedia streaming service deployed on a long-distance bus.

Each user story was evaluated through one or more of four different methods, depending on the nature of the CAM user story and appropriateness to context and logistical constraints. The methods were (a) controlled trials in which test users were inside the vehicles as passengers and observed the behaviour of the vehicles and the flow of events (used for the users stories related with advanced driving manoeuvres and the shuttle), (b) real world trials, for testing the multimedia streaming, in which the users could experience the actual service deployed on board of the long-distance bus,(c) online interviews, applied to the advanced driving manoeuvres, in which participants were presented with simulations of different scenarios of service performance and asked to evaluate them and (d) an online questionnaire, used to evaluate the advanced driving manoeuvres and the shuttle related user stories, to provide complementary information to the trials.

Overall, the user evaluation of the CAM proposals was positive, even in situations hindered by connectivity issues. This was observed for all user stories, across the different evaluation methodologies. Participants stated both quantitatively and qualitatively, that, if available, they would use the several proposed CAM user stories. They considered them to be useful, easy-to-use, reliable and trustable, hinting to the added value of the 5G-enabled features. Particularly strong correlations were found between the acceptability of the user stories and their perceived usefulness as well as the conveyed feeling of trust.

Regarding the border context, results show that connectivity interruption or general service degradation may negatively impact acceptability, but that this will depend on how the CAM technological proposal is designed to behave in cases of deficient connectivity. Concretely, this means that degraded network conditions may, from the user point-of-view, be regarded as worse than a complete network interruption, if the behaviour of the vehicle is somehow perceived as insecure (even if, objectively, safety is ensured). This means that acceptability may be impacted not just by the failure of connectivity itself, but by the observable vehicle response, including the fail-safe mechanisms that will be in place when the connectivity performance decreases or fails entirely and if the vehicles behave in ways that are perceived as less safe.

In terms of structure, the deliverable begins by highlighting the adaptations that were necessary both in the scope and in the methodological framework initially defined in earlier deliverables. It proceeds with the description of the user evaluation model constituted by a set of psychological constructs, known to be relevant for technology acceptability. It then details the assessment methods applied to the different user stories. It proceeds by analysing and discussing the results and concludes by comparing the key KPIs across methodologies and user stories and providing the main conclusions. Finally, the deliverable also provides some lessons learned regarding the different methodological approaches.

The deliverable aims to be a reference in the assessment of the acceptability of different CAM proposals. It also aims to inform future implementations of CAM use cases, particularly regarding the automation behaviour when dealing with degraded function of enabling technologies such as 5G communications.

1 INTRODUCTION

1.1 5G-MOBIX concept and approach

5G-MOBIX aims to showcase the added value of 5G technology for advanced Connected and Automated Mobility (CAM) use cases and validate the viability of the technology to bring automated driving to the next level of vehicle automation (SAE L4 and above). To do this, 5G-MOBIX demonstrates the potential of different 5G features on real European (and Asian) roads and highways and creates and applies sustainable business models to develop 5G corridors. 5G-MOBIX will also utilize and upgrade existing key assets (infrastructure, vehicles, components).

5G-MOBIX executed CAM trials along cross-border (x-border) and urban corridors using 5G core technological innovations to qualify the 5G infrastructure and evaluate its benefits in the CAM context. The Project also defined deployment scenarios and identified and responded to standardisation and spectrum gaps.

5G-MOBIX first defined critical scenarios needing advanced connectivity provided by 5G, and the required features to enable some advanced CAM use cases. The matching of these advanced CAM use cases and the expected benefits of 5G were tested during trials on 5G corridors in different EU countries as well as in Turkey, China and Korea.

The trials also allowed 5G-MOBIX to conduct evaluations and impact assessments and to define business impacts and cost/benefit analysis, upon which new business opportunities for the 5G enabled CAM and recommendations and options for its deployment are developed.

Through its findings on technical requirements and operational conditions 5G-MOBIX expects to actively contribute to standardisation and spectrum allocation activities.

1.2 Purpose and structure of the deliverable

The purpose of this deliverable is to report on the results of the user acceptance evaluation activities conducted in the scope of the 5G-MOBIX project. These were aimed at evaluating the acceptance for the CAM user stories proposed. They also intended to investigate how breaks in service continuity, which may occur during border-crossing, may impact on the user experience and consequently, on the acceptability towards the CAM proposal. Understanding how different technologies and 5G configurations impact the evaluated CAM use cases is one of the core goals of the project. It is thus relevant to also understand how different levels of performance may impact user perception and consequently, acceptability.

Previously, D2.5 [1] reported on an initial set of evaluation KPIs and metrics that, in regard to user acceptance, aimed at defining the relevant dimensions that compose acceptability. It thus set a general framework for evaluations and comparisons across UCCs/USs. A subsequent deliverable, D5.1 [2], allowed further detailing of the KPIs and defined a general evaluation methodology to be followed for data collection and analysis.

D5.4 follows up the two previous deliverables by making a reassessment of the KPIs and methodology resulting from lessons learned in the first trials. It then proceeds to report on the procedures followed on the different evaluation activities and the obtained results. The deliverable concludes with a general assessment of the acceptance KPIs and comparison between user-stories.

The deliverable is structured as follows:

- **Section 2, User Evaluation Methodology**, begins by detailing the scope of the evaluation including changes during the course of the project. It then describes the initial hypotheses, the methods applied for the evaluation and the development of the initial user acceptance model that supported the evaluation. It finishes with a review of the evaluation KPIs;
- **Section 3, Advanced ManoeuvrEs**, describes the evaluation, initially by road trials and later by online interviews of the advanced manoeuvres user stories;
- **Section 4, Public Transport: HD Media Services**, details the evaluation of the user story with the same name, through real world trials;
- **Section 5, Automated Shuttle Driving Across Borders**, describes the acceptance evaluation of the user stories involving the automated shuttle, through road trials;
- **Section 6, Global Online Evaluation**, refers to the development and results' analysis of an online survey. This was intended to provide complementary data on the user stories evaluated through controlled trials and interviews (sections 3 and 5);
- **Section 7, General Discussion**, summarizes the findings of the previous four sections and compares the results across user stories;
- **Section 8, Conclusion**, summarizes the main conclusions and outcomes of the evaluation.

1.3 Intended audience

The dissemination level of D5.4 is public (PU). The document is intended primarily for (a) all members of the 5G-MOBIX project consortium, (b) the European Commission (EC) services and (c) the scientific community. This document is intended as a reference for anticipating end-users' acceptability, in the development of 5G-enabled CAM use cases, when issues of roaming and handover are at stake. It particularly addresses how technical (network) implementations as well as particular behaviours of the vehicle may affect acceptability.

2 USER EVALUATION METHODOLOGY

2.1 Scope of the evaluation

The methodology defined initially for assessment of user acceptance (D5.1 [2]) was based on two main methods: (1) Trial-based data collection - through self-reports of test subjects taking part on the trials as passengers of the vehicles and (2) an online user survey that could be answered by populations of interest, namely, potential users of the user stories. This survey had the purpose of providing complementary data to the trial-based evaluation, considering that the trials would always be limited to a reduced number of participants. Also, because trials are prone to unexpected interferences (e.g., technical issues with the technology or unforeseen external conditions) the survey was a way of obtaining measurements that are more easily comparable across user-stories.

Since assessing the acceptability of each of the project's user-stories independently is not logistically possible, the evaluation efforts were focused on the ones developed at the CBCs. These are representative of all the projects' five user story categories and thus offer a thorough representation of several types of that 5G-enabled automated mobility use-cases. Also, they were the ones implying a physical border crossing and were thus better suited to provide a most realistic experience for the users. Test trials with users were thus planned for the ES-PT (Spain – Portugal) and GR-TR (Greece – Turkey) corridors and the online survey was planned to cover the user-stories of both CBCs.

Nonetheless, technical and logistic constraints as well as the strong limitations placed by the COVID-19 pandemic have substantially hindered this plan, particularly for the GR-TR CBC. On this corridor the main population of interest would have been a) border guards and b) drivers of the transport vehicles, particularly those used to cross the border. However, substantial logistical hurdles placed by the "hard-border" context as well as technical constraints, prevented the conduction of trials involving this particular set of users. Likewise, reaching such a specific population in large enough numbers for the online survey to provide meaningful results also proved to be unfeasible.

The focus of the user-evaluation was thus placed on the ES-PT corridor. The population of interest of these user-stories includes any person that may use a personal car or a public transport and is thus much wider than the one of the GR-TR.

Thus, the user-stories directly addressed by the user-evaluation and reported on this deliverable are:

- US#1.1.a - Complex Manoeuvres in Cross-Border Settings: Lane Merge for Automated Vehicles
- US#1.1.b - Complex Manoeuvres in Cross-Border Settings: Automated Overtaking
- US#3.1.a - Complex Manoeuvres in Cross-Border Settings: HD Maps

- US#3.1.b - Public Transport: HD Maps
- US#1.5 - Automated Shuttle Driving Across Borders: Cooperative Automated System
- US#4.1 - Automated Shuttle Driving Across Borders: Remote Control
- US#5.1 - Public Transport: HD Media Services

2.2 Methods

Overall, the user acceptance evaluation of the 5G-Mobix projects follows an empirical approach that aimed to evaluate: 1) the acceptability of the user stories proposed and 2) how connectivity and handover issues relevant in the x-border context may affect the acceptability. It was hypothesized that:

1) Acceptability would in general be positive;
2) Network related technical issues at the border context could negatively impact acceptability.

The trial-based methodology first laid out in D5.1 addressed these hypotheses and particularly the second, in the sense that it was designed to confront evaluations conducted in local trials (in which x-border issues are not at stake) with the ones performed in x-border trials. By comparing the differences between the two it aimed to determine in which measure the user evaluation was an actual consequence of the border context.

However, the empirical evaluation of the user stories referring to complex manoeuvres (US#1.1.a, US#1.1.b and US#3.1.a) faced technical and logistical complications that prevented the application of this methodological approach. Concretely, it proved to be challenging to coordinate user evaluation and technical evaluation within the strict time windows of road closures that were possible to arrange. Thus, following a first set of unsuccessful trials that took place at the border an alternative plan was defined based on online interviews. These were supported by video-based simulations that illustrated the user stories (from the driver point-of-view). Maintaining the focus on understanding how x-border issues affect user perception, three simulation scenarios were developed: Best (BE), Average (AV) and Worst-case (WO). These aimed to mimic network conditions (BE would correspond to local trials while AV and WO would be associated with x-border trials). Importantly, the adjectives *best*, *average* and *worst* must be understood as referring to the network conditions, and not necessarily that the user-experience.

While simulation-based user assessments are less realistic compared to real-world testing, research shows that it can at least provide relative validity of the results [3], [4], meaning that they follow a similar pattern as they would in real-world studies although magnitudes of results may vary. In the context of the 5G-MOBIX project, allowed full control over variables and events and thus it was possible to define experimental conditions purposely built to address the research questions and compare the results systematically. This could not have been done in the real-world trials, particularly for the advanced manoeuvres, given the logistic and technical complexity associated with the trials. Simulation also allowed testing safety-critical situations, without putting participants at risk. Concretely, it was possible to place participants on the driver perspective of the automated vehicles, while in real-world trials they would only be passengers.

The difference in methods also proved to be an interesting opportunity to compare how different approaches for providing users with a technology experience compare to each other, in terms of their outcome. This will be discussed in the final part of the deliverable.

The user story Public Transport: HD Media Services (US#5.1) was a second exception to the dual evaluation. It is essentially a streaming media service provided on long duration travels. While poor connectivity at the border may jeopardize the experience, it would in principle only do so during a few seconds in an hourly-long travel. Thus, only the general acceptability hypothesis was evaluated.

Following the several changes reported above, the full evaluation methodology comprises four methods (Table 1). These are introduced next.

Table 1: Summary of user stories and evaluations methods in Cross-Border

US	Online Interviews	Controlled trials	Real world trials	Global online survey
US#1.1.a - Complex Manoeuvres in Cross-Border Settings: Lane Merge for Automated Vehicles (***LaneMerge***)	✓	✕		✓
US#1.1.b - Complex Manoeuvres in Cross-Border Settings: Automated Overtaking (***Overtaking***)	✓	✕		✓
US#3.1.a - Complex Manoeuvres in Cross-Border Settings: HD Maps (***HDMapsVehicle***) **US#3.1.b** - Public Transport: HD Maps (***HDMapsPublicTransport***)	✓	✕		✓
US#1.5 - Automated Shuttle Driving Across Borders: Cooperative Automated System (***CoopAutom***)		✓		✓
US#4.1 - Automated Shuttle Driving Across Borders: Remote Control (***RCCrossing***)		✓		✓
US#5.1 - Public Transport: HD Media Services (***MediaPublicTransport***)			✓	

The (✓) marks the methods applied for a user story, while the (✕) marks user stories where the method was completed only in local scenario in Spain but not in Cross-Border.

A) **Controlled trials**

This approach was first laid out in D5.1 and it was aimed at testing the user-stories directly with users, granting them a good approximation to the complete user experience. It follows the two-fold approach of confronting evaluations conducted in local trials (in which x-border issues are not at stake) with the ones performed in x-border trials and compare the two.

The evaluation was planned to begin before the trials, with participants filling the acceptability questionnaire and providing qualitative information regarding their expectations of automated mobility and the user story, through focus groups or interviews. In a second phase participants would take place in local trials after which they would evaluate acceptability filling an acceptability questionnaire. This was followed by a third phase in which the same subjects participated in x-border trials followed by a second post-test questionnaire and a final interview.

Controlled trials were partially conducted for ***LaneMerge***, ***Overtaking***, ***and HDMapsVehicle*** (section 3.1) and conducted in full for the ***CoopAutom*** and ***RCCrossing*** (section 5).

B) **Real-world trials**

For the case of the ***MediaPublicTransport*** it was possible to perform trials involving real end-users. Concretely, the user-story was trialled on a commercial route between VIGO and the Francisco Sá Carneiro airport operated by the transport company ALSA.

Participants were invited to use the system and then provide their evaluation, filling an acceptability questionnaire, through an electronic form available on the interface of the media service.

C) **Online Interviews**

This approach aimed to provide quantitative and qualitative insights with participants, in user-stories where real-world trials could not be done, namely ***LaneMerge***, ***Overtaking***, ***and HDMapsVehicle*** (section 3.2). The evaluation was based on the three scenarios developed: *Best*, *Average* and *Worst*-case.

Each interview (with a single participant) was divided into sections. In the initial one, participants provided complementary qualitative information regarding their views on driving and their expectations of automated mobility. This was followed by the presentations of video simulations of the user stories in each condition. After viewing each simulation, participants filled in the acceptability questionnaire. In the last section they provided a qualitative overview of the user story.

D) **Global online survey**

This is an online questionnaire (no direct contact between respondents and researchers) covering all the ES-PT user-stories except US#5.1. The goal was to provide respondents with a visual and textual description of the user-stories and to have quantitative evaluation of their acceptance. Following a similar rationale to the online interviews, the same three scenarios (*Best*, *Average* and *Worst*-case) were used, mimicking to an extent the local and x-border contexts.

When filling out the online questionnaire, each respondent started by introducing socio-demographic information. They were then randomly assigned one user-story in a specific scenario. They would be presented with a description of the user-story and respective events and in the end, fill in the acceptability questionnaire.

2.2.1 The scenarios

The user-story scenarios (BE, AV and WO) that supported the online interviews and the global online survey were developed by considering a set of network KPIs and determine what would be the observable behaviour of the system for the different values. The four KPIs were:

- TE-KPI1.1 - User experienced data rate (UL / DL)
- TE-KPI1.3 - E2E Latency
- TE-KPI2.3 - Mobility Interruption Time
- TE-KPI2.2 - Application Level Handover Success Rate

For each of the above KPIs, the user-story leaders were asked to identify threshold values and to describe what would be the observable behaviour between them. This allowed the user-acceptance team to develop short storylines reporting the three scenarios for the users-stories listed in Table 1 (summary tables of this information can be found in Annex 1). These story lines were illustrated with graphic depictions and short stop-motion clips (see Figure 1 for an example; videos can be found here). These materials were directly used in the online survey and as support in the other trials. The complete set of storylines can be found in Annex 2).

The technical evaluation showed that, in general, the behaviour of the systems and the user stories flow (from the user point-of-view) was close to the best-cases scenarios, for all network configurations.

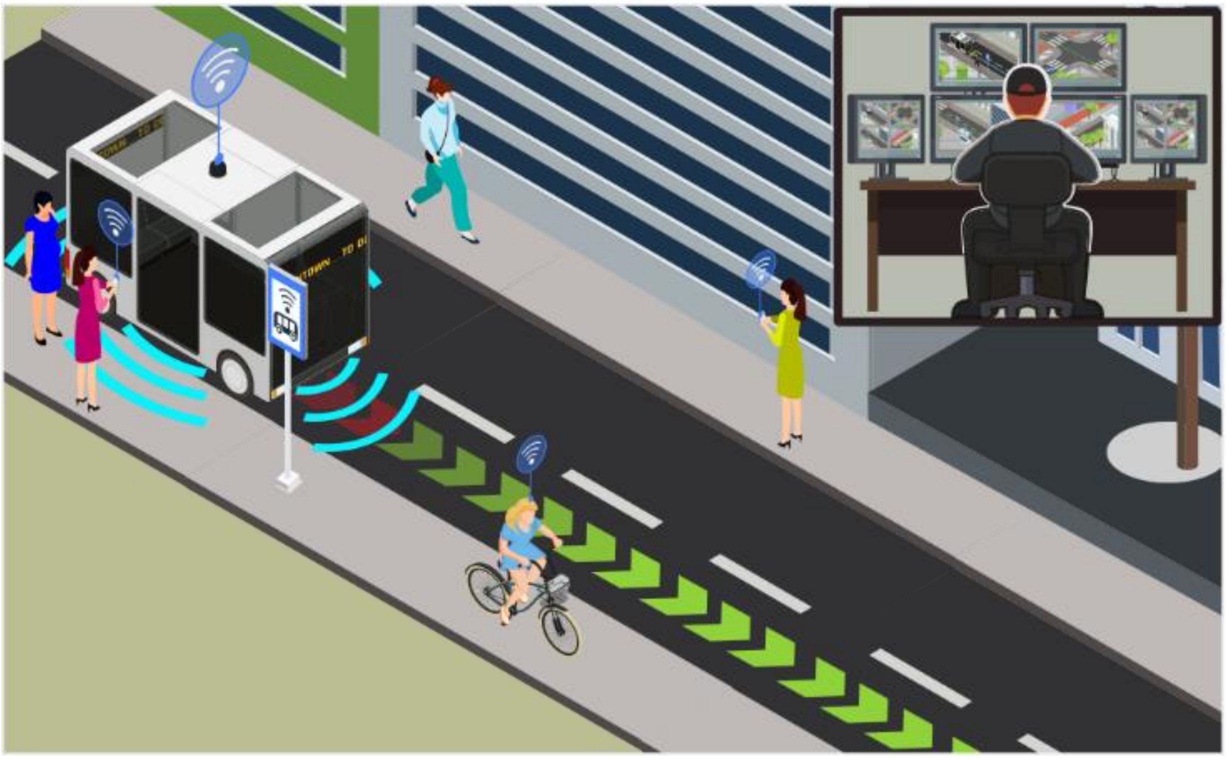


Figure 1: Example of graphic depiction of one of the user-stories involving the automated shuttle

2.3 User Acceptance for Automated Driving

An important element of the evaluation is the main data collection instrument that took the shape of a multi-dimensional psychometric scale. This scale named User Acceptance for Automated Driving (UAAD) includes 24 questions covering the most important KPIs and was grounded in the acceptability model introduced in D5.1 [2]. It was developed purposely for the 5G-Mobix project following the steps described in D5.1. These include:

1) Theoretical procedure - in which the main psychological constructs of acceptability were investigated and a theoretical framework was defined. For each relevant construct a set of initial items (questions) was defined that was then discussed by experts and reduced to an initial set.
2) Empirical procedure – in which the scale was administrated to a group to collect a sample of answers. This is followed by a statistical analysis aiming to determine a) the dispersion or variability of the answers and b) the twofold coherence of this dispersion: regarding the connection of this item to the other items in a given dimension (internal validity), and regarding its association with behaviours external to the scale but equally associated with the dimensions under evaluation (generalizability).
3) Analytical procedures – Based on the empirical analysis the final set of questions is selected and randomized.

It is important to note that the constructs of the survey are aligned with the KPIs proposed for User Acceptance evaluation.

2.3.1 Conceptual definition

The UAAD builds strongly on the Technology Acceptance Model (TAM) introduced by Davis [5] to explain user acceptance of systems or information technologies. This model postulates that the *intention to use* – « the degree to which a person believes it would use a technology » can be essentially explained by (1) the *perceived usefulness* – « the degree to which a person believes that using a particular system would enhance his or her job performance » and (2) the *perceived ease-of-use* – « the degree to which a person believes that using a particular system would be free of effort ». These factors are in turn affected by other external variables.

The UAAD model proposed in this project explores the three constructs of TAM, namely 1) *intention to use*, 2) *perceived usefulness* and 3) *perceived ease-of-use*. It also includes others proposed by Venkatesh et al., [6] and Venkatesh & Bala [7], namely, 4) *facilitating conditions* defined as the individual's belief that organizational and technical infrastructure are in place to support the system, 5) *subjective norm*, defined as the individual's perception that other people important to him/her believe he/she should use the system, 6) *self-efficacy*, defined as the individual's belief on his/her own ability to perform a task using the technology and 7) *anxiety*, defined as the individual's apprehension when using the system.

Considering that CAM use-cases are inherently safety-critical, it is assumed that feelings of trust and safety will play a major role in modulating acceptance. As such, based on the proposal of Zhang et al. [8], two additional constructs were included: 8) *trust* - which refers to the individual's belief that the system will operate correctly even in uncertain and vulnerable situations, 9) *reliability* – which refers to the individual's belief that the system will perform consistently under different circumstances and 10) *perceived safety* - defined as the individual's belief that using the system will be free of risk.

2.3.2 UAAD scale development

Figure 2 details the four steps taken to develop the UAAD scale. The initial one was the selection of six items (questions) per construct, from the supporting bibliography [5]–[12]. These were then reviewed by the team and adapted to the specific CAM user-stories addressed by the project. From this resulted a set of 10 x 6 = 60 items. For an independent analysis, these items were then subjected to feedback from three external researchers, not involved in the project, who were asked to select, the four questions they believed were the most suited to illustrate each construct. Their analysis was taken to a consensus meeting attended by the researchers involved in task T5.4. Four items per construct were finally selected (see Annex 3), resulting in a total of 40.

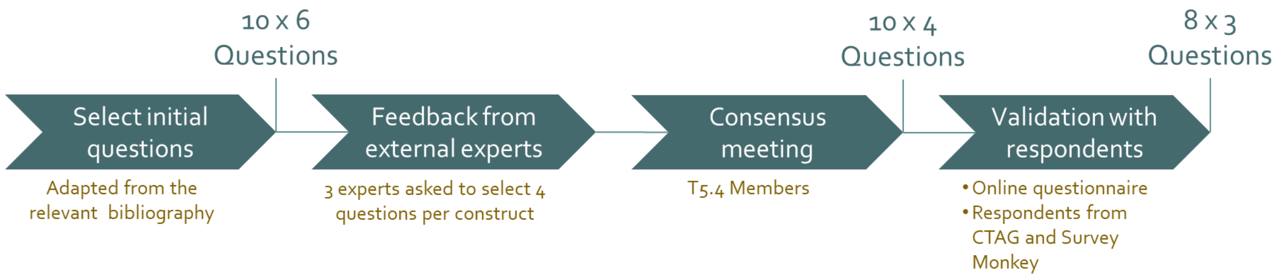


Figure 2: Stages of the scale development

The next and final step of the validation was done through an online survey. It was composed by a description of the user-story: US#4.1 – "*Automated Shuttle Driving Across Borders: Remote Control*" in the best-case scenario, followed by the forty items, presented in random order. Answers to each item were given by a 5-item Likert scale[1] (1=totally disagree; 5=totally agree). Focus on a single user story and scenario for the validation was intended to increase statistical power of the analysis, by ensuring that all answers would address the same technological concept.

2.3.3 UAAD validation

563 answers were collected from the validation survey. 129 were collected initially between CTAG collaborators from October to November 2020. 434 more answers were later collected using the online service SurveyMonkey + MTurk from January to February 2021. After cleaning the dataset (removing incomplete answers and clearly random responses), the sample was reduced to a sample of 396 answers (Table 2).

Table 2: Demographic data (Gender and age) of the participants taking part on the validation online survey

		Overall
		396
Gender	Female	118
	Male	269
	Prefer not to say/No answer	9
Age	18-30 Years	190
	31-40 Years	144
	41-50 Years	48
	51-60 Years	9
	61-70 Years	5

[1] Psychometric scale in which respondents state their degree of agreement or disagreement with one or more statements.

Respondents answered to a cluster of 40 items (see Annex 3). Data was analysed using RStudio (version 2022.02.02+485).

Confirmatory Factor Analysis (CFA) [13] was used to verify the psychometric structure of the UAAD scale, which was formed by the 10 factors mentioned above, namely (1) *intention to use*, (2) *perceived ease-of-use*, (3) *perceived usefulness*, (4) *trust*, (5) *reliability*, (6) *perceived safety*, (7) *facilitating conditions* (8), *subjective norm*, (9) *self-efficacy* and (10) *anxiety*. The technique allowed to assess how well data observations fit to a theoretical model defined *a priori*. Robust maximum likelihood was used to estimate the model parameters. The total sample was divided randomly in two parts: a calibration sample and a validation sample and CFA was applied to both.

The calibration sample was composed of 200 respondents. Estimated parameters were significant χ^2 (695) = 1206.96, $p < 0.001$. However, the Comparative Fit Index (*CFI*) was not acceptable since its value was under 0.90 (*CFI* = 0.729) while the Root Mean Square Error of Approximation (*RMSEA*) had a value of 0.082. The Standardized Root Mean Square Residual (*SRMR*) was 0.106. Given these indicators the model fit could not be accepted and the factor structure could not be confirmed[2]. This motivated a second step of the analysis as reported next.

Figure 32 - Annex 3 presents the diagram with the relations between item and factors and the standardized estimates of the factor loadings for each item. High-value (results greater than 0.60) and significant loadings are presented in bold. After a reliability analysis to assess the internal consistency, a decision was made to eliminate the factors and items with non-significant loadings (see Table 50 - Annex 3) and change the factor structure. The following changes were made:

- Maintain the 4 items for *intention to use*;
- Maintain the 4 items for *perceived usefulness*;
- Maintain the 4 items for *perceived ease-of-use*;
- Eliminate Q18 in the *trust*;
- Maintain the 4 items for *reliability*;
- Eliminate the factor perceived *safety*;
- Maintain the 4 items for *subjective norm*;
- Eliminate factor *facilitating conditions*;
- Eliminate Q7. in *self-efficacy*;

[2] The model chi-square (χ^2), CFI, RMSEA are SRMR are measures of model fit. They are used to verify how well a dataset fits into a pre-specified model. For χ^2 a value < 0.05 is considered indicative of significance and thus, acceptable. For CFI a cut-off criterion of CFI > 0.95 is normally agreed. For RMSEA, values < 0.08 are considered good. Regarding SRMR, values < 0.05 are normally considered as an indication of a good fit. See [31] for further details.

- Eliminate Q24 in *anxiety*;

Following these changes, the model was refitted with the calibration sample using the same method. Obtained parameters were significant χ^2 (349) = 541.689, p < 0.001. In this case, *RMSEA* (0.067) and *SMRS* (0.067) were more acceptable although *CFI* (0.893) was still not satisfactory. The loadings for each factor are presented in Table 50 (Annex 3). As it can be observed, most of them are greater than the previous one.

Taking into consideration the second part of the sample (validation sample) composed by 196 respondents, this second model was tested. Similar results were found in this validation sample. Again, parameters were significant χ2 (349) = 605.599, p < 0.001, but *CFI* (0.81) was still not satisfactory while *RMSEA* and *SRMR* were acceptable (0.071 both).

To study if the model fit would be similar for the completed dataset, a confirmatory factorial analysis of this second model was tested in the total sample. Thus, the eight-factor structure was analysed with the 396 participants. As it can be pointed out in Figure 3, all the loadings are higher than 0.50, even over 0.70 for factors as *intention to use*, *trust* or *anxiety*. *CFA* with the total sample provided good fit indexes. The χ^2 was significant (χ^2 (349) = 793.047, p < 0.001). *CFI* was good with a value of 0.91. Moreover, *RMSEA* (0.056) and *SRMR* (0.056) were both under 0.060.

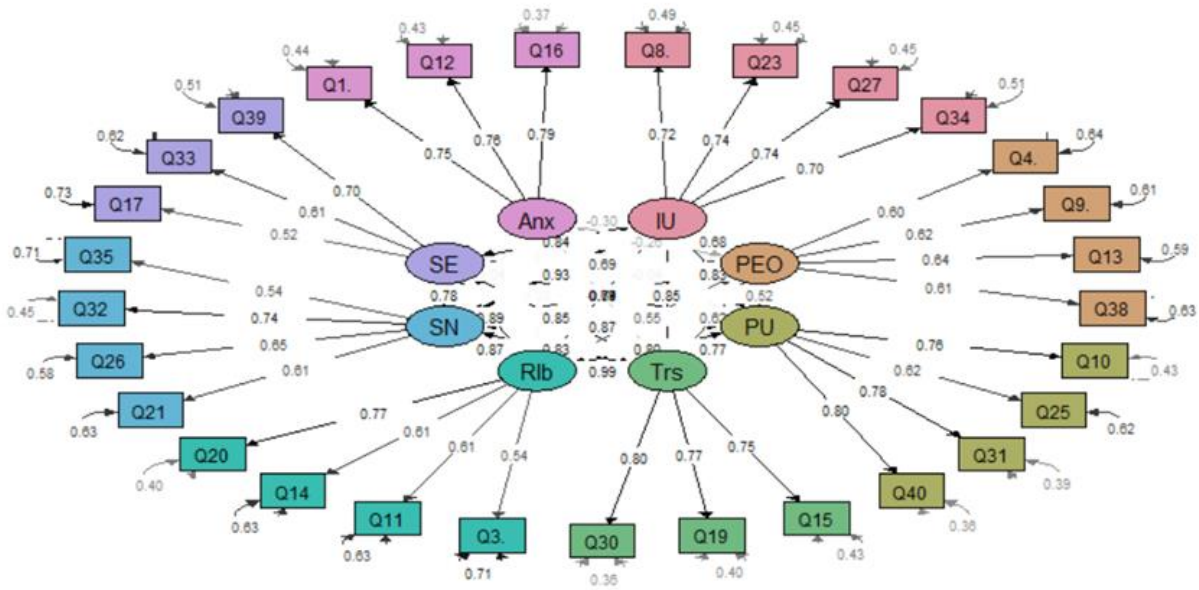


Figure 3: CFA Estimations for second structure model with total sample (Study I)

Based on the results of the analysis, a decision was made to maintain this second factorial structure. For the sake of simplicity, the three items with the higher loadings of each factor were selected to integrate the final instrument. The internal consistency of these items was generally good as indicated by the *Cronbach's Alpha*

(Table 3), with only the construct *self-efficacy* fairing below 70% (values between 60% and 70% are normally considered as questionable, but not unacceptable. Given the novelty of the domain and the not large sample size, an option was made to maintain the *self-efficacy* questions).

When using the UAAD, for each set of collected answers, a mean value of each construct is calculated by averaging the rating given for the three corresponding questions. Thus, for a given participant answering the questionnaire for a specific user-story, a total of eight values will be calculated.

Table 3: Final structure model detailing the questions of the UAAD. Cronbach's Alpha is presented for each construct

Construct	Attribute	Cronbach's Alpha
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	82%
	If it is available, I plan to use the automated vehicle in the future.	
	Assuming I have access to an automated vehicle, I intend to use it.	
Trust	Overall, I could trust the automated vehicle.	82%
	I would feel confident using the automated vehicle.	
	I would trust the automated vehicle while driving.	
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	62%
	I could reach my destination using the automated vehicle even if I had no assistance.	
	I would feel confident using the automated vehicle because I understand clearly how to use it.	
Reliability	I believe that an automated vehicle would be free of error.	72%
	I believe that automated vehicles will perform consistently under a variety of circumstances.	
	I believe that I could rely on automated vehicles.	
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	71%
	I would find the automated vehicle easy to use.	
	I would find it easy to get the automated vehicle to do what I want it to do.	
Anxiety	The automated vehicle is somewhat intimidating to me.	81%
	I would hesitate to use the automated vehicle for fear of making mistakes.	
	Driving with the automated vehicle would make me feel nervous.	
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	83%
	I would find the automated vehicle useful in my daily life/work.	
	Using the automated vehicle would increase my travel comfort.	

Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	74%
	I would be proud to say to people that are close to me that I use the automated vehicle.	
	I would recommend the automated vehicle to my family or friends to use.	

2.4 ATI scale

Beyond the UAAD scale, several of the evaluations reported here make use of the Affinity for Technology Interaction (ATI) scale to control for a tendency and/or enthusiasm of participants to engage with technology, a factor that is known to affect acceptability. This is a widely used psychometric scale that evaluates a user's proneness to interact with technological artefacts [14]. It is a nine-item scale, where each item is answered in a 1 – 6 scale (1 – completely disagree; 6 – completely agree). The following items are part of the questionnaire:

1. I like to occupy myself in greater detail with technical systems.
2. I like testing the functions of new technical systems.
3. I predominantly deal with technical systems because I have to.
4. When I have a new technical system in front of me, I try it out intensively.
5. I enjoy spending time becoming acquainted with a new technical system.
6. It is enough for me that a technical system works; I don't care how or why.
7. I try to understand how a technical system exactly works.
8. It is enough for me to know the basic functions of a technical system.
9. I try to make full use of the capabilities of a technical system.

The final rating of the scale is obtained by inverting the answer to negatively worded items (3,6,8) and then computing a global mean.

2.5 KPIs for user evaluation

Following the validation and considering the several constraints experienced during the trials the KPIs initially proposed in deliverable D2.5 [1] and D5.1 [2] had to be reviewed, with a few being discarded. Table 4 summarizes and explains the changes.

Table 4: Summary of user acceptance KPIs

Class	ID	Description	Notes
General Technology Acceptability metrics	UA-M1.1	Acceptance Intention (statement of interest)	Corresponds to the *intention to use* construct of UAAD; Collected for all user-stories.
	UA-M1.2	Perceived Technology Usefulness	Corresponds to the *perceived usefulness* construct of UAAD; Collected for all user-stories.
	UA-M1.3	Perceived Technology Ease-of-use	Corresponds to the *perceived ease-of-use* construct of UAAD; Collected for all user-stories.
	UA-M1.4	Affinity for Technology Interaction	Collected through an additional survey, for the participants that took part on the trials and the online interviews
	UA-M 1.5	Acceptability difference between prior and post-contact with technology	Calculated for the participants that took part in the trials;
Trust on the System metrics	UA-M2.1	Perceived Safety	Discarded given that no relevant difference was found to the perceived trust, during validation;
	UA-M2.2	Perceived Trust	Corresponds to the *trust* construct of UAAD; Collected for all user-stories
	UA-M2.3	Perceived Reliability	Corresponds to the *perceived reliability* construct of UAAD; Collected for all user-stories
Systems Usability metrics	UA-M3.1	General usability metric	KPI not collected, because the participants had no opportunity to interact directly with the technology (they were merely observers). *Perceived ease-of-use* can be considered as the closest approximation to the initial purpose of the KPI, but based on self-reporting of the participant.
	UA-M3.2	Effectiveness	KPIs not collected, since they were based on objective metrics measured from the interaction. The participants had no opportunity to interact with the system.
	UA-M3.3	Efficiency	
	UA-M3.4	Satisfaction	

			Perceived reliability can be considered as the closest approximation to the initial purpose of the KPI, but based on self-reporting of the participant.
Error tolerance metrics	UA-M4.1	Error dealing effectiveness	KPIs not collected. The participants had no opportunity to interact with the system and to make errors.
	UA-M4.2	Error dealing efficiency	
	UA-M4.3	Error dealing satisfaction	

Yellow cells correspond to KPIs not collected directly but that can be replaced by others. Red cells are KPIs not collected and that cannot be replaced.

2.6 Conclusion

The next sections (3 – 6) describe in detail how the methods presented were applied to the several user-stories and the results of the evaluation. Section 7 provides a general summary and discussion of the results of the different sections.

3 ADVANCED MANOEUVRES

This chapter is divided into two sections. The first (3.1) refers to the first attempt to do evaluation of the advanced manoeuvres user-stories by conducting trials in which test participants took part in real-world tests. Only the local trials involving participants at ES were conducted, as technical and logistical issues prevented the remaining one from being completed. Following the impossibility of successfully completing this real-world based assessment, a second methodology was developed based on online interviews. This is described in section (3.2).

3.1 Real world evaluation

The goal of this evaluation was to assess the degree of user acceptability regarding the "Interurban complex scenarios" user-story and how they are affected by the x-border context. To do so, participants were expected to take part on (1) local trials, with no network handover (no border handover) and in (2) x-border trials, where handover was expected. In both situations an assessment of their experience was expected to be provided. The goal was to compare the assessments and verify (1) their general acceptability towards the user-story (first evaluation) and (2) how the border affects the acceptability (second evaluation in comparison with the first).

The evaluation was planned to be composed of three phases (see Figure 4):

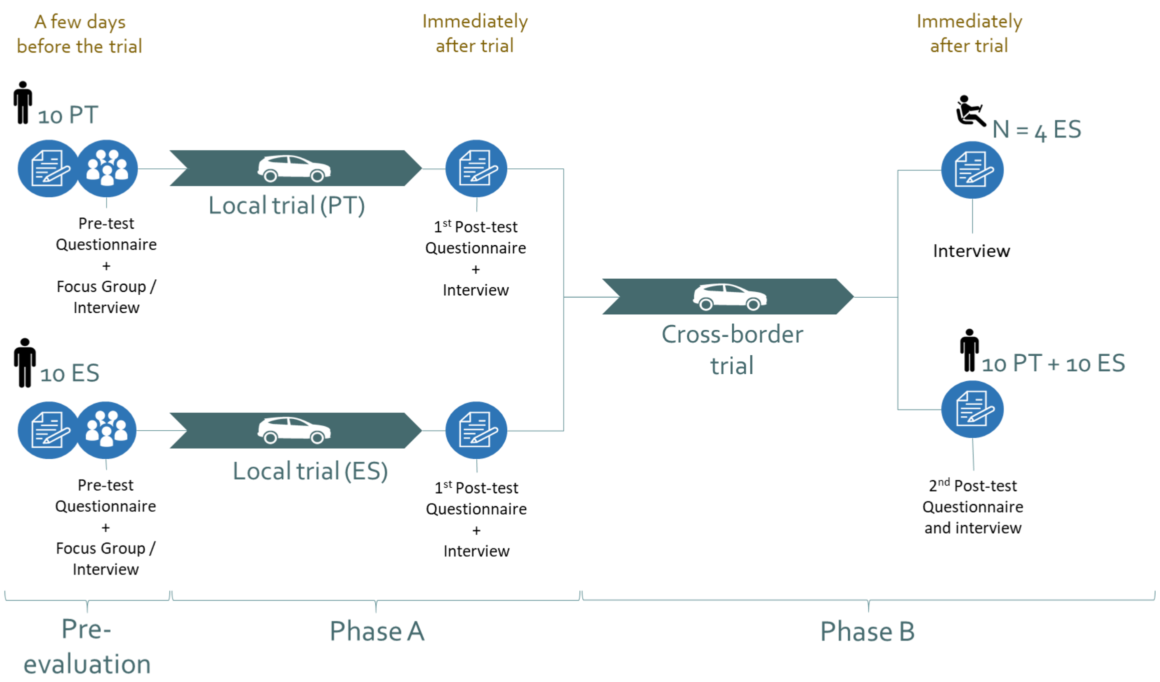


Figure 4: Diagram of the real-world evaluation

Pre-evaluation: During this phase participants filled the UAAD and took part either on a focus group or in an individual interview (depending on availability), both of which were aimed at presenting the user-stories and explore their expectations regarding Autonomous driving technology and the concrete user-story.

Phase A: This was the first phase of the evaluation. Participants took part in the local trial and afterwards filled in the UAAD and answer a set of open questions.

Phase B: This was the second phase of the evaluation. Participants would take part in the x-border trial and afterwards fill in the UAAD and answer another set of open questions. As mentioned in section 2.2, this phase was not conducted.

3.1.1 Methodology

3.1.1.1 *Technical implementation*

Local trials were done in a closed road in Spain. No handover occurred. From the technical point-of-view, trials were successful, with the technical KPI measurements reaching their target values (with the exception of throughput, which was lower, due to the low requirements placed by ETSI messages (see deliverable "D5.2 – Technical Evaluation" for further details [15]). Observable vehicle behaviour was in accordance with the planned user story flow (corresponding to the best-case scenario described in section 2.2).

3.1.1.2 *Participants*

Spanish participants were selected by internal recruitment from the CTAG workers (due to insurance policies). Selection requirements to be fulfilled were: no previous knowledge of the project and a valid driving license in the moment of taking part in the trials. A total of 24 participants took part in one of the 3 different local trials for testing ***Overtaking***, ***LaneMerge*** and ***HDMapsVehicle*** conditions. Table 5 summarizes the main characteristics for the profile of the sample for the three Spanish local trials.

Table 5: Demographic data of the participants taking part on the advanced manoeuvres' trials

		Overall	Lane Merge	Overtaking	HD Map
		24	7	10	7
Gender	Female	4	3	0	1
	Male	20	4	10	6
Age	18-30 Years	11	5	2	4
	31-40 Years	12	2	7	3
	41-60 Years	1	0	1	0

Do you have a valid driving license?	I don't have a driving license	0	0	0	0
	Yes, and I drive often	24	7	10	7
	Yes, but I rarely drive/ don't drive	0	0	0	0
How long has driving license?	less than 5 years	3	1	0	2
	5 -14 years	9	4	3	2
	15 - 24 years	5	2	0	3
	more than 24 years	7	0	7	0
Have you ever tried an autonomous vehicle?	No	14	5	8	1
	Yes	10	2	2	6
Have you ever driven an automatic gear vehicle?	No	7	2	2	3
	Yes	17	5	8	4

Figure 5 shows the mean values of the answers for the ATI scale for all the sample using a radar chart. Generally, the scores were high, with most answers around 5 (scores are between 1 and 6), indicating high propensity to interact with technology. The item with the lowest value was: "I predominantly deal with technical systems because I have to" (M = 4.30). The individual ATI scores for the three user-stories (lane merge, overtaking and HD-Maps) can be found individually in Annex 4.

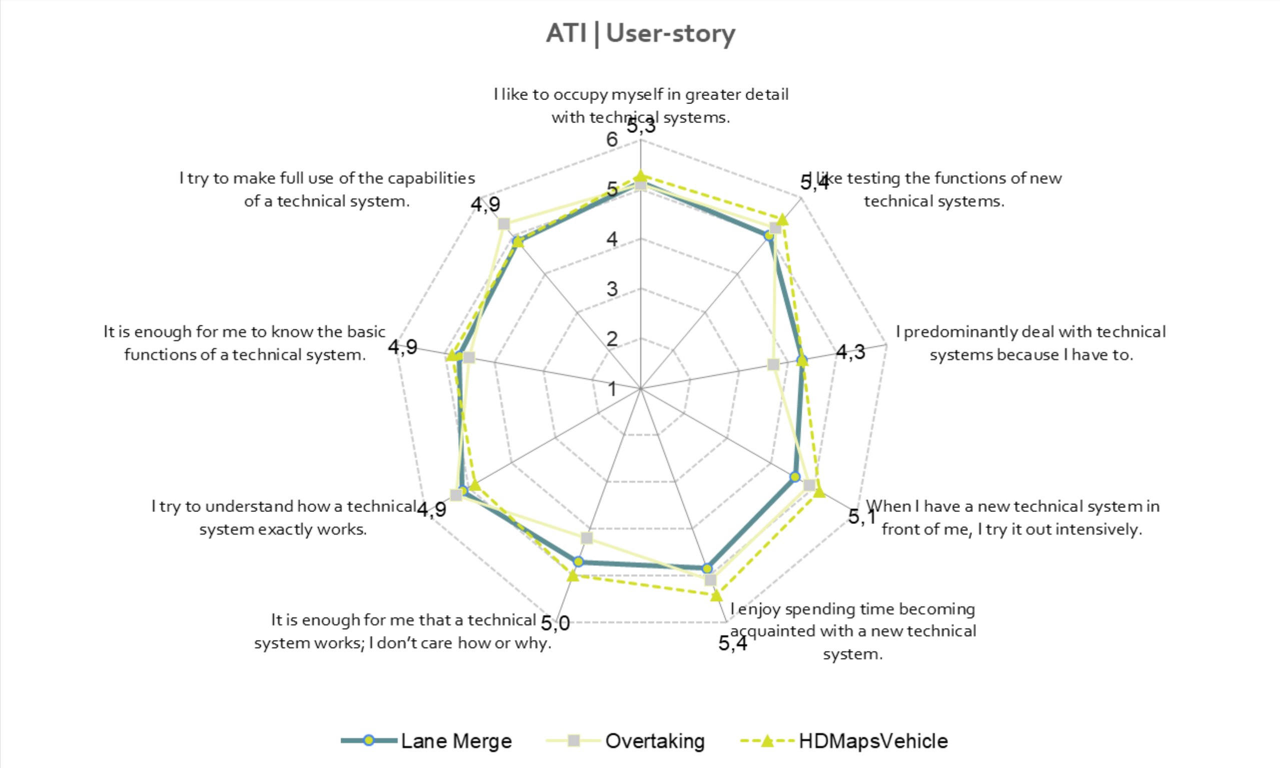


Figure 5: Radar chart for ATI answers (Spain Local Trials)

3.1.1.3 Procedure for focus groups and interviews

Before participating in the study all participants signed the informed consent and doubts about their participation were answered before joining. As it was indicated in the previous diagram of the real-world evaluation (Figure 4), a pre-evaluation was conducted before the participants could test the functions in real settings. In this pre-evaluation participants filled in a questionnaire to provide data for creating the profile of the sample. They were then selected according to their convenience to participate in either a focus group session or an individual interview to know their expectations and opinions about autonomous vehicles, and to get feedback on the different use cases. Both activities, focus groups and interviews were done online. Thus, in each user story there were participants that took part in the focus group, interviews or both activities. For the post-test, only online interviews were conducted. The next table summarizes the number of interviews and focus group for each user story.

Table 6: Summary of Interviews & Focus Group by User-Story

User Story	PRE-TEST		POST-TEST	
Lane Merge	INTERVIEWS	7 Participants	INTERVIEWS	8 Participants
	FOCUS GROUP	--	FOCUS GROUP	--
HD-Maps	INTERVIEWS	1 Participant	INTERVIEWS	9 Participants
	FOCUS GROUP	6 Participants	FOCUS GROUP	--
Overtaking	INTERVIEWS	4 Participant	INTERVIEWS	7 Participants
	FOCUS GROUP	6 Participants	FOCUS GROUP	--

3.1.1.4 *Procedure for local trials*

All the Spanish local trials took place at night due to the need to close the roads to regular traffic. A professional driver was in charge of the autonomous vehicle, mainly in case, it was necessary to take over control, as participants were not allowed to drive.

Local trials with participants were performed in the following dates: ***LaneMerge*** Local trials in November 2021 (w44), ***Overtaking*** in September 2021 (W39) and October 2021 (W43) and ***HDMapsVehicle*** trials in September 2021 (w39).

All participants waited at the CTAG facilities until the scenario and the User Story was ready to be trialled. Participants were divided into groups of three/four people. When the testing setup was ready, each group was transported to the trial area and split between two cars. Two participants went in the autonomous vehicle to have the experience of being inside and to be able to see the information displayed on the instrument cluster that was available to the autonomous vehicle driver (passengers changed their position in the rear seats from right to left and vice-versa, between trials). The other two participants (or one in the case of 3 participants group) travelled in the other car which took part of the user story scenario to have a different view of the situation. The order by which participants were assigned to the cars was counterbalanced. All participants experience 6 rounds of the trial (left rear seat [2x]; right rear seat [2x];

other car [2x]). After the test the participants filled in the post-test questionnaire and had a post interview in the next days. Figure 6 shows pictures of the real road world tests with participants.

Figure 6: Pictures of real road where local trials were performed

3.1.2 Results

This section presents the main results for the pre-test interviews and focus groups and the feedback of participants regarding the User-Stories after the trials. Completed information about the information obtained in interviews and focus group can be found in Annex 5.

Most of the participants were experienced drivers with knowledge in Advanced Driver Assistance Systems (ADAS) systems (ACC, SL but also with FCW, Lane Keeping or BSD). They perceive themselves as responsible drivers, contrarily to other drivers they observe on their daily life. The majority of respondents considered that they frequently observe dangerous manoeuvres for the 3 user stories and they considered that the autonomous car could be a way to improve the situation.

Figure 7 presents the mean score of constructs of the UAAD survey for the ***LaneMerge*** User-Story before and after testing the autonomous vehicle in this scenario. In this case, all averages scores are above 3 points (except for *anxiety* construct which has a score around 2 points). There is a trend of scoring increase for *intention-to-use*, *perceived ease-of-use*, *trust* and *subjective norm*. The same mean score before and after was obtained for *perceived usefulness*. Besides, scores have reduced for *self-efficacy*, *reliability* and *anxiety* (score drop from 4.19 to 2.05).

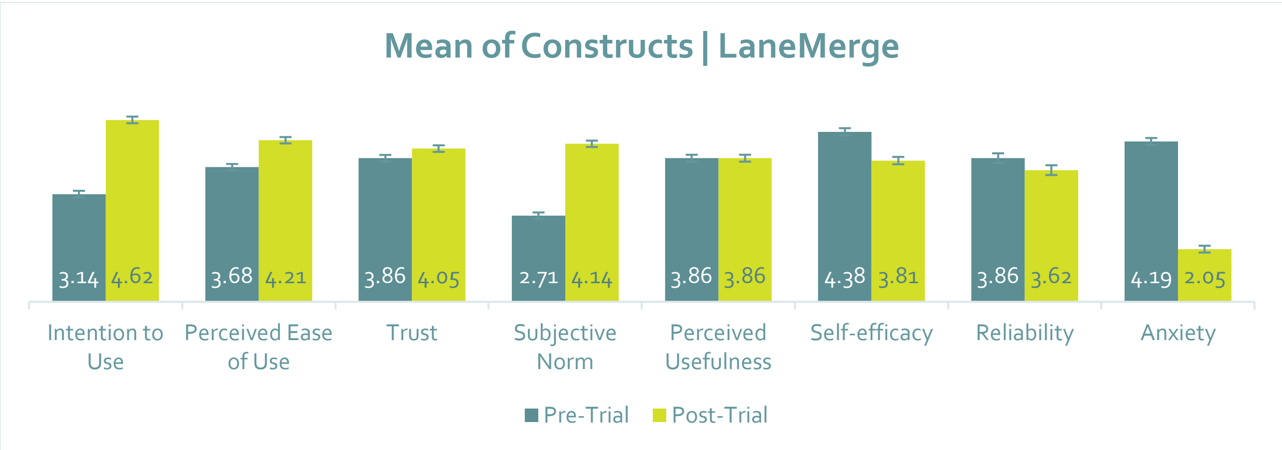


Figure 7: Mean of Constructs for Lane Merge (Spanish Local Trials)

Regarding the ***Overtaking*** manoeuvre, participants scores were lower than for the ***LaneMerge*** manoeuvre (Figure 8). The lowest values were given for *reliability* (pre-test: 3.30 and post-trial: 2.85) and *anxiety* (pre-trial: 2.42 and post-trial: 2.48) constructs. The factor with the highest value is *perceived ease-of-use* (pre-trial: 4,00 and post-trial:4.08). Scores increased after testing the manoeuvre for all the factors except for *trust* and *reliability* but, in any case, this increase is minimal.

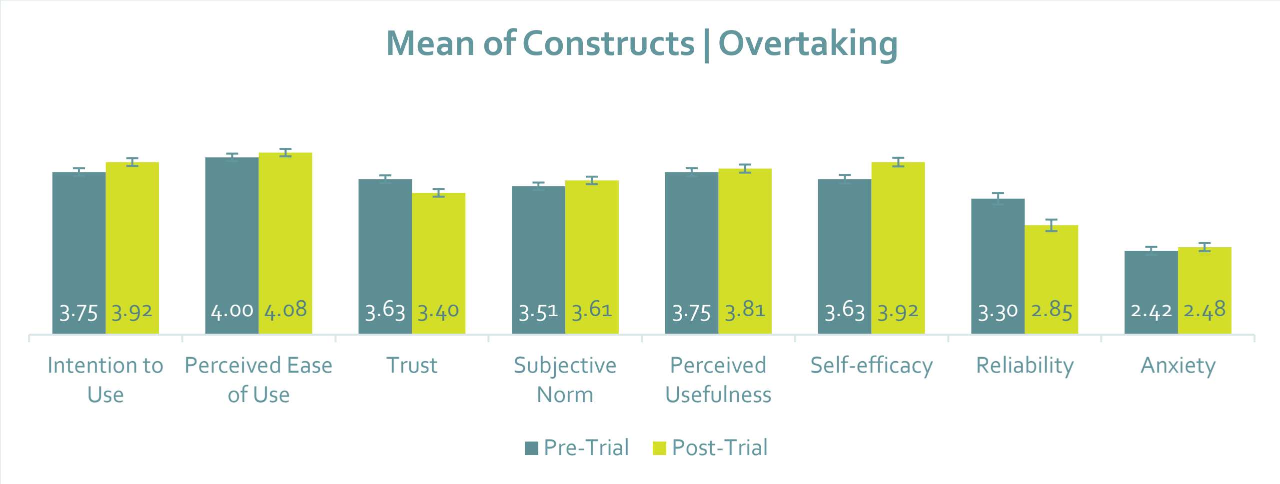


Figure 8: Mean of Constructs for Overtaking (Spanish Local Trials)

Finally, scores for the ***HDMapsVehicle*** (Figure 9) had the lowest values for the *anxiety* construct (it has decreased after testing this User-Story from 2.10 to 1.71). All the other factors evaluated have been increased after the trial in real road. The highest scores after the test were for *intention-to-use* (4.29), *perceived ease-of-use* (4.25), *trust* (4.05) and *perceived usefulness* (4.29).

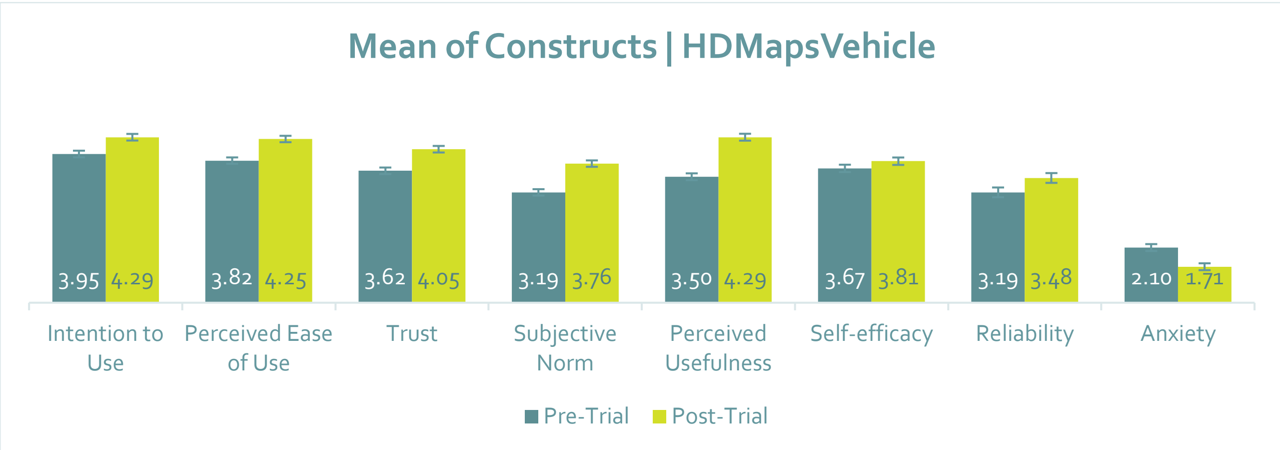


Figure 9: Mean of Constructs for HDMapsVehicle (Spanish Local Trials)

3.1.2.1 User acceptance KPIs

The following tables summarize the KPIs collected for the different user stories and conditions (pre-trial and post-trial).

Table 7: Summary of KPIs for the *LaneMerge* user story

ID	Description	Results						
		Cond.	Mean	STD	MAX	MIN	Perc 95	CI95%
UA-M1.1	Acceptance Intention (Intention to use)	Pre	3.1	0.6	4.3	2.3	4.0	2.7 – 3.6
		Pos	4.6	0.3	5	4	5	4.3 – 4.9
UA-M1.2	Perceived Technology Usefulness	Pre	3.8	0.9	5	2.5	4.8	3.2 – 4.5
		Pos	3.8	0.9	5	2	4.8	3.2 – 4.5
UA-M1.3	Perceived Technology Ease-of-use	Pre	3.7	0.9	5	2.5	4.8	3.0 – 4.3
		Pos	4.2	0.5	4.7	3.2	4.7	3.8 – 4.6
UA-M1.4	Affinity for Technology Int eraction	-	4.2					
UA-M 1.5	Acceptability difference (Post-pre)	-	1.5	0.7	2.3	0	2.2	0.9 – 2.0
UA-M2.2	Perceived Trust	Pre	3.8	0.6	4.7	3	4.6	3.4 – 4.3
		Pos	4.0	0.6	5	3	4.9	3.6 – 4.5
UA-M2.3	Perceived Relia bility	Pre	3.8	0.7	5	27	4.8	3.3 – 4.4
		Pos	3.6	0.6	4.7	2.7	4.5	3.1 – 4.1

Table 8: Summary of KPIs for the *Overtaking* user story

ID	Description	Results						
		Cond.	Mean	STD	MAX	MIN	Perc 95	CI95%
UA-M1.1	Acceptance Intention (Intention to use)	Pre	3.75	1.1	5	1.7	5	3.1 – 4.4
		Pos	3.9	1.0	5	2	5	3.2 – 4.7
UA-M1.2	Perceived Technology Usefulness	Pre	3.7	0.9	5	2.3	5	3.2 – 4.3
		Pos	3.8	0.8	5	2.3	4.9	3.2 – 4.4
UA-M1.3	Perceived Technology Ease-of-use	Pre	4	0.6	4.7	2.7	4.6	3.7 – 4.3
		Pos	4.1	0.7	4.7	2.7	4.7	3.6 – 4.6
UA-M1.4	Affinity for Technology Int eraction	-	4.3					

UA-M 1.5	Acceptability difference (Post-pre)	-	0.2	1.3	2.3	-1.3	2.2	-0.6 – 1.1
UA-M2.2	Perceived Trust	Pre	3.6	1.1	5	1.7	5	3.0 – 4.3
		Pos	3.4	1.0	5	2	4.9	2.7 – 4.1
UA-M2.3	Perceived Relia bility	Pre	3.3	1.1	5	2	5	2.7 – 3.9
		Pos	2.8	0.7	4	2	3.9	2.4 – 3.3

Table 9: Summary of KPIs for the *HDMapsVehicle* user story

ID	Description	Results						
		Cond.	**Mean**	**STD**	**MAX**	**MIN**	**Perc 95**	**CI95%**
UA-M1.1	Acceptance Intention (Intention to use)	Pre	3.9	1	5.0	2.3	5.0	3.2 – 4.7
		Pos	4.3	0.8	5.0	3.0	5.0	3.7 – 4.9
UA-M1.2	Perceived Technology Usefulness	Pre	3.5	0.9	5.0	2.0	4.7	2.8 – 4.2
		Pos	4.3	0.7	5.0	3.0	5	3.8 – 4.8
UA-M1.3	Perceived Technology Ease-of-use	Pre	3.8	0.4	4.25	3.2	4.2	3.5 – 4.1
		Pos	4.2	0.3	4.75	3.7	4.7	4.0 – 4.5
UA-M1.4	Affinity for Technology Int eraction	-	4.2					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.3	1.5	2.66	-1.3	2.4	-0.8 – 1.4
UA-M2.2	Perceived Trust	Pre	3.6	0.6	4.33	2.7	4.2	3.2 – 4.0
		Pos	4.0	0.7	5	3	4.9	3.5 – 4.6
UA-M2.3	Perceived Relia bility	Pre	3.2	0.4	4	2.7	3.8	2.9 – 3.5
		Pos	3.5	0.6	4	2.33	4.0	3.0 – 3.9

3.1.3 Discussion

Only a few drivers could test the autonomous vehicle in real road world conditions. Safety was the most important premise for the trials, reason why participants were not allowed to experience the driver position and also why all the trials were performed at night in close roads. Since the overall number of participants was reduced no statistical analysis were carried out to assess statistically significant differences among the pre and post-trial evaluation. Consequently, this evaluation only provided some exploratory feedback from users. It also offered insights for the interpretation of the online interviews (to be presented next). As explained before, online interviews were selected as an alternative in view of obtaining further information, for the Advanced manoeuvres user stories.

Regarding the post-trial scores obtained, one can observe substantial differences between the three user stories, which may be due to the limited number of participants that took part in the trials. Still scores were in general positive, except for the *anxiety* construct (the value was higher for the ***LaneMerge*** user story, but only in the pre-evaluation). In fact, in the post-interviews, participants expressed that they did not feel anxious using self-driving vehicles. Still, as noted by Lemercier et al. [16] it is essential to work on knowing the emotional and cognitive considerations for reducing anxiety consequences on self-driving cars passengers, mainly for those who do not have a technical profile.

The ***Overtaking*** User Story presented more moderated scores for the factors. In the focus group and interviews, participants stated they considered this action to be one of the most dangerous manoeuvres when driving, not only due to the influence of the human factor (e.g., age) but also for the effect of the state of the infrastructure conditions [17], [18].

Nevertheless, and overall, most participants considered the experience as positive and stated their belief that self-driving is the future of mobility. Still, improvements are necessary for some autonomous features and for the infrastructure, not only roads, but also on advanced connectivity among cars and infrastructure. They also stated that using 5G connectivity will mean more and faster information for this kind of autonomous systems.

3.2 Online Interviews

Given the difficulty in conducting user-evaluation in the real-road scenario an alternative approach was devised which aimed to evaluate the "*Interurban complex scenarios*" user-story and how they are affected by the x-border context. In general terms, the approach consisted of individual online interviews, in which each participant was confronted with one of the three different user-stories/scenarios, presented through specially developed video simulations and then asked to rate the situations using the UAAD instrument (see section 2.3). For each participant the user-story was presented in different scenarios. For the advanced manoeuvres and lane change, three network scenarios (Best - BE, Average - AV and Worst - WO) were presented in three different animations. For the ***HDMapsVehicle***, two network scenarios were presented (Best and Worst). For each scenario the participant was asked to fill in the UAAD instrument. Beyond the numerical dimension, qualitative insights were also collected and analysed regarding each of the KPIs.

3.2.1 Methodology

3.2.1.1 Participants

62 Participants took part in the study (24 women and 38 men) with the age distribution shown in Table 10. Among the participants, there were 41 Portuguese, 18 Spanish, 2 Iranians and 1 Pakistani. All participants had driving licenses obtained between less than 1 year and 37 years (M = 15.2; SD = 9.1). The variability of the participants' basic degrees is relevant, with most from the STEM areas (66%) while others have degrees such as Economics, Sociology, Geography, Design, Architecture, Veterinary, Psychology, Accounting and Social Communication. Participants were distributed by the three scenarios evaluated, ***LaneMerge*** (19), ***Overtaking*** (19) and ***HDMapsVehicle*** (24).

Table 10: Demographic data of participants – online interviews

		Overall	Lane Merge	Overtaking	HD Map
		62	19	19	24
Gender	Female	24	6	8	10
	Male	38	13	11	14
Age	18-30 Years	28	11	7	10
	31-40 Years	17	3	6	8
	41-60 Years	17	5	6	6
Do you have a valid driving license?	I don't have a driving license	1	0	1	0
	Yes, and I drive often	55	17	17	21
	Yes, but I rarely drive/ don't drive	6	2	1	3
	less than 5 years	5	2	1	2

How long has driving license?	5 -14 years	29	9	9	11
	15 - 24 years	16	4	5	7
	more than 24 years	12	4	4	4
Have you ever tried an autonomous vehicle?	No	38	12	14	12
	Yes	24	7	5	12
Have you ever driven an autonomous vehicle?	No	36	10	13	13
	Yes	26	9	6	11

3.2.1.2 *ATI evaluation*

Figure 10 shows the mean values of the answers for the ATI scale. Generally, the ratings were high, with most answers above 4. Mean value was 4.5. with Cronbach's Alpha = 81.9%. Overall, the participants had a medium-to-high affinity for technology interaction.

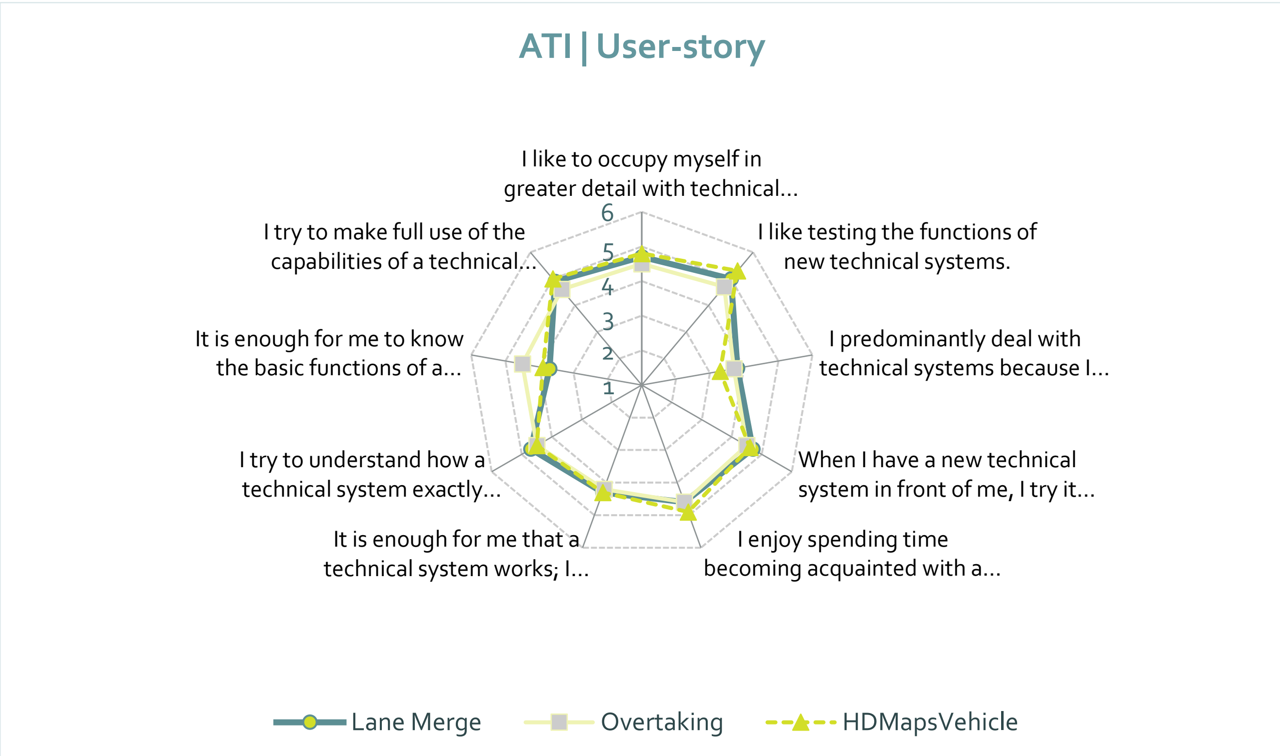


Figure 10: ATI answers for the online interviews

3.2.1.3 *Video animations*

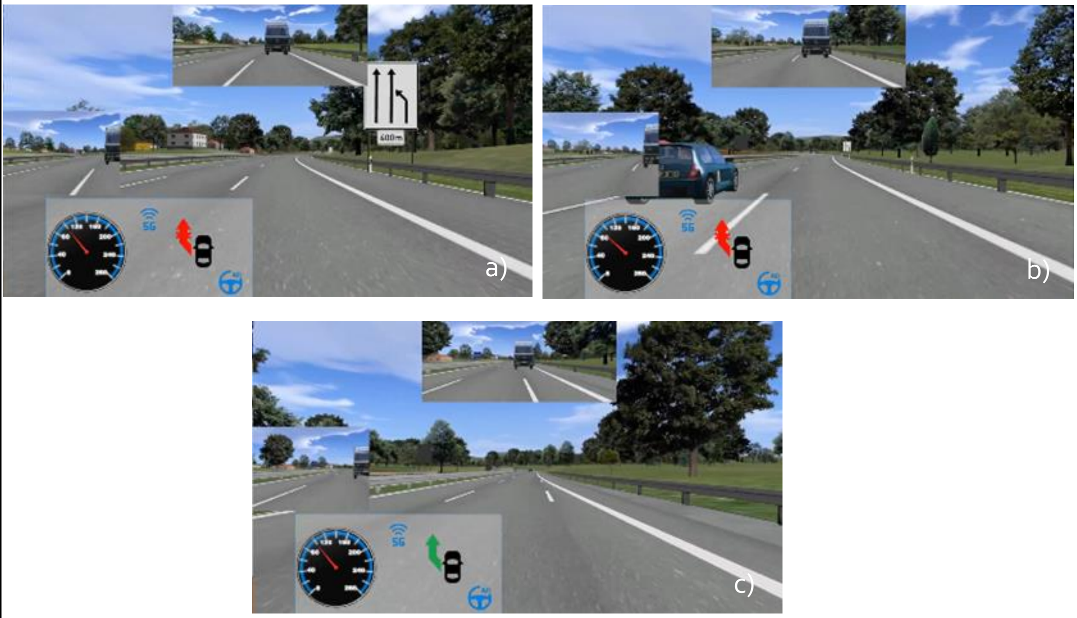
The video animations were developed using the SILAB software, developed by WIVW GmbH. This software's purpose is to design and test scenarios for driving simulators and it is used in several research areas such as ergonomics, vehicle component design, traffic-related scientific investigation, etc. In this case, the software was used to create animations of an automated vehicle driving from the point-of-view of the driver (see Figure 11).

Figure 11: Snapshot of the animations produced with the SILAB software

The "storylines" of the animations differed, depending on the condition which they aimed to represent. Table 11 presents a short description of each of the animations. In each animation the scenarios were developed to replicate a border context in a highway/motorway, including graphical elements such as road signs and markings, landscape (hills and mountains, trees, houses) and other road users (light and heavy vehicles). Sound is also simulated. The road layout, such as the shape and length of the tracks, lane merges and roadworks, was specifically designed for each "storyline". Road users around the vehicle follow a scripted behaviour according to its position and velocity. The automated vehicle uses a developed Automated Driving algorithm that simulates up to level 4 automated driving (lane control, adaptative cruise control and intelligent overtaking), and most of its behaviour is also scripted to follow the "storyline". A Head-Up display (HUD) was depicted for all animations. The elements and icons on the HUD were designed according to the conditions of each advanced manoeuvre. These simulations were recorded and converted into a playable video format (videos can be found here).

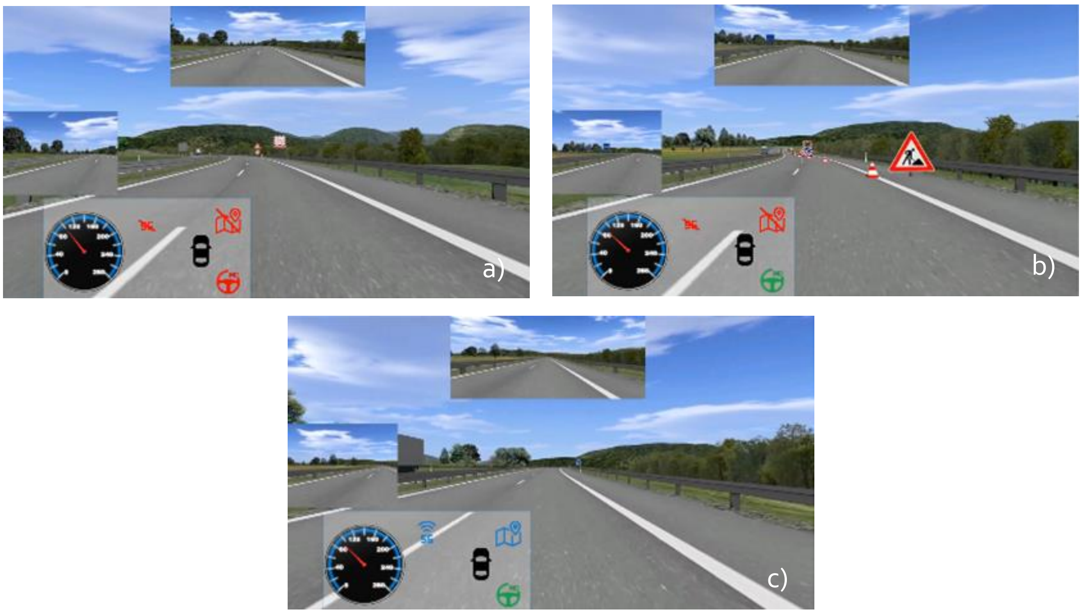
Table 11: Description of the action depicted on the simulations

LaneMerge	
Best connectivity	The car is in autonomous mode and the 5G network is fully available. During the journey, the vehicle receives the information that the number of lanes will change from 3 to 2 lanes, meaning that the lane in which he is travelling will disappear. The vehicle's autonomous system is in communication with the approaching car, and although the truck is blocking its sensors, it delays the lane merge manoeuvre [a)],

	waiting for the other car to pass by [b)]. Then it performs the manoeuvre to safely enter the next lane [c)].
	
Average connectivity	The car is in autonomous mode and the 5G network is intermittent. During the journey, the vehicle receives the information that the number of lanes will change from 3 to 2 lanes, meaning that the lane in which he is travelling will disappear. The truck is blocking the vehicle sensors and the cars are communicating but with failures due to the intermittent network [a) and b)]. It senses another car only when it tries to make the manoeuvre and then it decides to abort it returning to its previous lane. After that, with a clear view of the road it performs the manoeuvre [c)].
	

Worst connectivity	The car is in autonomous mode and the 5G network is unavailable [a)]. During the journey, the vehicle observes that the number of lanes will change from 3 to 2 lanes, meaning that the lane in which he is travelling will disappear. The truck is blocking the vehicle sensors, preventing it from receiving information concerning other vehicles in the target lane. The vehicle stops at the end of the lane so the truck passes by until it has a clear view of the road. Only then it changes lane [b)].
	 
Overtaking	
Best connectivity	The car is in autonomous mode and the 5G network is fully available. The vehicle is moving faster than the vehicles in the same lane in front and following behind it, there is a truck that occludes the vehicle sensors. However, the vehicle receives shared information regarding other vehicles, decides to delay an overtaking manoeuvre for another car to pass by [a)] and then, performs the manoeuvre [b)].
	 
Average connectivity	The car is in autonomous mode and the 5G network is intermittent. The vehicle is moving faster than the vehicles in the same lane in front and following behind it, there is a truck that occludes the vehicle sensors. The vehicle receives delayed information regarding a vehicle on the left lane that is approaching, and it starts changing lanes. When it detects the approaching vehicle through its own sensors, it decides to cancel the manoeuvre returning to its previous lane [a)]. It then slows down and follows the front car until it has a clear view of the road. Then it performs the overtake [b)].

	
Worst connectivity	The car is in autonomous mode and the 5G network is unavailable [a)]. The vehicle is moving faster than the vehicle in the same lane. There is a truck behind it that occludes the vehicle sensors. The car detects the approaching vehicle on the left lane through its own sensors [b)], it slows down and follows the front car. When the truck passes by and the vehicle gets a clear view of the road it overtakes [c)]. 
HDMapsVehicle	
Best connectivity	The vehicle is in autonomous mode, the 5G network is fully available, and it is using High definition (HD) Maps updated from other vehicles [a)]. During the journey the car receives information about some roadworks ahead and navigates autonomously passing by the roadworks area [b)].

	
Worst connectivity	The vehicle is in autonomous mode, the 5G network is unavailable, and it cannot use an HD Map [a)]. When the car detects the roadworks area ahead, it asks the driver to take control of the driving. The car falls back to manual control [b)] and after passing by the roadwork area, the vehicle requests control again. It returns to autonomous driving mode [c)].
	

3.2.1.4 *Procedure*

Each interview began with a stage in which participants were asked a set of open-ended questions to understand their expectations and opinions regarding automated driving and their driver profile. After these introductory questions, they were presented with videos (animations, from the driver point-of-view, as explained above) of one of the three Advanced manoeuvres (***Overtaking***, ***LaneMerge*** or ***HDMapsVehicle***). Each participant observed three or two situations (best case, average case and worst case for ***Overtake*** and ***LaneMerge***; best and worst case for ***HDMapsVehicle***), by a random order. These "cases" correspond to possible outcomes of the user-stories at the border context. Then, participants were asked to do a quantitative assessment through the UAAD instrument after each video. After the three videos (or two for the ***HDMapsVehicle***), participants were asked to answer a second set of open-ended questions addressing each of the constructs of the UAAD. A schematic depiction of the procedure for these interviews is presented in Figure 12.

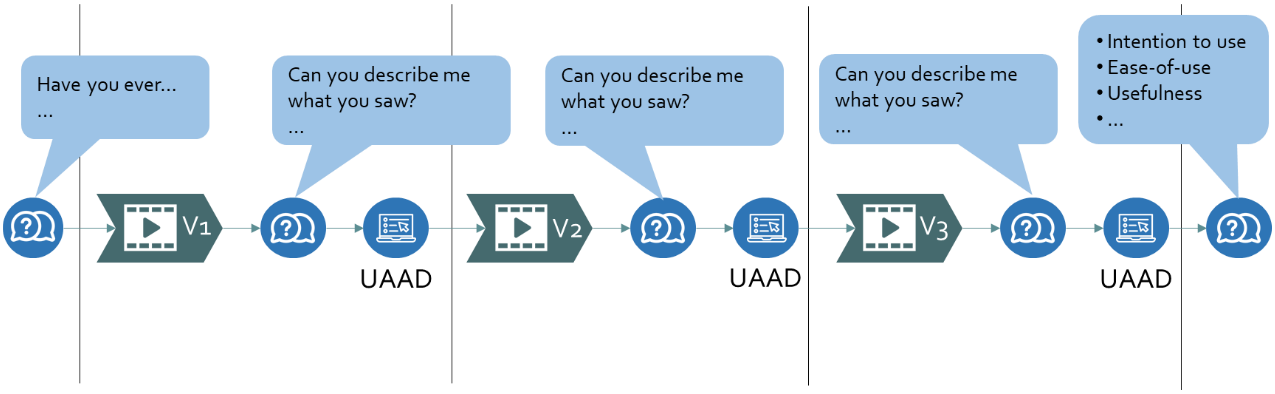


Figure 12: Procedure for the online interviews

3.2.1.5 Data Analysis

UAAD subscales were checked for consistency using Cronbach's Alpha, calculated per construct and user-story. Mean values were calculated for each construct and scenario. For each construct, the effects of scenario were independently analysed. For ***LaneMerge*** and ***Overtaking*** (3-levels scenario) this was done with Friedman rank sum tests[3], followed by post-hoc analysis[4] (when significant) with pairwise Wilcoxon signed-rank tests[5], with Holms corrections[6]. For the ***HDMapsVehicle*** user-story (2-levels scenario) the effect of scenario was analysed using Wilcoxon signed-rank tests. P-values below 0.1 were considered marginally significant and below 0.05 were deemed significant.

Regarding the interviews, the analysis followed an inductive coding approach. A framework was developed in order to organize the contents within a logical thematic structure. The following topics were defined:

- As a driver: Contents related to the behaviour and experiences of the participant as a driver;
- Autonomous vehicle: Content related to the experience, knowledge and expectations of the participants in relation to autonomous vehicles;

[3] Non-parametric statistical test, that assesses the significance of the effect of a factor (in this case, the scenario) for a group of participants. See [32] for additional details.
[4] A follow-up analysis performed after a first statistically significant result. In this case, if a global effect of the scenario is found by the Friedman rank sum test, a post-hoc analysis is done to determine which scenario(s) was(ere) different from the others.
[5] Non-parametric statistical test, for comparing to paired sets of results. The results are paired because each value in a set is related with a value in the other set, since both came from the same participant and thus cannot be considered independent. See [32] for additional details.
[6] A method used to counteract the problem of multiple corrections, by adapting the threshold p-value as a function of the number of tests performed.

- After the videos: Content related to the opinions of the participants about the scenarios presented, considering the differences in vehicle behaviour;
- Constructs: content related to each construct presented in the UAAD.

After organizing the content, in each question of the interview, the speeches of the participants were treated in order to simplify and encode them in key phrases by similarity, making it possible to group and quantify the key ideas in each topic.

3.2.2 Results

This section begins by drawing initial insights, from the first phase of the interviews (intended to understand participants' perception on their driver profile and their expectations and opinions regarding automated driving). It proceeds with an overview of the first impressions communicated immediately after the presentation of the videos. This is followed by individual sections presenting quantitative and qualitative results for each subscale of the questionnaire and finally an analysis of the correlations between scales. The qualitative analysis of each construct is intended to inform possible explanations for the differences found in the ratings and insights for future research. It is mostly constituted by individual statements of the participants, but no statistical validity is attributed to them.

3.2.2.1 Initial insights

Participants as drivers

Most of the participants drive frequently, but for 23% of them, it is not considered a pleasurable activity. Even for the drivers who enjoy this activity, there are some situations that decrease their feeling of pleasure, such as jammed traffic, long and monotonous trips, the bad behaviour of other drivers, and the need to be aware and alert all the time. The most commonly used ADAS are the speed limiter, the Lane Departure Sensor (LDW), the pre-collision sensor, and the Adaptive Cruise Control (ACC). Some ADAS, despite being massively used, still generate some discomfort, such as ACC ("Looks like the car comes to life"), LDW ("*Very sensitive, unnecessarily active*") or Parking sensors ("*Very sensitive, sometimes has more space*", "*Very noisy*"). Regarding avoided behaviours or situations on the road, some participants reported avoiding speeding (18%), driving close to ahead vehicles (15%), using their cell phones while driving (8%), and others mentioned that, when possible, they avoid high traffic routes (8%).

Experiences and expectations regarding autonomous vehicles

Almost half of the participants (42%) reported that they had already had some kind of experience with autonomous vehicles, which may have been through test drives, cars or shuttles at events like trade shows, conferences and research projects. From these participants that have experienced autonomous vehicles, most reported that it was a good experience overall, but 11% reported some concern ("*At the beginning I was a bit afraid because of the need to pay attention to recover control on the vehicle*"). Despite some concerns, 82% of the participants believe that autonomous vehicles could help in some manoeuvres, mainly those in which vehicle-to-vehicle communication is present, giving them predictive abilities.

The biggest advantage stated by the participants was the increase in road safety with fewer accidents due to the proliferation of autonomous vehicles. This would lead to the human driving behaviour withdrawal and road event predictability and unexpected situations prediction ("*The advantage is to eliminate human fatigue and distraction*", "*It is safer, the time reactions are lower than the driver*", "*The autonomous vehicle can predict situations and control speeds and this is very important, it will be prepared for unexpected situations*"). Another relevant advantage pointed out by the participants was regarding the better use of the time for other activities, such as resting or working (*"On long journeys you can optimize what you need to do, you can be more relaxed*"). Conversely, some disadvantages were also pointed out to autonomous vehicles, such as: reducing people's driving skills *("I think more and more people would stop knowing how to drive")*; contributing to distraction states when it is necessary to regain control *("Drivers are more inattentive in unforeseen circumstances")*; and over-reliance on technology (*"Vehicles make decisions fuelled by wrong information*").

3.2.2.2 First impressions of the manoeuvres performed by the autonomous vehicle

After seeing the manoeuvres performed by the autonomous vehicles in the proposed scenarios, the majority of the participants mentioned that they were not surprised or stated that the videos displayed an expected behaviour (60%). Contrarily, 40% of the participants reported that they were surprised at some point with at least one of the videos presented. Of those surprised participants, 28% expressed they were pleasantly surprised by the vehicle, mainly due to its conservative and safe behaviour that prioritizes the safest condition, especially when there was no 5G network (*"When the vehicle ran out of 5G network and decided to wait*"). Another topic that surprised the participants was the vehicles' ability to anticipate situations *("The vehicle was able to predict the approach of a vehicle even without visibility*"). Participants who mentioned being negatively surprised (72%) pointed out unexpected situations regarding the 5G network instability (*"I was surprised when the 5G network became unstable and the vehicle tried to do the manoeuvre*", "*When the vehicle hesitates, it gave me less stability*"; "*I felt a bit nervous when the 5G connections were irregular"*).

When asked about what would they do differently regarding the scenarios and vehicles' behaviour, the majority of the respondents stated that they would not do anything differently (*"I feel good because it [vehicle] is doing it in a proper way").* Others suggested that they would prefer to take over if the 5G network is unstable or unavailable ("*With the network unstable, as a user, it would be a nerve-wracking situation. I would prefer the vehicle to assume that it has no network"*). Despite these unexpected situations, the participants, in general, felt good, safe and enjoyed the experience and the stories portrayed on the videos ("*It was a nice surprise"*, "*It [vehicle] has enough time to deal with the manoeuvre in a safe way"*).

3.2.2.3 *UAAD analysis*

Consistency analysis of the UAAD was generally considered satisfactory. Cronbach's Alpha was at least acceptable (values > 60%) for almost all constructs (see Annex 9). A general presentation of the results can be seen in Figure 13, which presents mean values of the UAAD constructs per user-story and scenario.

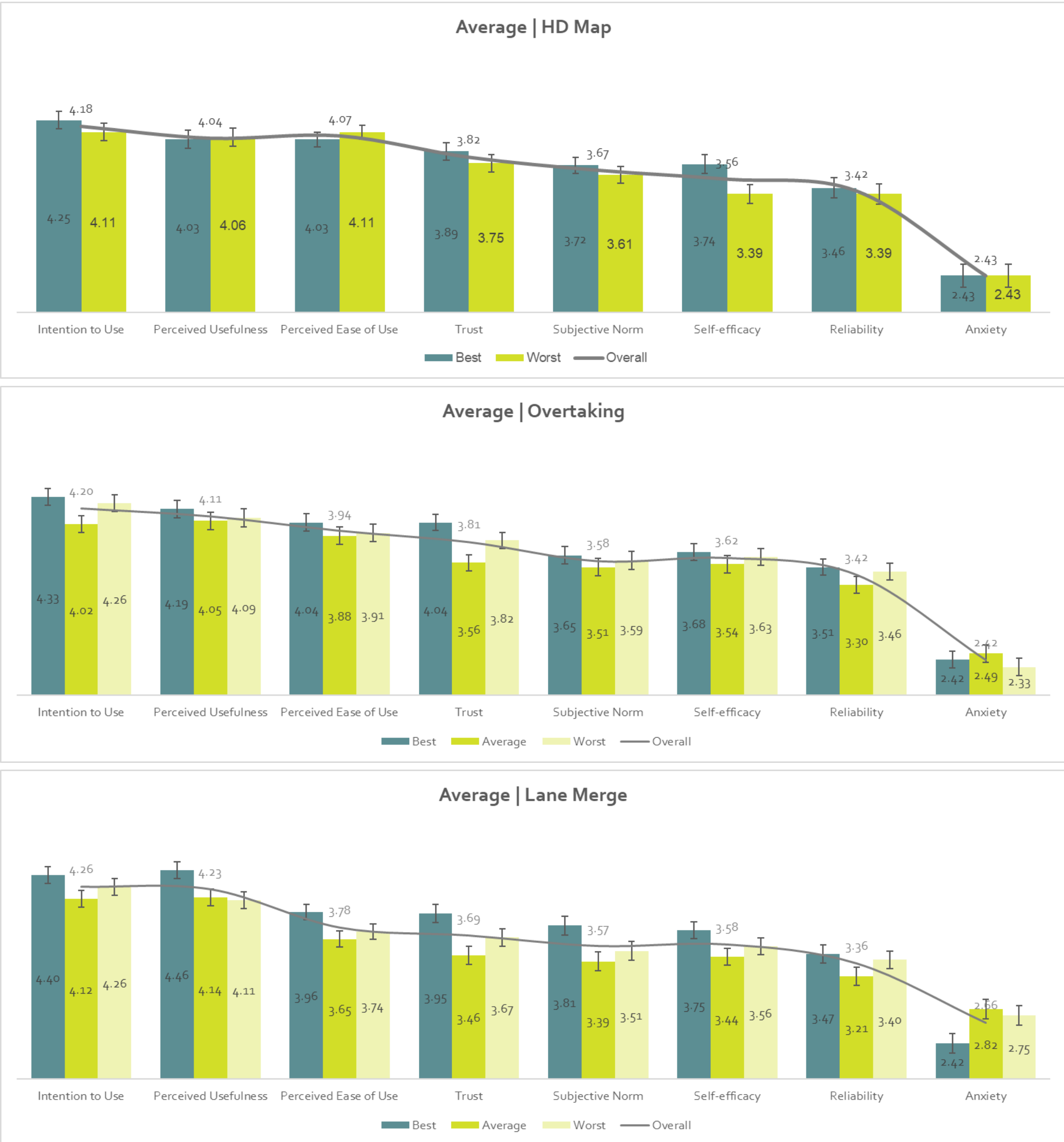


Figure 13: Mean and standard error of the constructs for each user story and scenario – Advanced Manoeuvres

Intention to use

Mean ratings for the *intention to use* were generally high for all user-stories (between 4 and 5), although only a marginally significant effect of the scenario was found for ***LaneMerge***. For ***Overtaking***, differences were significant, although the post-hoc comparisons revealed only marginally statistically significant differences between BE and AV. Differences for ***HDMapsVehicle*** here also significantly different (Table 12).

Table 12: Statistical analysis of the *intention-to-use* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi2$ (2) = 5	**0.08***	BE-AV	**0.038****
			BE-WO	*n.s.*
			AV-WO	*n.s.*
Overtaking	$\chi2$ (2) = 7	**0.004****	BE-AV	**0.051***
			BE-WO	*n.s.*
			AV-WO	*n.s.*
HDMapsVehicle (BE-WO)	*Z* = -1.965	**0.025****	-	-

Remarkably, the AV scenario, collected the lowest values of *intention to use*, both for the ***LaneMerge*** and ***Overtaking*** user stories. One can hypothesize that this is because, in this scenario, the system shows a somewhat uncertain behaviour, making participants feel more unsafe about the vehicle.

Qualitative data shows that generally participants were favourable to using the automated vehicle, independently of the user-story they were presented with. A few participants mentioned that they would feel the need of taking part in a test drive before deciding to use *("I would try it first. If it went well on the test drive, I would use an autonomous vehicle", "I would only buy it after trying it out in a test drive.")*. Some also made specific reference to the cost, that may be a relevant decision factor for adoption *("Depends on the price, if it's not too expensive... everything has a price in this life", "I would buy it but it depends on how much it would cost").*

Perceived usefulness

Ratings were generally high, particularly for the BE connectivity scenario, followed by relative similar values for AV and WO in ***LaneMerge*** and ***Overtaking***. There was significant effect of the scenario in the ratings for ***LaneMerge*** with the post-hoc test revealing statistically significant differences between BE and AV and BE and WO. No differences were found for ***Overtaking*** or ***HDMapsVehicle*** (Table 13).

Table 13: Statistical analysis of the *perceived usefulness* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi2(2) = 10$	**0.006****	BE-AV	**0.003****
			BE-WO	**0.004****
			AV-WO	*n.s.*
Overtaking	$\chi2(2) = 1$	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	$Z = -0.171$	*n.s.*	-	-

Qualitative analysis showed that, overall, participants consider that the vehicle would be useful, particularly in the context of long journeys *("I find it useful when I need to make long trips", "Mainly if I don't want to drive in specific scenarios or if I want to rest on long trips")* and by freeing the driver to do other things like working *("I could get the work done, avoid delays", "On long-distance trips, it could work while the car is driving.")* or resting *("I take long daily trips and it would be nice to rest")*. A few participants mentioned that they believe the automated vehicle would be safer to use than a conventional one *("Are safer because it eliminates fatigue and human errors", "An autonomous vehicle has more information processing capacity than the driver", "The unpredictability disappears")* and that it could reduce stress *("Take the stress out of traffic", "I don't have to pay attention to all the situations on the road")*. A few participants mentioned the importance of the 5G connection, as a way of having access to information about events in the road ahead *("Having information previously (before the event) through C2C", "Enlarged view of events with the 5G network").*

Perceived Ease-of-Use

The scenario BE collected the higher ratings, although differences were only marginally significant for ***LaneMerge*** and non-significant for ***Overtaking*** and ***HDMapsVehicle*** (Table 14).

Table 14: Statistical analysis of the *perceived ease-of-use* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi2(2) = 5$	**0.07***	BE-AV	**0.07***
			BE-WO	**0.07***
			AV-WO	*n.s.*
Overtaking	$\chi2(2) = 0.8$	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	$Z = -1.019$	*n.s.*	-	-

Generally, the interviewees considered the vehicle easy-to-use. Several participants stated their belief that the system would be intuitive and simple to use *("I imagine it will be simpler than it already is, more intuitive", "It's supposed to be getting easier and easier to use technology", "I think it will be as simple as possible, I press two buttons and it does everything by itself.")*, with a few mentioning that it would take some time to get used to *("I would have to get used to it, but nothing too complex", "I will need training, we are not prepared for driving this kind of cars")*.

Trust

Trust values were the higher for the BE case scenarios in all user-stories. The effect of scenario was marginally significant for ***LaneMerge*** with post-hoc showing differences between BE and AV. The difference between BE and AV (and the fact that they are larger than between BE and WO) gives support to the view that the behaviours of the AV scenario are seen as more uncertain and as such less trustable (Table 15).

Table 15: Statistical analysis of the *perceived trust* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi2(2) = 5$	**0.06***	BE-AV	**0.01***
			BE-WO	*n.s.*
			AV-WO	*n.s.*
Overtaking	$\chi2(2) = 7$	**0.03****	BE-AV	**0.007****
			BE-WO	*n.s.*
			AV-WO	*n.s.*
HDMapsVehicle (BE-WO)	$Z = -0.946$	*n.s.*	-	-

Still, when directly addressed, the majority of participants stated that they believe they would eventually trust the vehicle, although several of them stated that they would need to experience it for some time *("The more I use it, the more I trust", "I would need a period of getting used to it", "I will trust it when I have more experience with this car.")*. Some specified that their trust would be conditional, depending for instance on the infrastructure *("I would only trust on highways, in routine situations", "In the urban context it is more complicated but, on the highway, I would trust", "Infrastructure must improve, to be better for autonomous driving")*. A few stated their belief that if a vehicle is released on the market, then, it means that it is a tested technology and as such worth of their trust *("If they are available, it is because they are trustworthy", "Once it is in the market, I will trust it")*.

Reliability

Analysis of the ratings of *reliability* showed no significant effect of scenario although values are generally higher for the BE and with WO higher than AV in ***LaneMerge*** and ***Overtaking*** (Table 16).

Table 16: Statistical analysis of the *reliability* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	χ2(2) = 3	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
Overtaking	χ2(2) = 0.2	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	*Z* = -0.697	*n.s.*	-	-

Qualitative analysis is in line with the UAAD ratings, since participants' answers were mixed. Around half stated that they would consider the vehicle to be reliable, but the other half expressed doubts or stated their disbelief regarding the vehicle's *reliability*. A few stated their doubts regarding the vehicle's ability to deal with unexpected situations, particularly those in the ***HDMapsVehicle*** user-story *("I find it difficult for the car to react to all situations", "I don't think it would have the flexibility to deal with unexpected situations").* In this case, there were references to the 5G network *("Depending on how the 5G network is, it might not be consistent"*), loss of connection (*"If the network is unstable or out of network, I find it difficult to be reliable in more complex contexts")* or the possibility of the most recent changes not being correctly mapped *("The maps could be a problem, with a lost connection or last changes", "I'm not sure about reliability, some functions are easier to implement without surprises, but with maps, I am not sure because it is complex*"). There were also a few references to the vehicle's learning curve, with some respondents mentioning that the vehicle with get better with time *("It depends on the learning curve of the system, how fast the system will learn and consider new situations as routine situations", "As technology evolves, reliability will increase."*).

Subjective Norm

Subjective Norm ratings generally followed the order BE – WO – AV. Effect of the scenario was significant for ***LaneMerge***, with significant differences between each pair of scenarios. Differences were also significant for the ***HDMapsVehicle*** (Table 17).

Table 17: Statistical analysis of the *subjective norm* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	χ2(2) = 14	**0.001****	BE-AV	**0.004****
			BE-WO	**0.007****
			AV-WO	*n.s.*
Overtaking	χ2(2) = 2	*n.s.*	BE-AV	-

			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	Z = -2.21	**0.02****	-	-

Qualitative analysis showed that generally participants see other people's opinion as favourable towards the self's use of the autonomous vehicles *("Other people will be curious", "They will think that people who use these vehicles are more open to new technologies"*), although a few stated their indifference *("I don't worry about it")*. Regarding the specific question of whether they would recommend it to a friend, several participants stated their belief that the autonomous vehicle would be useful for people with limited mobility *("For older people", "People who can no longer drive").* Several also stated that they will first need to see if it worked well (*"The moment I feel comfortable, I will recommend", "I will recommend after using and confirming that it works well").*

Self-efficacy

Ratings of *self-efficacy* also followed the pattern of BE – WO – AV. There was an effect of scenario for the ***LaneMerge*** user-story, with post-hoc analysis revealing only marginally significant differences between BE-AV and BE-WO. There were also significant differences for the ***HDMapsVehicle*** user-story (Table 18).

Table 18: Statistical analysis of the *self-efficacy* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi 2(2) = 9$	**0.01****	BE-AV	**0.053***
			BE-WO	**0.065***
			AV-WO	*n.s.*
Overtaking	$\chi 2(2) = 2$	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	*Z* = -2.226	**0.013****	-	-

The majority of participants stated they would be able to use the technology, with references to the belief that the autonomous vehicle will be easy to use/intuitive *("I'm assuming they will be designed to be simple", "I think these things are made to be intuitive").* Several stated that they will need some prior explanations *("I need a basic tutorial", "If they teach me before")* or to read the manual (*"With the help of a user manual", "I would read the user manual first*"). A few also stated that using the vehicle would be less difficult for those that have contact with technology *("Anyone who interacts with cell phones and technology would do it without any problems", "My generation has a lot of contact with technology"*).

Anxiety

For ***LaneMerge*** and ***Overtaking***, ratings of *anxiety* were higher for AV followed, by WO and BE, although differences were non-significant in all cases. For ***HDMapsVehicle***, the ratings of *anxiety* are similar for BE and WO (Table 19).

Table 19: Statistical analysis of the *anxiety* construct: Online interviews

User-story	Statistic	*p*	Post-hoc comparisons	
			Pair	*p*
LaneMerge	$\chi2(2) = 3$	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
Overtaking	$\chi2(2) = 0.7$	*n.s.*	BE-AV	-
			BE-WO	-
			AV-WO	-
HDMapsVehicle (BE-WO)	$Z = 0.337$	*n.s.*	-	-

Answers regarding anxiety were mixed. Most participants indicated that they would feel anxious driving the vehicle, although some of them stated that this would be on the initial contacts *("The first time I would be anxious but, little by little it would pass, "In the beginning I would be anxious until I gained confidence"*).

3.2.2.4 Relations between constructs

Table 20 presents the correlation matrices (only significant values) for the UAAD constructs, for the three user-stories. It is noticeable that the correlation between *intention-to-use* and *perceived usefulness* is particularly strong, especially for ***LaneMerge*** and ***Overtaking***. *Perceived ease-of-use* is also correlated with *intention-to-use*, but the correlation is weaker for ***Overtaking*** and non-significant for ***HDMapsVehicle***. Actually, in this user-story it's the *trust* construct that has the highest correlation with *intention-to-use*. It is also strongly correlated with *reliability* and usefulness. *Anxiety* has the weakest correlations with all other constructs, especially in the ***HDMapsVehicle*** user-story, in which all correlations are non-significant.

Table 20: Correlation matrices for the constructs, for the different user stories: online interviews

LaneMerge	Intention to Use	Trust	Self-efficacy	Reliability	Ease of Use	Anxiety	Usefulness	Subjective Norm
Intention to Use	-							
Trust	0.60	-						
Self-efficacy	0.61	0.64	-					
Reliability	0.55	0.65	0.50	-				
Ease of Use	0.71	0.67	0.71	0.56	-			
Anxiety	-0.40	-0.32	-0.38	n.s.	-0.55	-		
Usefulness	0.79	0.59	0.62	0.52	0.72	-0.41	-	
Subjective Norm	0.68	0.68	0.65	0.73	0.74	n.s.	0.72	-

Overtaking	Intention to Use	Trust	Self-efficacy	Reliability	Ease of Use	Anxiety	Usefulness	Subjective Norm
Intention to Use	-							
Trust	0.65	-						
Self-efficacy	0.46	0.64	-					
Reliability	0.61	0.66	0.48	-				
Ease of Use	0.54	0.54	0.71	0.41	-			
Anxiety	-0.39	-0.51	-0.47	-0.32	-0.49	-		
Usefulness	0.81	0.60	0.53	0.59	0.57	-0.37	-	
Subjective Norm	0.56	0.37	n.s.	0.33	0.44	-0.32	0.65	-

HD Map	Intention to Use	Trust	Self-efficacy	Reliability	Ease of Use	Anxiety	Usefulness	Subjective Norm
Intention to Use	-							
Trust	0.72	-						
Self-efficacy	0.37	0.58	-					
Reliability	0.69	0.80	0.59	-				
Ease-of-Use	n.s.	n.s.	0.29	n.s.	-			
Anxiety	n.s.	n.s.	n.s.	n.s.	n.s.	-		
Usefulness	0.69	0.71	0.44	0.66	n.s.	n.s.	-	
Subjective Norm	0.62	0.67	0.44	0.65	n.s.	n.s.	0.74	-

3.2.2.5 *User acceptance KPIs*

The following tables summarize the mean values of the KPIs, for the different user-stories.

Table 21: Summary of KPIs for the *LaneMerge* user story

ID	Description	Results						
		Cond.	*Mean*	*STD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	BC	4.4	0.8	5	2.3	5	4.0 – 4.8
		AC	4.1	0.7	5	2.3	5	3.8 – 4.4
		WC	4.3	0.6	5.0	2.7	5	4.1 – 4.5
UA-M1.2	Perceived Technology Usefulness	BC	4.5	0.7	5.0	2.3	5	4.2 – 4.8
		AC	4.1	0.8	5.0	2.0	5	3.7 – 4.5
		WC	4.1	0.7	5.0	2.3	5	3.8 – 4.4
UA-M1.3	Perceived Technology Ease-of-use	BC	4.0	0.9	5.0	2.0	5.0	3.7 – 4.3
		AC	3.6	0.7	5.0	2.3	5.0	3.2 – 4.0
		WC	3.7	0.7	5.0	2.7	4.7	3.4 – 4.0
UA-M1.4	Affinity for Technology Interac tion	-	4.5					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.17	0.6	1.3	-0.3	1.3	0.1 – 0.2
UA-M2.2	Perceived Trust	BC	3.9	0.8	5.0	2.3	5.0	3.5 – 4.3
		AC	3.5	0.7	5.0	2.0	4.4	3.2 – 3.8
		WC	3.7	0.8	5.0	2.3	5.0	3.4 – 4.0
UA-M2.3	Perceived Reliabilit y	BC	3.5	0.9	5.0	2.0	4.7	3.1 – 3.9
		AC	3.2	0.8	5.0	2.0	4.4	2.8 – 3.6
		WC	3.4	0.7	5.0	2.0	4.7	3.0 – 3.8

Table 22: Summary of KPIs for the *Overtaking* user story

ID	Description	Results						
		Cond.	*Mean*	*STD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	BC	4.3	0.7	5.0	3.0	5	3.9 – 4.7
		AC	4.0	0.80	5	2.7	5	3.6 – 4.4
		WC	4.3	0.7	5	3.0	5	4.0 – 4.6
UA-M1.2	Perceived Technology Usefulness	BC	4.2	0.8	5.0	2.7	5	3.8 – 4.6
		AV	4.1	0.8	5.0	2.3	5	3.7 – 4.5
		WC	4.1	0.8	5.0	2.3	5	3.7 – 4.5

UA-M1.3	Perceived Technology Ease-of-use	BC	4.0	0.8	5.0	2.7	5.0	3.6 – 4.4
		AV	3.9	0.9	5.0	2.0	5.0	3.5 – 4.3
		WC	3.9	0.7	5.0	2.5	5.0	3.5 – 4.3
UA-M1.4	Affinity for Technology Interaction	-	0.2					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.1	0.5	1.3	-1.0	1.0	-0.4 – 0.6
UA-M2.2	Perceived Trust	BC	4.0	0.7	5.0	2.7	5.0	3.6 – 4.4
		AV	3.6	0.8	5.0	2.0	5.0	3.2 – 4.0
		WC	3.8	0.4	5.0	2.7	4.7	3.5 – 4.1
UA-M2.3	Perceived Reliability	BC	3.5	0.7	4.7	2.3	4.4	3.2 – 3.8
		AV	3.3	0.8	4.7	2.3	4.7	3.0 – 3.6
		WC	3.5	0.7	5.0	2.0	4.7	3.2 – 3.8

Table 23: Summary of KPIs for the *HDMapsVehicle* user story

ID	Description	Results						
		Cond.	***Mean***	***STD***	***MAX***	***MIN***	***Perc 95***	***CI95%***
UA-M1.1	Acceptance Intention (Intention to use)	BC	4.3	0.7	5.0	3.0	5	4.1 – 4.5
		WC	4.1	0.7	5.0	2.3	5	3.8 – 4.4
UA-M1.2	Perceived Technology Usefulness	BC	4.0	0.8	5.0	2.3	5	3.6 – 4.4
		WC	4.1	0.7	5.0	3.0	5	3.9 – 4.3
UA-M1.3	Perceived Technology Ease-of-use	BC	4.0	0.9	4.7	1.7	5.0	3.7 – 4.3
		WC	4.1	0.6	5.0	2.0	4.9	3.8 – 4.4
UA-M1.4	Affinity for Technology Interaction	-	4.5					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.1	0.4	0.7	-0.7	0.7	-0.2 – 0.4
UA-M2.2	Perceived Trust	BC	3.9	0.8	5.0	2.3	4.9	3.6 – 4.2
		WC	3.8	0.6	5.0	2.3	4.7	3.6 – 4.0
UA-M2.3	Perceived Reliability	BC	3.5	0.9	4.7	1.7	4.6	3.2 – 3.8
		WC	3.4	0.8	4.7	2.0	4.3	3.1 – 3.7

3.2.3 Discussion

Overall, the acceptability values for the Advanced manoeuvres user stories evaluated in the interviews were high. This can be directly observed through the ratings on the UAAD scale, in which mean values of *intention to use* were above 4 in all situations, even for the scenarios with lower ratings. While differences between scenarios were to be expected it is remarkable that the average connectivity scenario was generally the one that collected less positive results. It can be hypothesized that this occurred due to the relatively more "unpredictable" behaviour of the vehicles that the participants could observe in this scenario. Several participants felt unsafe with the vehicle behaviour in this scenario, with a few mentioning that it would be better to have a behaviour similar to the WO scenario. Congruently, there was a significant difference for *trust* in the ***LaneMerge*** and ***Overtaking*** between BE and AV, but not between BE and WO.

Overall it seems that participants do assign additional value to a situation where the capacities of the vehicle are extended by the additional information provided through the 5G network. However, they also recognize the value of a vehicle able to drive autonomously based on its own sensors and individual functionalities (even if they may prefer the former). On the other hand, the intermediate situation where the autonomous vehicle relies on inaccurate information conveyed through the network resulted in an attempted but interrupted manoeuvre that, although still safe, jeopardized the feeling of trust and reduced acceptability [19], [20]. An important consideration to make is thus that, although the technology performance is an important factor for acceptability, the way in which the interaction is designed (including failsafe mechanisms) is also paramount for the user acceptance. This is especially true in situations in which technology behaves in sub-optimal parameters. It is important to ensure that users are able to feel safe and this may mean to develop systems that act, at times, over-cautiously [21].

Congruent with this observation is the difference between mean values of the *trust* construct (comparing differences between BE-AV), which is around 0.5. This is well above the 0.2 of the *intention-to-use* or *reliability*, showing that *trust* suffers the most from the unreliable behaviour.

Generally, the attitude towards self-driving technology was positive. This can be observed from the values of *usefulness* and *subjective norm* of the UAAD, but also from the qualitative analysis, with several participants manifesting belief on the potential of the technology, both as a way of gaining free time while in the vehicle and as a way of improving safety.

Observation of the correlation matrices shows that *perceived usefulness* is the most important predictor of *intention-to-use*. This is in line with previous studies of automated driving technology [22]. The lack of a stronger relation between perceived ease-of-use and intention-to-use is also consistent with other studies of autonomous driving acceptance [23], even if a bit unexpected in light of the technology acceptance literature [5], [6]. This may perhaps be explained by the fact that participants did not, in fact, interact with the technology (they only observed the action) and thus were unable to fully evaluate the usability of the system.

4 PUBLIC TRANSPORT: HD MEDIA SERVICES

The Quality of Service (QoS) Use Case Category in the Spanish-Portuguese CBC means two different scenarios in public transport: ***HDMapsPublicTransport*** and ***MediaPublicTransport***. Only the latter was evaluated by final users. The infotainment service called "High Definition Media Services for Passengers" takes advantage of the high capabilities of 5G for improving the quality of information consumed in form of media services. Users of this service will be able to enjoy different multimedia services while travelling in the public transport, including high bandwidth data consumption applications (Figure 14). Users can access to multimedia services through a multimedia device and reproduce high quality content without delays or interruptions, using the 5G connection

Figure 14: QoS evaluation with ALSA bus passengers

The objective of the tested user story was to provide real-time connected services to the ALSA public transport fleet that connects the cities of Vigo and Porto (Sá Carneiro Airport). The duration of the x-border trip between Spain and Portugal is of approximately two hours with stops in Valença do Minho and Vila Nova de Cerveira (Figure 15).

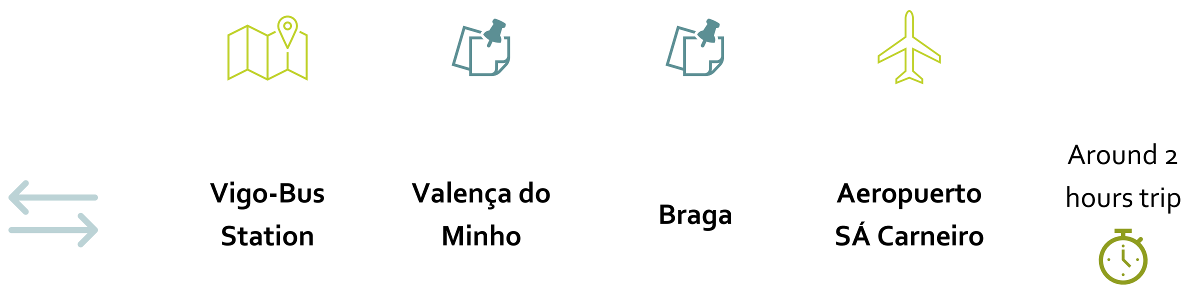


Figure 15: X-border ALSA Travel itinerary schema

4.1 Methodology

In this section, a description of the participants that agreed to participate in the study is first provided, followed by an explanation of the procedure used to collect the data.

4.1.1 Technical implementation

The service was implemented on board of a bus from the company ALSA. The multimedia devices were tablets installed in front of the passengers (attached to the seat in front of them), connected to a 5G MiFi device. The streaming used the *HTTP Live Streaming* (HLS) protocol typically used for Video-on-Demand content. Four 5G antennas, were placed near the New Bridge (the border crossing), where the (technical) network evaluation was conducted (to check agnostic network evaluation see D3.7 and to check mobility network evaluation, D5.2). Streaming was in general of medium quality (pixelated and blurry) with limited interruptions due to connectivity limitations with the MiFi and the tablet devices (in moments of high demand, the wireless bus network and the on-board router itself had difficulty in processing the full volume of frames). Despite these conditions, the evaluation of the users was positive for the majority, considering that it was the first time that the passengers had access to the visualization of these videos during their trip (as shown in section 4.2) so it seems that their availability prevails over the quality of the service.

4.1.2 Participants

43 final users took part of this study travelling in an ALSA bus equipped with a multimedia service, between October 25th, 2021 and May 11th, 2022. Participants began by agreeing to respond the questionnaire, by filling an informed consent to participate in the study before answering the questions.

Table 24: Number of passengers by travel itinerary

Travel Itinerary		Number of passengers
Porto Airport	Vigo Bus Station	7
Porto Airport	Valença do Minho	6
Braga	Vigo Bus Station	5
Vigo Bus Station	Porto Airport	19
Vigo Bus Station	Braga	4
Vigo Bus Station	Valença do Minho	2
	TOTAL	**43**

Around half of the sample travelled (19) from Vigo Bus Station to Porto Airport, other passengers gone in the inverse travel from Sá Carneiro Airport to Vigo (7 passengers) or Valença do Minho (Table 24). More than half are men (56%). Taking in consideration the age of the sample: a quarter of the sample is between 25 and 34 years old and almost 45% is between 35 and 50 years old (Table 25). They regularly use the bus service to make cross-border transfers with an average of 7 annual trips to Portugal and 8 to Spain.

Table 25: Profile of the sample (age & gender)

	Male	Female	No defined	Total
18-24 Years	5	3		8
25-34 Years	4	6	1	11
35-50 Years	13	5	1	19
51-60 Years	2	3		5

In relation to the level of studies of the participants, almost a quarter of the sample (23%) has finished high school, a quarter has an associate degree and a fifth of the sample has a bachelor's degree (Table 26).

Table 26: Profile of the sample (level of studies)

	18-24 years	25-34 years	35-50 years	51-65 years	Total
Highschool Degree	5	2	3		10
Some college	1		2	4	7
Associates Degree (2 years)	1	4	6		11
Bachelor Degree (4 years)	1	3	5		9
Graduate Degree			1		1
Other		2	1		3
Not studies			1	1	2

Finally, it is worth noting that the travellers who used the 5G-Mobix devices are people with a high technology profile: most of them scored 5 or upper 5 points for technology experience and affinity as it can be observed in the figure for user perception about technology evaluation. Average for Tech Experience is 8.18 points (SD = 1.66) and for Tech Affinity 8.27 (SD = 1.59) respectively (Figure 16).

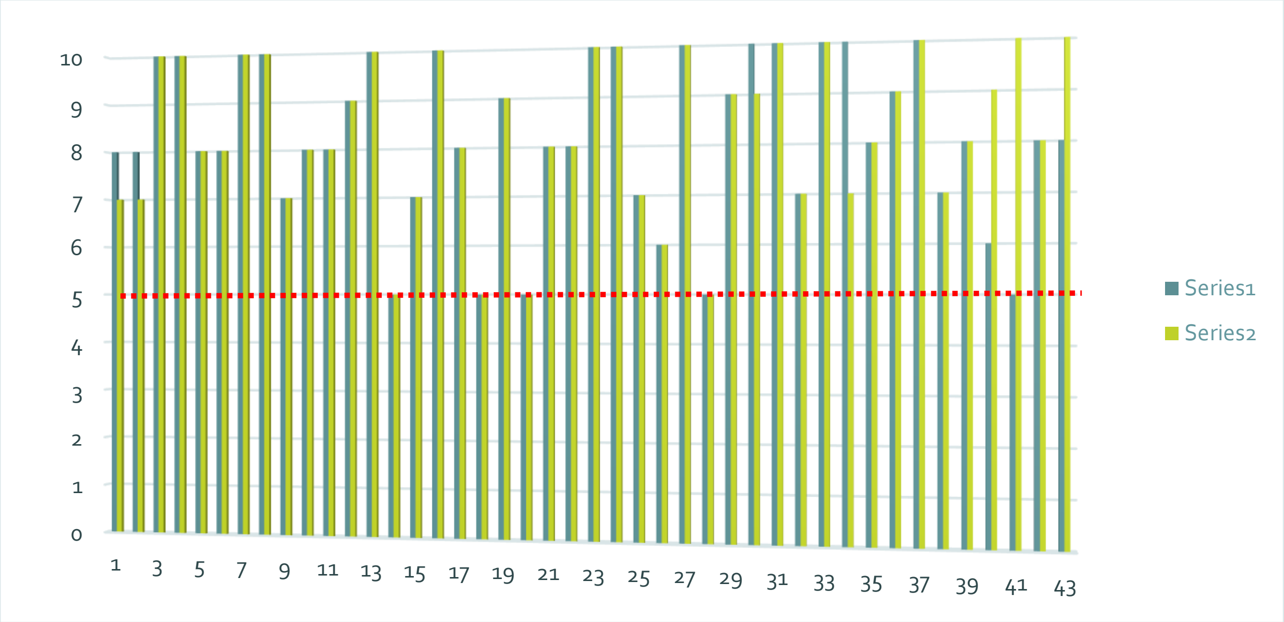


Figure 16: User perception about technology passenger's profile: experience (series 1) & affinity (series 2)

4.1.3 Procedure

All the participants in this study travelled in a bus equipped with High Definition (HD) streaming devices where they could visualize different videos. In Figure 17 it can be observed the bus used by participants in a regular trip offered by ALSA company:

Figure 17: ALSA bus where passengers travelled

After using that device and visualizing these videos, users were asked to fill in a questionnaire. Videos showed to participants were related to different issues as it is summarized in Table 27.

Table 27: List of available videos for passengers

Videos available	Link	
Video about project	http://37.187.138.194/mobix5g/MOBIXVIDEO.mp4	
Relaxing video	http://37.187.138.194/mobix5g/INK4K.mp4	
Video about earthspace	http://37.187.138.194/mobix5g/earthspace4K.mp4	
Galicia Video	http://37.187.138.194/mobix5g/Galicia4K.mp4	
Porto Video	http://37.187.138.194/mobix5g/Porto4K.mp4	
Galicia Estuary Video	http://37.187.138.194/mobix5g/rias4K.mp4	

One of these videos was randomly presented to passengers during the trip.

The questionnaire was put at passenger's disposal ten minutes before arriving destination. In the survey participants provided general profile information, they scored their degree of tech affinity and experience. Finally, they offered a score between 0 to 10 about their experience with the multimedia service. Questionnaire is presented in Annex 7. The procedure is summarized in the next figure:

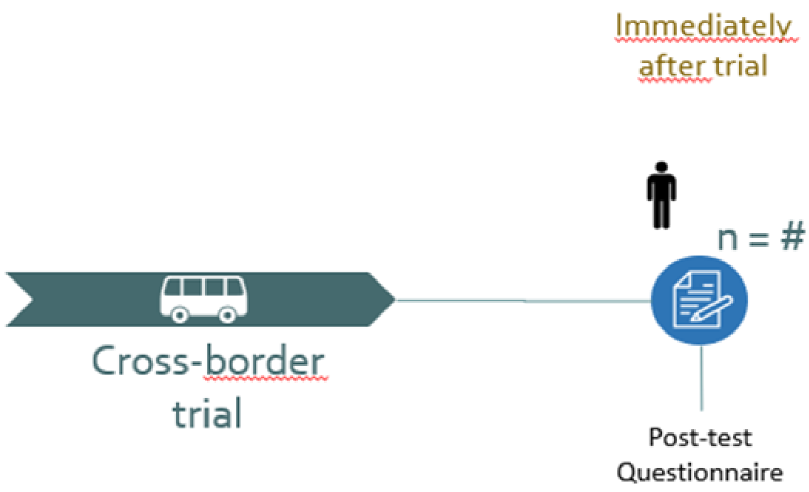


Figure 18: Diagram of the trial of the User acceptance Evaluation procedure for ALSA bus

4.2 Results

Answers to the questionnaire after watching the video, show that all the constructs had scores equal to or greater than 7.19 except for the anxiety construct, whose score was 3.76 and for p*erceived safety* with an average score from 5.51 (Figure 19). The highest score is for the constructs *perceived ease-of-use*, *subjective norm*, *trust*, *reliability* and *facilitations conditions*. These 5 factors have scores greater than 8. Annex 9 includes a table with the scores for the mean and standard deviation of the 10 factors considered in this study.

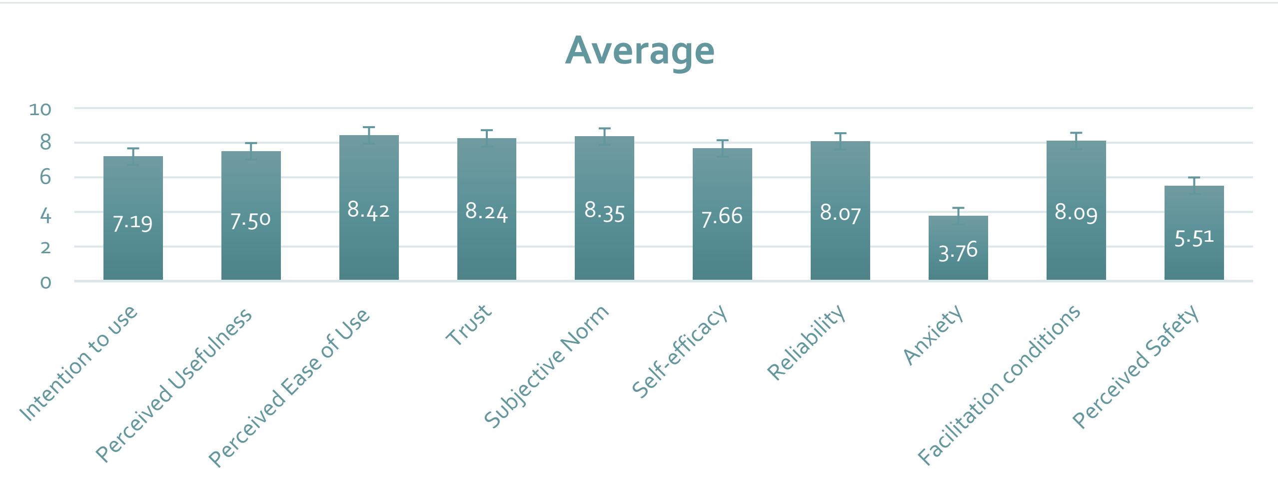


Figure 19: Bars graphic for average ALSA bus questionnaire results (I).

A Pearson correlation coefficient was computed to assess the linear relationship between ALSA bus questionnaire factors. Results are presented in the Table 28. As one can observe all factors of UAAD scale show a positive correlation except for the factor *anxiety*, which have a negative correlation with the others (except with the factor *subjective norm* where the correlation is next to zero). Stronger positive correlations were found between *perceived ease-of -use* and *reliability* (r=0.69), between *reliability* and *trust* (r=0.63) and *perceived ease-of-use* and *intention-to-use* (r=0.60).

Moreover, it is important to highlight that in this study were included questions regarding the factors *facilitating conditions* and *perceived safety*, although these two factors were eliminated in the first preliminary findings for questionnaire validation. In this case, negative correlation was found between *perceived safety* and *intention to use*, *trust*, *self-efficacy*, *reliability* and *perceived ease of use*.

Table 28: Pearson correlation coefficients for ALSA bus questionnaire factors*.

ALSA BUS	Intention to Use	Trust	Self-efficacy	Reliability	Perc. Ease of Use	Anxiety	Perceived Usefulness	Subj. Norm	Facil. Conditions	Perceived safety
Intention to Use	-									
Trust	0.37	-								
Self-efficacy	0.55	0.47	-							
Reliability	0.47	0.63	0.37	-						
Perceived Ease of Use	0.60	0.44	0.37	0.69	-					
Anxiety	-0.09	-0.22	-0.17	-0.30	-0.36	-				
Perceived Usefulness	0.27	0.22	0.12	0.58	0.43	-0.02	-			
Subjective Norm	0.23	0.31	0.12	0.47	0.31	0.01	0.43	-		
Fac. Conditions	0.59	0.31	0.30	0.58	0.64	-0.33	0.34	0.38	-	
Perceived Safety	-0.21	-0.20	-0.50	-0.13	-0.29	0.52	0.21	0.25	-0.07	-

*** Note: In this table it is presented coefficients including "Facilitating conditions" and "Perceived Safety" factors. These two factors were eliminated in the UAAD questionnaire after validation, but it was decided to maintain in ALSA bus results for including maximum of information for this study.**

4.2.1.1 *User acceptance KPIs*

Table 29 summarizes the mean values of the KPIs, for the ***MediaPublicTransport*** user story.

Table 29: Summary of KPIs for the *MediaPublicTransport* user story

ID	Description	Results						
		Cond.	Mean	STD	MAX	MIN	Perc 95	CI
UA-M1.1	Acceptance Intention (Intention to use)	7.2	7.2	1.3	10	4.7	8.7	6.8 - 7.6
UA-M1.2	Perceived Technology Usefulness	7.5	7.5	2.0	10	3	10	6.9 - 8.1
UA-M1.3	Perceived Technology Ease-of-use	8.4	8.4	1.3	10	5	10	8.0 - 8.8
UA-M1.4	Affinity for Technology Interaction		8.3	1.6				
UA-M2.2	Perceived Trust	8.2	8.2	1.6	10	5	10	7.8 - 8.7
UA-M2.3	Perceived Reliability	8.1	8.1	1.2	10	5	10.0	7.7 - 8.4

4.3 Discussion

A total of 43 passengers participated in this study, all of whom made the cross-border journey between Spain and Portugal, traveling on an ALSA bus equipped with a high-definition multimedia service. Most of these passengers made the journey between the Vigo bus station and the Porto Airport. Many of these users had an average age between 35 and 50 years with a technological profile.

Referring to public transport, Carreira and colleagues [24] stated that it would be of interest to pay attention to the global experience of travellers not only from the point of view of the characteristics of the transport service itself (for example, timekeeping of transport) but also other aspects that can add value to the trip, including entertainment services for passengers. As these authors indicate, traveling is a broader experience than just moving from one place to another. Congruently, cross-border service passengers participating in the study were able to enjoy a series of videos shown on devices installed on the bus itself.

The positive evaluation of the bus multimedia service, even considering the imperfect quality of the video streaming hints that the availability of the devices has in general improved travel conditions and that it could help increase the desire to use public transport (video quality may be detrimental, especially for continued use). Users expressed that the service was easy to use and that the perception of the others regarding the use of this service would be positive. The system provides an extra service that can improve the travel experience and, in addition, could be used as an extra channel to provide information about the trip. Both aspects were pointed out by Hildén et al. [25] as key aspects for the design of digital travel services in the future. Moreover, Leng & Corman [26] highlighted the importance of, in case of a disruption in the trip, to provide information on the delays, as this increases the satisfaction of public transport passengers. This kind of information could be shown on the screens of devices used for entertainment purposes.

5 AUTOMATED SHUTTLE DRIVING ACROSS BORDERS

The goal of this evaluation was to assess the degree of user acceptability regarding the user-stories **US#4.1** - *"Automated Shuttle Driving Across Borders: Cooperative Automated System (**CoopAutom**)"* and **US#1.5** - *"Automated Shuttle Driving Across Borders: Remote Control (**RCCrossing**)"*. Importantly, it was also aimed at evaluating how acceptability is affected by the x-border context. To do so, participants took part on (1) local trials, in which the x-border challenges were not an issue (no border handover) and in (2) x-border trials, in which the x-border issues were at stake. In both situations they provided an evaluation using the UAAD. Following the trials, they were inquired in individualized interviews.

This procedure allowed comparing the assessments in local vs x-border trials and verify (1) their general acceptability towards the user-story (first evaluation) and (2) how the border affects the acceptability (second evaluation in comparison with the first).

5.1 Methodology

The evaluation methodology comprised four phases (see Figure 20):

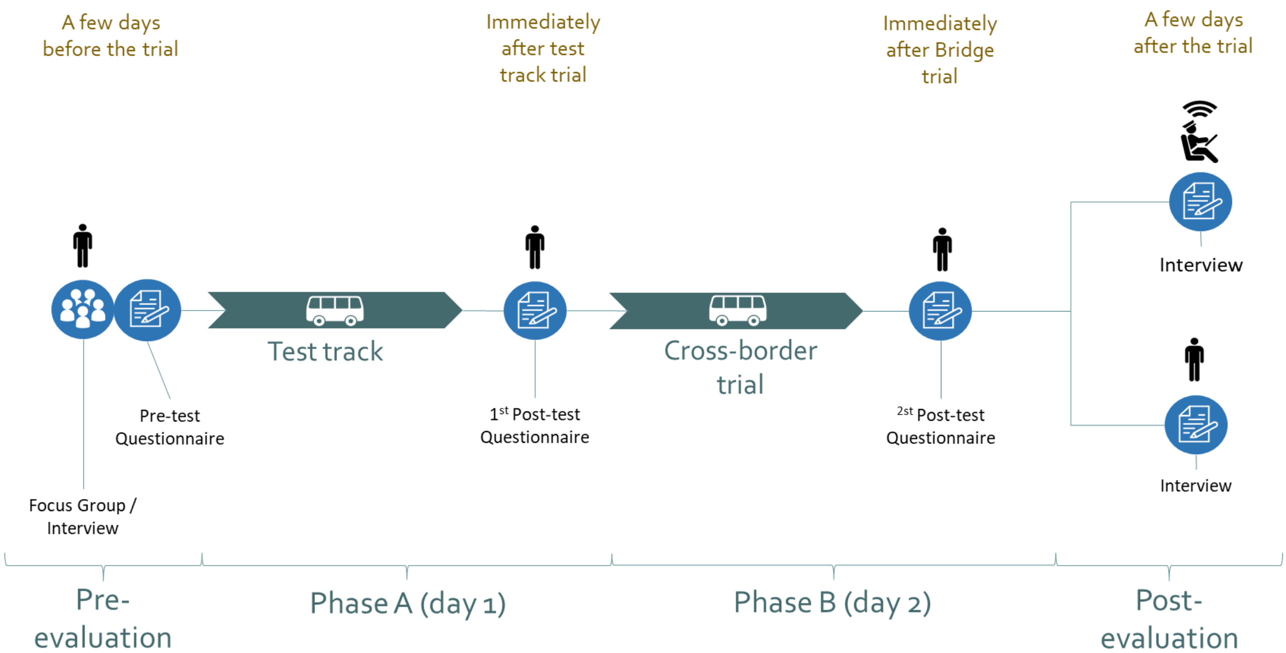


Figure 20: Procedure for the evaluation of the *Automated Shuttle* user stories

Pre-evaluation: During this phase, participants took part in a focus group or in an individual interview (depending on availability) that aimed to explore their expectations regarding autonomous driving technology and the concrete user story under evaluation, which was presented at this stage. They were then asked to fill in the UAAD questionnaire.

Phase A: This was the first phase of the evaluation. Participants took part in the trial at CTAG test track. A specific, circular course was designed that started and ended at a simulated bus stop, where the participants boarded and left the shuttle. The course was designed to include the two user-stories. For ***RCCrossing***, an obstacle was placed in the middle of the test track, that forced the intervention of the remote driver. For ***CoopAutom*** an actor (experimenter), initially hidden behind a building next to the track crossed in front of the vehicle (simulating a pedestrian) while being captured by the pedestrian radar. The information of the radar fed the AD system and made the shuttle to slow down and stop. After that the shuttle continued on its way.

For each group of participants, the shuttle performed two laps, allowing the occupiers to observe each user-story twice. A member of the technical team was inside the shuttle the whole time, controlling the emergency brake.

Phase B: Second phase of the evaluation. Participants took part in the x-border trial (old bridge) that included a hand-over event. A circular course was designed that started on the PT side, crossed the bridge towards the ES side, then made a U-turn, crossed the bridge again towards the opposite side, and then made a new U-turn, thus going back to starting point. The two user-stories were included on the course. For ***RCCrossing***, an obstacle (cyclist) was placed in the middle of the bridge (during the movement from PT-to ES. For ***CoopAutom*** an actor (experimenter), hidden behind a bridge column in the ES side crossed in front of the vehicle (simulating a pedestrian) while being captured by the pedestrian radar. Like in phase A, the information of the radar fed the AD system and made the shuttle slow down and stop

The shuttle performed two laps, allowing the occupiers to observe each user-story twice. A member of the technical team was inside the shuttle the whole time, controlling the emergency brake.

Post-evaluation: Last phase of the evaluation. Participants were interviewed individually and inquired regarding the individual constructs of the evaluation.

5.1.1 Technical implementation

Trials at CTAG were done without roaming or handover. X-border trials were done in the PT to ES direction with ES SIM (Home routing configured for roaming transitions with inter-PLMN handover). Handover occurred on the bridge as expected (in between the green lines in Figure 21). The actor in ***CoopAutom*** was placed within the handover area yellow dot in Figure 21).

Network connectivity was in general good and the user stories' flow occurred as planned (consistently with the best-case scenario described in section 2.2), both at the test track and at the border. The shuttle was moving at a 10 Km/h speed. Network KPIs were not processed during the user acceptance evaluation trials, but observation by the team indicated that they were in line with the values registered during the technical evaluation trials, namely streaming with latencies well below 100 ms (recommended value for driving at 10 km/h), data rates of 11 Mbps and near 100% reliability (further details can be found in deliverable D5.2 [15].

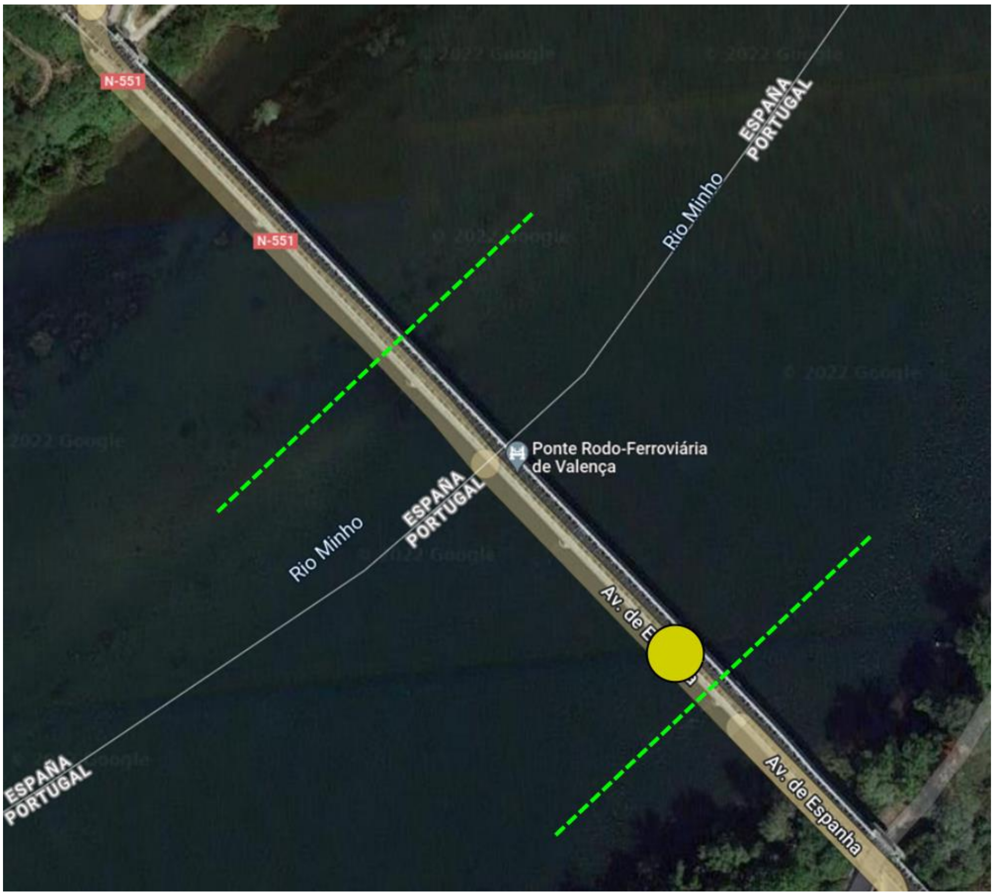


Figure 21: Satellite view of the Old Bridge

5.1.2 Participants

22 Participants took part in the study (4 women and 18 men) with the age distribution shown in Table 30. Among the participants, there were 9 Portuguese, 11 Spanish, 1 Iranian and 1 Philippine. All participants had a valid driving license, from which 50% obtained it >15 years ago, and four <5 years ago (M = 14.3; SD = 8.2). All, except one, had an academic background in STEM areas.

Table 30: Summary of demographic data of the participants - Automated shuttle

		N	%
		22	**100.0%**
Gender	Female	4	18.2%
	Male	18	81.8%
Age	18-30 years	9	40.9%
	31-40 years	5	22.7%
	41-50 years	8	36.4%
Do you have a valid driving license?	Yes, and I drive often	22	100.0%
How long has driving license?	less than 5 years	4	18.2%
	5 -14 years	7	31.8%
	15 - 24 years	10	45.5%
	more than 24 years	1	4.5%
Have you ever tried an autonomous vehicle?	No	12	54.5%
	Yes	10	45.5%
Have you ever driven an autonomous vehicle?	No	20	90.9%
	Yes	2	9.1%

5.1.2.1 ATI evaluation

Figure 22 shows the mean values of the answers for the ATI scale. Mean value was 4.6, with Cronbach's Alpha = 64%, meaning that overall participants considered themselves to be apt for technology interaction.

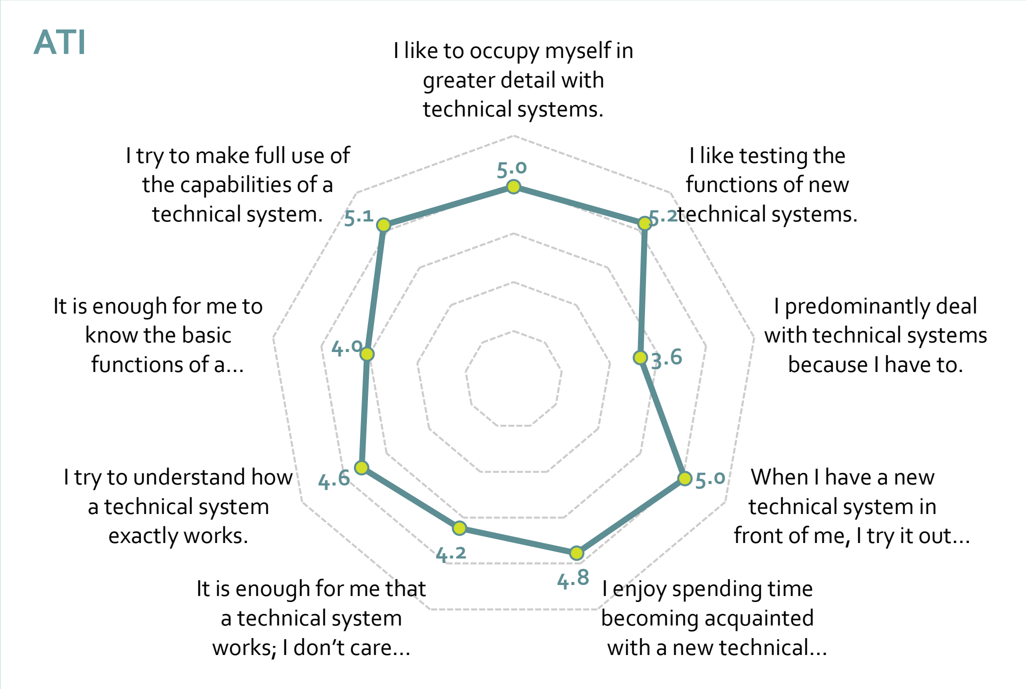


Figure 22: ATI answers for the Automated Shuttle

5.1.3 Procedure

Pre-evaluation: Before experiencing the local and x-border trials, fourteen participants were assigned to one of the two focus group sessions (six Spanish speakers and eight Portuguese speakers). Eight of the remaining participants were not able to join the focus groups and were individually interviewed according to their availability. One participant was not able to participate in this phase and joined the other participants on Phase A.

This phase entailed a set of guiding questions aiming to understand the participant's experience with public transportation; main concerns on automated mobility and technology maturity; and expectations for future automated mobility, with a special focus on the automated shuttle use cases. In addition to open-ended questions, to address the *Remote Control (**RCCrossing**)* use case, a video of the best-case scenario was presented to the participants of the focus group sessions to illustrate the user story. They were asked to describe the situation and give their opinion, while considering their expectations about future mobility in general, and their expectations about riding an automated shuttle, in particular.

At the end of the focus groups sessions and interviews participants were asked to fill out the UAAD questionnaire.

Phase A: This phase took place at CTAG premises, on the test track (Figure 23). Twenty-one participants were received in groups of 5 and taken to start off the course (two participants were not able to attend the local trial but were present on the x-border one that took place on the following day). They were then asked to sit comfortably inside the shuttle and to observe the events during the journey. The shuttle then began to move and performed the two laps. After the trial participants were asked to fill two paper copies of the UAAD (adapted to the shuttle), one regarding the ***RCCrossing*** and other about the ***CoopAutom***. They were then dismissed until the second day.

Figure 23: Images from the Shuttle trials on CTAG test track

Phase B: This phase took place at the bridge (Figure 24). The procedure was essentially similar to the one of phase A, with the participants observing the event during the course and then being asked to fill out two new copies of the UAAD, one for ***RCCrossing*** and the other ***CoopAutom***. In the end, the experimenter thanked the participants and reminded them that they would be contacted afterwards for the post-trial interview.

Figure 24: Images from the Shuttle trials at the bridge

Post-evaluation: All participants (n = 23) were scheduled for an individual post-trial interview. The main goal of this final interview was to gather their thoughts, feelings and opinions about the trial experience and gain qualitative insights regarding each of the KPIs that were also subjected to a quantitative evaluation by the participants who were asked to fill out once again the UAAD questionnaire (post-test) at the end of the interview.

5.1.4 Data analysis

Data was analysed following a procedure similar to the one used for the Advanced Manoeuvres analysis (section 3.2.1.5). UAAD subscales were checked for consistency using Cronbach's Alpha, calculated per construct and user-story. Mean values were calculated for each construct and scenario. For each construct, the effects of scenario were independently analysed. Statistical comparisons between scenarios were done with pairwise Wilcoxon signed-rank tests.

The focus groups and interviews were analysed following an inductive coding approach. A framework was developed in order to organize the contents within a logical thematic structure. The following topics were defined:

- Experience with public transportation: Content related to the experiences of the participants as passengers
- Main concerns on automated mobility and technology maturity: Content on experiences and expectations regarding perceived future technical challenges
- Expectations for future automated mobility (the automated shuttle use-case): Content related to the experience, knowledge and expectations of the participants in relation to autonomous vehicles in general, and automated shuttles in particular
- Final comments: Content related to the opinions of the participants about future mobility

In what concerns the post-trial interviews (post-evaluation), the data was organized into the following:

- Experience on trials: Content related to the experience and opinions regarding phase A and phase B
- Constructs: content related to each construct presented in the UAAD

After organizing the content, in each question of the interview, the speeches of the participants were treated in order to simplify and encode them in key phrases by similarity, making it possible to group key-ideas in each topic.

5.2 Results

This section begins by drawing initial insights, from the pre-evaluation. This is followed by an analysis of the UAAD and post-trial interviews, with individual sections presenting quantitative and qualitative results for each subscale of the questionnaire and finally an analysis of the correlations between scales. Like in section 3.2.2, the qualitative analysis of each construct is intended to inform possible explanations for the differences found in the quantitative ratings and insights for future research. It is mostly constituted by individual statements of the participants, but no statistical validity is attributed to them.

5.2.1.1 *Pre-evaluation: focus groups and interviews*

Experience with public transportation

The majority of the participants are not frequent passengers of the public transportation system. Mainly due to accessibility issues, they prefer using the car (*"We all use public transport as much as it is accessible and meets our goals"*). However, four participants said that the train is preferable to travel longer distances and pointed out the comfort aspect of this vehicle when compared to others. The subway was also preferred by some participants for daily commutes. The bus was not considered as useful mainly because of the schedule and the delays they are subjected to because of traffic. Overall, participants feel safe when using public transport, even though they considered that bus drivers drive aggressively (e.g., sudden braking and acceleration) because buses should be on time (*"I think, at least, from what I've seen that drivers are a bit aggressive because they have to be on time"*), and also because drivers are normally assigned to drive on the same routes. On this subject, a participant also added concern regarding Human Factors: (*"may be that the driver is tired, is bored or distracted, makes errors and so on"*).

Main concerns on automated mobility and technology maturity

Participants acknowledge that the available autonomous driving technology is still immature which has led to the non-adoption of some car systems. On the topic, two participants mentioned having bad experiences on the road due to ADAS technology. One participant also said that when buying a new car "*they don't explain to us how these systems work*" and added that *"people are expected to read a two-hundred-page manual to understand how the car works"*. Other than that, cybersecurity issues were referred (*"The autonomous car also has its weaknesses such as hacking, things that are not tested and doing something that is not expected"*) and others commented on the problems that could arise from the coexistence of autonomous and non-autonomous vehicles. Programming errors or the possibility of failure when technology has not been tested before were also mentioned by participants.

Expectations for future automated mobility: the automated shuttle

When presented with the video participants were able to describe the situation they were presented with, and pointed out that the shuttle needed to have external help from the control room when facing the obstacle. What was not clear for them was if the remote driver was granting permission to the vehicle to do the overtaking or if he was actually doing the manoeuvre from the control room (*"Either the person gives authorization or performs the manoeuvre"*).

Many participants mentioned that they would be more willing to trust a fully autonomous driving vehicle when compared to a vehicle that can sometimes be driven by a remote driver. They considered that if there is a need for having a remote driver, then it would probably mean that the technology is not totally prepared to face the road challenges. However, some pointed out that a driver inside the shuttle would provide more safety to passengers, even though that would be contrary to the idea of an autonomous shuttle (*"A driver inside does not make sense to me, if not that he already drives, having a remote person would seem good to me* *for very extreme situations that could act in an emergency*"). They also agreed on the risk of having just one remote driver monitoring many situations as presented in the video, and one participant pointed out a cost-related advantage of that scenario (*"A person in a remote control would control several shuttles and that would reduce costs"*). Another participant added a possible advantage of this scenario if applied in a real context, this time referring to 5G: *"if we use 5G connection it could help to have good communication with the infrastructure and other cars".*

Finally, some participants express their willingness to use a shuttle on regular commutes if available. Although they agreed on preferring to have an exclusive track for the shuttle, rejecting the existence of a mixed vehicle road environment (*"This hybrid [road environment/context] issue is not going to work, ever"; "I don't trust having autonomous cars and humans driving on a common road"; "The coexistence between the railroad, the motorcyclist, the pedestrian, the bicycle is already a problem in itself. If we introduce an autonomous vehicle, it's one more problem"*), they did not agree on the information that would have to be delivered to the passengers for a good experience. Some participants suggested that maybe it would be better not to have information about the shuttle's behaviour (*"I don't know if I would prefer to see all the cameras with everything that was happening outside the vehicle or if I would rather not see it. Maybe I would prefer not to see it because if I were riding the shuttle that would mean that I have a certain confidence/ trust to be there (...) because being always aware would feel as if I was driving"*), while others would prefer to be given information (*"The important thing would be for the shuttle to tell me what it is doing, to have information and inform"; "The information I would like is having cameras inside the shuttles that show me the road ahead"*). One of the participants pointed out that he would like to have access to risk data (*"What would be important is to deal with the risk through hard data about safety. There may be a risk threshold which I am willing to accept and above which I am not. People should be given statistics so they may or may not accept that risk"*).

Final comments

It was highlighted that the most important issue for this kind of public transport is safety. In general, participants agreed that autonomous shuttles would be the future of public transport but more research will be needed to ensure higher safety levels.

For the Spanish speakers a final question was added to close the focus group session. Participants were asked to imagine a media title that would summarize the main conclusions of the discussion. The following were the results of that exercise:

- *"Autonomous shuttles are closer than we think"*
- *"In a few years we won't have to drive"*
- *"Autonomous shuttles are not yet ready"*
- *"The shuttle and road safety in the future is the key"*

- *"Autonomous shuttles are here to stay, they just need to improve"*
- *"Autonomous shuttles will be the future of public transport"*

5.2.1.2 Analysis of survey and post-interviews

Mean values for the constructs are presented in Figure 25. All participants declared they had a good experience during the local and x-border trials. Some noted that it was their first contact with this kind of technology and that they were glad to have the opportunity to participate.

Overall, they mentioned that the systems under testing performed according to their best expectations (*"In both cases it stopped when it should stop"*) and that no problems arose (*"I have not perceived problems of connectivity no test track nor bridge"*). However, some participants noted an episode in which a more sudden break was experienced and reflected on the situation (*"On the bridge, there was an incident in which the pedestrian crossed at the last minute and the vehicle made a very sudden stop. Knowing it has this quick response-ability is encouraging"*). Apart from that moment and regarding performance, no differences were noticed between trials. The remote control concept was valued by many participants (e.g., *" Maybe the use case of remote control is a bit slow but it is great to have the possibility to control it remotely"; "I felt calm because the shuttle managed both use cases right, it has enough information to deal with that and even it has extra help with the remote control"*) and on the downside, a very frequent comment from participants was in regard to low-speed in both scenarios. In what concerns the shuttle performance for the use cases derived from ***RCCrossing*** and ***CoopAutom*** user-stories, no objective differences were pointed out by participants, except for one comment: *"It managed fine, mainly the detection of the pedestrian".*

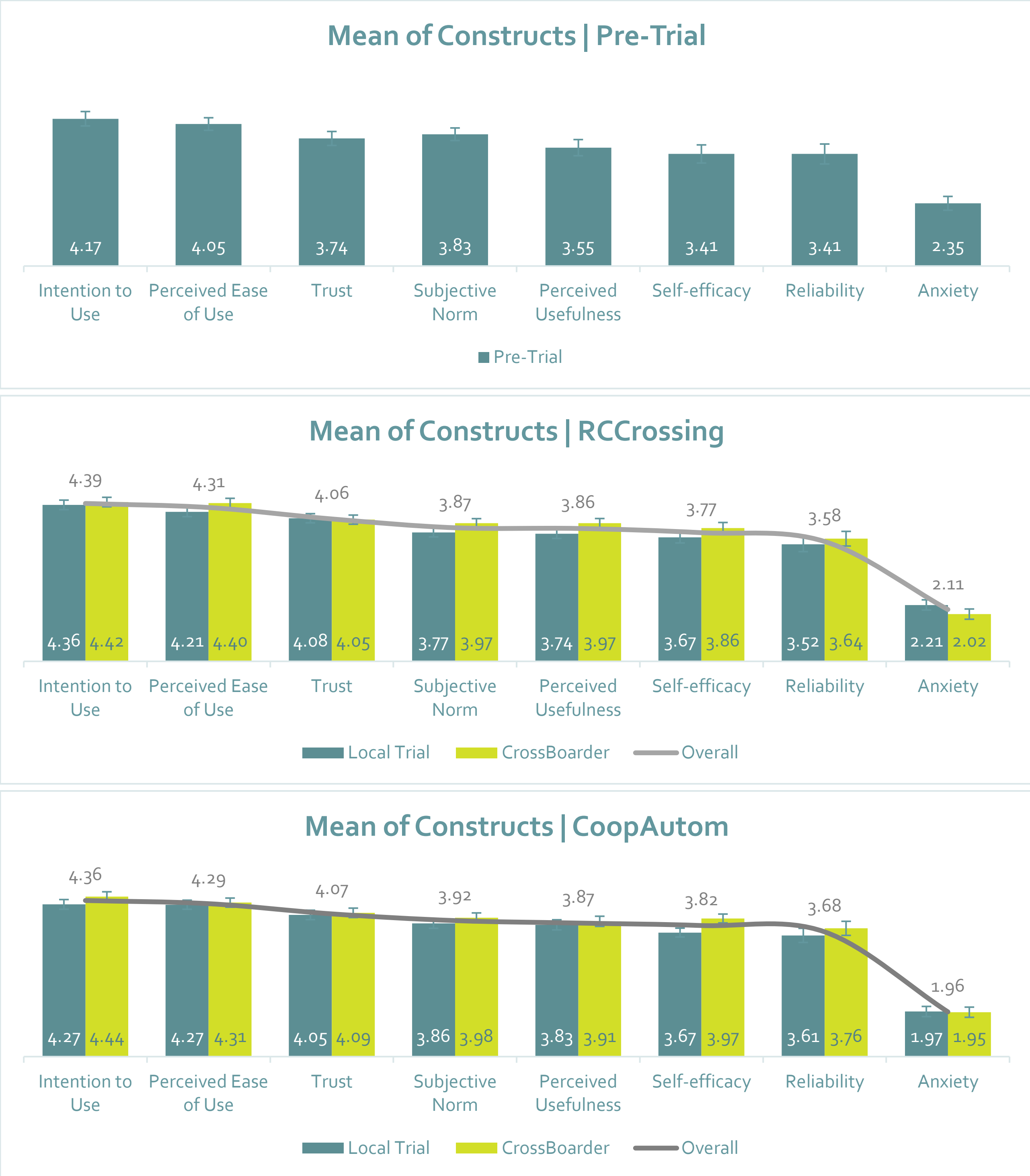


Figure 25: Mean and standard error of the constructs for each user story and scenario – Automated Shuttle

Intention-to-use

Regarding the UAAD, the *intention-to-use* was higher in the X-border compared with the Local trial, for both user-stories, although the difference was non-significant (RCCrossing: Z = 0.82. p>0.05 CoopAutom: Z = 1.538 p>0.05).

Almost all participants acknowledge the intention of using a shuttle if available, especially to go to work or to commute in the city. One participant mentioned that it would not be useful for him as he lives on the outskirts of the city and could not foresee a scenario in which the accessibility to it would be possible for him, which illustrates the fact that the usefulness of individual mobility solutions depends substantially on the users' personal context and needs.

Some also added the benefits of using such a shuttle for practical reasons, and because they found it a comfortable way of commuting. One participant was not so sure about the *usefulness* and *intention-to-use*, justifying his wariness about technological maturity: "*In the future it may be, but for now technology still requires work*". Some participants that manifested their intention to use a shuttle emphasized that the frequency would be a critical factor to choose using it or not: "*It also depends on the frequency of the shuttles*".

Ease-of-use

Ratings of *perceived ease-of-use* were higher in the X-border scenario compared to the local, in both user stories. Differences were non-significant (RCCrossing: Z = 1.927, p>0.05 CoopAutom: Z = 10.356 p>0.05).

The participants agreed that the system was easy to use, as it does not imply any action from the user. However, one participant referred that the older generation could have some resistance to using the shuttle, and another suggested that an App would be needed to use a shuttle.

Perceived usefulness

Ratings of *usefulness* were higher in the X-border condition compared to the local trial, in both user-stories. Differences were non-significant (RCCrossing: Z = 1.379, p>0.05 CoopAutom: Z = 0.536, p>0.05).

Most of the participants said that they would find a shuttle very useful on daily or urban commutes. One example of a daily commute would be for the *"first and last mile"* of a larger trip, as suggested by one of the participants.

Trust

Ratings of *trust* for the ***RCCrossing*** were higher in the local trial condition compared to the X-border, while for the ***CoopAutom***, the opposite was true. Differences were, nevertheless, non-significant (RCCrossing: Z = -0.473. p>0.05 CoopAutom: Z = 0.799, p>0.05).

Most of the participants suggested that they would trust an autonomous shuttle but that would depend on their technological maturity and previous experiences. Three participants argued that their trust perception was based on a shuttle that was subjected to a controlled environment, on a pre-defined route with low risk and that as it is a prototype it will require more testing to ensure complete trust. This may explain the slight diminishing of trust for the ***RCCrossing***, in the X-border context.

Reliability

Ratings of *reliability* were higher in the X-border condition compared to the Pre-trial, in both user-stories, although differences were non-significant (RCCrossing: $Z = 0.896$, $p>0.05$; CoopAutom: $Z = 1.200$. $p>0.05$).

Although six participants concluded that the shuttle would be reliable, twelve participants were cautious, referring to the need of maturing the technology and testing: *"Theoretically it could respond to various situations but it would have to be tested "*, and the need for evolving the prototype through testing: *"In CTAG the vehicle was confused about a shadow on the crosswalk"; "I believe that it is necessary more test to detect more errors"; "I am not sure, it is necessary more communication among the shuttle and the environment using 5g connectivity"*.

Subjective norm

Ratings of the *subjective-norm* construct were higher in the X-border condition compared to the Pre-trial, in both user-stories. Differences were non-significant (RCCrossing: $Z = 2{,}326$, $p>0.05$ CoopAutom: $Z = 1.126$, $p>0.05$).

The participants said that they would recommend the shuttle to their friends and family, mainly because they felt safe and enjoyed the experience.

Self-efficacy

Ratings of the *self-efficacy* construct were higher in the X-border condition compared to the Pre-trial, in both user-stories. Differences were non-significant (RCCrossing: $Z = 1.589$, $p>0.05$ CoopAutom: $Z = 2.144$, $p>0.05$).

For this question, the participants did not focus on their individual perceived capability of doing a longer trip on a shuttle, maybe because of the *perceived ease-of-use*, and deflected their responses to the need for the shuttle to reach a higher speed in order to be useful to long-range routes.

Anxiety

Contrary to most of the constructs mentioned so far, ratings of *anxiety* were higher in the local trial condition compared to the X-border, in both user-stories. Differences were non-significant (RCCrossing: $Z = -0.974$, $p>0.05$ CoopAutom: $Z = -0.550$. $p>0.05$).

Generally, participants claimed not feeling anxious about riding an automated shuttle, based on their good experience in a controlled environment.

5.2.1.3 *Relations between constructs*

Table 31 presents the correlations between constructs for the two user-stories. It is noticeable that *trust*, followed by *perceived usefulness* have the stronger correlations with the *intention-to-use*. *Perceived ease-of-use* does not seem to be strongly related with the *intention-to-use*. *Anxiety* appears also strongly correlated with *trust*.

Table 31: Correlation matrices for the automated shuttle user-stories

RCCrossing	*Intention to Use*	*Perceived Ease of Use*	*Trust*	*Subjective Norm*	*Perceived Usefulness*	*Self-efficacy*	*Reliability*	*Anxiety*
Intention to Use	-							
Perceived Ease of Use	0.42	-						
Trust	0.66	*n.s.*	-					
Subjective Norm	0.43	*n.s.*	0.35	-				
Perceived Usefulness	0.61	*n.s.*	0.46	0.41	-			
Self-efficacy	0.39	0.45	0.58	0.49	0.34	-		
Reliability	0.31	*n.s.*	0.57	0.44	*n.s.*	0.55	-	
Anxiety	-0.52	-0.33	-0.68	*n.s.*	*n.s.*	-0.47	-0.41	-
CoopAutom	*Intention to Use*	*Perceived Ease of Use*	*Trust*	*Subjective Norm*	*Perceived Usefulness*	*Self-efficacy*	*Reliability*	*Anxiety*
Intention to Use	-							
Perceived Ease of Use	0.52	-						
Trust	0.68	0.56	-					
Subjective Norm	0.49	*n.s.*	0.48	-				
Perceived Usefulness	0.68	*n.s.*	0.46	0.36	-			
Self-efficacy	0.38	0.54	0.57	0.44	0.30	-		
Reliability	0.47	*n.s.*	0.74	0.48	0.36	0.50	-	
Anxiety	-0.33	-0.52	-0.64	*n.s.*	*n.s.*	-0.52	-0.49	-

5.2.1.4 *User acceptance KPIs*

The following table summarize the values of the KPIs for each of the remote shuttle user stories.

Table 32: Summary of KPIs for the RCCrossing user story

ID	Description	Results						
		Cond.	*Mean*	*STD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	Local	4.4	0.6	5.0	3.0	5.0	4.2 – 4.6
		x-border	4.4	0.8	5.0	2.0	5.	4.0 – 4.8
UA-M1.2	Perceived Technology Usefulness	Local	3.7	1.1	5.0	1.3	5.0	3.2 – 4.2
		x-border	4.0	1.0	5.0	1.7	5.0	3.6 – 4.4
UA-M1.3	Perceived Technology Ease-of-use	Local	4.2	0.6	5.0	3.0	5.0	3.9 – 4.5
		x-border	4.4	0.7	5.0	2.7	5.0	4.1 – 4.7
UA-M1.4	Affinity for Technology Interaction	-	4.6					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.6	0.5	1.0	-1.3	0.7	0.3 – 0.9
UA-M2.2	Perceived Trust	Local	4.1	0.6	5.0	2.7	5.0	3.9 – 4.3
		x-border	4.0	0.8	5.0	2.7	5.0	3.6 – 4.4
UA-M2.3	Perceived Reliability	Local	3.5	0.6	4.7	2.7	4.3	3.2 – 3.8
		x-border	3.6	0.7	5.0	2.3	4.6	3.3 – 3.9

Table 33: Summary of KPIs for the CoopAutom user story

ID	Description	Results						
		Cond.	*Mean*	*STD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	Local	4.3	0.74	5.0	3.0	5.0	4.0 – 4.6
		x-border	4.5	0.7	5.0	3.0	5.0	4.2 – 4.8
UA-M1.2		Local	3.8	1.1	5.0	1.7	5.0	3.3 – 4.3

	Perceived Technology Usefulness	x-border	3.9	1	5.0	1.7	5.0	3.4 – 4.4
UA-M1.3	Perceived Technology Ease-of-use	Local	4.3	0.73	5.0	3.0	5.0	4.0 – 4.6
		x-border	4.3	0.8	5.0	2.7	5.0	3.9 – 4.7
UA-M1.4	Affinity for Technology Interaction	-	4.6					
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.2	0.5	1.3	-1.0	1.0	0.1 – 0.2
UA-M2.2	Perceived Trust	Local	4.0	0.72	5.0	2.0	5.0	3.6 – 4.4
		x-border	4.1	0.62	5.0	3.0	5.0	3.8 – 4.4
UA-M2.3	Perceived Reliability	Local	3.6	0.7	4.7	2.3	4.3	3.3 – 3.9
		x-border	3.7	0.7	5.0	2.3	5.0	3.3 – 4.1

5.3 Discussion

During the pre-trial, participants highlighted several doubts and concerns that are relevant for the automated driving technology, such as, for instance, concerns with the maturity of the technology, inadequate training when acquiring an automated/partially automated vehicle or cybersecurity. Regarding specifically the ***RCCrossing*** user story, several participants highlighted their willingness to use the shuttle for regular commutes (if available), although they have manifested doubts regarding the idea of shared traffic (autonomous and manual vehicles). A curious reference was the statement that, if an automated shuttle needs a remote driver, then the technology is not prepared for real road. Overall the main concern highlighted by the participants was the safety of the technology.

Generally, the acceptability values for the two user stories involving the automated shuttle were high. This can be directly observed through the ratings of the UAAD scale, in which mean values of *intention-to-use* were above 4 in all situations. The value of most of the constructs were higher at the x-border condition (except for *anxiety* which has an opposite trajectory), although differences were generally non-significant. Importantly, values were also higher when compared with the pre-trial (although a direct statistical comparison cannot be made). This highlights the fact that, by experimenting a technology, users may increase their acceptability towards it [22].

The results also hint that handover/roaming connectivity disruption was negligible on the service level for these particular user stories and test conditions, although more extensive trials and pilots will be needed to ensure this remains true for other conditions. For instance, in trials using the S10 interface in Home Routed in ES and PT NSA networks, observable maximum communication latencies surpassed the value of 300 ms.

Such values may disrupt the remote driving performance and force emergency stops, even at speeds of 10 km/h.

This is important. It could possibly be commented that this finding is of considerable value taking into account that the X-border condition included an inter-PLMN handover. Namely, this result demonstrates that the handover/roaming connectivity disruption is practically negligible on the service level for this particular user stories and test conditions. It must be highlighted though that more extensive trials & pilots are needed to come up with an exhaustive set of tests covering all possible timings i.e., occurrence of handover with respect to road/vehicle conditions.

In the same guise as the advanced manoeuvres, there is a correlation between *intention-to-use* and *perceived usefulness*, while *perceived ease-of-use* does not appear strongly correlated. A hypothesis similar to the one made in the advanced manoeuvres can then be done: The fact that the participants could not exactly interact with the system, does not allow them to evaluate properly this construct and thus the connection with intention-to-use is not elicited. *Trust*, on the other hand, appears as a strong indication of acceptance. This is in line with studies of [8]. It is possible that the nature of the trial (with the users inside a real vehicle) has favoured the emergence of this construct.

6 GLOBAL ONLINE EVALUATION

This chapter reports on the acceptability evaluation of the user-stories through the online survey. This method was used to provide complementary data to the trials and as a way to obtain acceptability measurements, more directly comparable across user-stories. The survey covered all the complex manoeuvres user-stories and the two Automated Shuttle user stories, which, were combined. The rationale for combining them (***RCCrossing*** and ***CoopAutom***) was that it was understood that the ***CoopAutom*** could not be properly understood without first describing the concept in ***RRCrossing***. Here this combined user story is referred simply as ***AutomatedShuttle***. The ***HDMapsPublicTransport*** user story was not directly included but its concept was evaluated together with the ***HDMapsVehicle***.

6.1 Methodology

The survey was developed using the user-stories descriptions reported in Annex 2 and the UAAD instrument reported in chapter 2. The user-stories and the UAAD questionnaire were translated into 7 additional languages: Portuguese, Spanish, French, German, Italian and Greek. A landing page was prepared in which a respondent could select the language in which to respond. Upon selecting the language, the respondent was forwarded to a form with four sections, presented sequentially:

1) Project presentation, that introduced the topic and scope of the project as well as the survey instructions:

> *"Thank you very much for participating in this online survey conducted by 5G-MOBIX project (https://www.5g-mobix.com/).*
>
> *5G-MOBIX is a research project co-financed by the European Commission that is testing automated vehicle functionalities using 5G technologies in cross-border areas.*
>
> *The survey will take approximately 10 minutes. Don't be deterred by the length, due to multiple illustrations and some explanatory text for each scenario; the questions themselves are very quick to answer as they are statements that you indicate to agree or disagree with. There are no right or wrong answers; the idea is to know your opinion about different issues related to automated vehicle functionalities using 5G connection. If you are not sure, please select the alternative that comes closest to your own beliefs.*
>
> *Your participation in this research study is completely voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time. We do not collect any identifying information such as your name, email address or phone. We just collect the strictly necessary amount of personal data for the purposes of this study, limited to your age, level of education, occupation and frequency of travel. The information provided in this questionnaire will*

not be combined with any other data source. Therefore, your answers will be anonymous as they will not be linkable to you in any way.

Furthermore, we are implementing applicable measures to protect the information from being disclosed to any unauthorized external parties. The results of this study will be exclusively shared with 5G-MOBIX partners for the user acceptance evaluation task. Eventually, the information will be permanently deleted from all databases four years after the completion of the project.

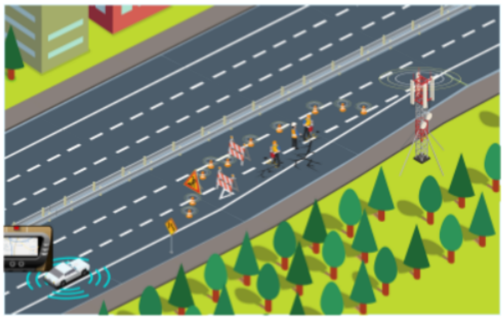
Please tell us if you agree to logging and analysing your questionnaire data?

Yes, I agree.

No, I don't agree."

2) A randomly assigned description of one of the user-stories in a specific scenario (best, average, worst). This was followed by a corresponding stop-motion video.

You are travelling on a highway in an automated vehicle. This vehicle is capable of driving itself from one destination to another, doing all required manoeuvres. If the vehicle finds a situation it is unable to deal with, it will request that **you** take over control. This vehicle is connected wirelessly to an ITS (Intelligent Transportation System) server. This is a cloud-based service that centralizes information received from all the vehicles connected to it, plus sensors installed in the road's infrastructure. It processes and shares the information it receives with all the connected vehicles, including your own. The information your vehicle receives can be, for instance, about road conditions and events (for example, accidents) on the road ahead or location of surrounding vehicles. It is used to improve the driving performance of your automated vehicle.



3) The UAAD questionnaire;

* 2. Indicate the number that best reflects your agreement with each statement listed below. Answer from the perspective of a driver (1=totally disagree and 5=totally agree).

	Totally disagree 1	2	3	4	Totally agree 5
Overall, I could trust the automated vehicle.	◯	◯	◯	◯	◯
I would be able to handle whatever happens while using the automated vehicle.	◯	◯	◯	◯	◯
I believe that an automated vehicle would be free of error.	◯	◯	◯	◯	◯
I could reach my destination using the automated vehicle even if I had no assistance.	◯	◯	◯	◯	◯
If I had such an automated vehicle, I would use it frequently during my trips.	◯	◯	◯	◯	◯

4) A demographic questionnaire collecting data referring to Age, Gender and other relevant information.

The survey was disseminated through the projects mailing lists and by each partner individually on social media accounts and contacts. A video "teaser" was also prepared to serve as supporting material on the dissemination. Data collection took place between April 2022 and July 2022.

6.2 Data Analysis

Data was analysed following a procedure similar to the one used for the UAAD in the Advanced Manoeuvres analysis (section 3.2.1.5). UAAD subscales were checked for consistency using Cronbach's Alpha, calculated per construct and user-story. Mean values were calculated for each construct and scenario. For each construct, the effects of scenario were independently analysed. The effect of scenario was analysed using Kruskal–Wallis one-way analysis of variance[7]. When significant, post-hoc comparisons between pairs (testing if the first is greater than the second) were done through Wilcoxon rank sum tests. P-values below 0.1 were considered marginally significative and below 0.05 were deemed significative.

[7] Non-parametric statistical test to determine if three or more independent groups of values are statistically different.

6.3 Results

6.3.1 Participants

The online survey was open to the general population. It was disseminated in the social networks of the project and of the project's participants and partners. A total of 556 respondents answered the online survey, from which 257 complete responses (the remaining participants abandoned the questionnaire before completing it) were obtained (56.8% men, 32.7% women and 10.5% did not answer/preferred not to declare) with the age distribution shown in Table 34. Among the respondents, most live in Spain (23.0%), Portugal (17.1%) and United Kingdom (14.4%). The vast majority have a driving license (91.8%) for a time between 1 and 55 years (M = 22; SD = 12.5). The level of education can be considered high, with most respondents having a master's degree (38.1%) and PhD (20.6%) and 82.0% with full-time employment. Participants were distributed across the four scenarios evaluated, ***LaneMerge*** (72), ***Overtaking*** (63), ***HDMapsVehicle*** (39) and ***AutomatedShuttle*** (83).

Table 34: Demographic data of participants – online survey

		Overall	Automated vehicle			Automated Shuttle
			Lane Merge	Overtaking	HD Map	Remote Control
Gender	Female	84	28	24	7	25
	Male	146	38	34	27	47
	Prefer not to say	9	2	1	2	4
	No answer	18	4	4	3	7
Age	18-30 Years	55	19	10	12	14
	31-40 Years	78	18	19	10	31
	41-50 Years	56	14	19	7	16
	51-60 Years	35	13	5	5	12
	61-70 Years	15	1	6	5	3
	Over 70 Years	5	3	2	0	0
	No answer	13	4	2	0	7
What is your highest education level?	Primary school/ elementary school	1	0	1	0	0
	Secondary/ technical/ business school	20	5	7	3	5

	Bachelor	16	8	1	1	6
	Degree	50	16	13	10	11
	Master	98	25	25	19	29
	PhD	53	13	12	6	22
	Don't know /No answer	19	5	4	0	10
What is your current employment status?	Pupil, student, apprentice	11	1	5	0	5
	Seeking employment	1	0	0	1	0
	Part-time employment	7	2	2	0	3
	Full-time employment	212	61	50	37	64
	Retired	7	3	2	0	2
	Freelance	1	0	1	0	0
	Research fellow	1	1	0	0	0
	Don't know/No answer	17	4	3	1	9
Which best describes your living situation	Outside town/city in house in countryside	45	11	11	11	12
	In house on town/city outskirts	47	8	8	11	20
	Within town/city, but outside town/city centre in purely residential area	73	26	24	2	21
	In apartment in immediate town/city centre	78	23	18	14	23
	Don't know/No answer	14	4	2	1	7
Do you own a valid driver's license?	Yes	236	65	59	38	74
	No	8	3	2	1	2
	Don't know / No answer	13	4	2	0	7
Have you ever been driven by an Automated Vehicle?	Yes	66	16	13	9	28
	No	178	52	48	30	48
	Don't know/No answer	13	4	2	0	7

Table 35 presents the travel habits of the participants and it can be seen that on a daily basis, most respondents travel by foot (46.3%) or in a car, as a driver or passengers (46.7%). The daily use of transport is restricted to 9.3% while 21.4% travel by bicycle at least once a week.

Table 35: Travel habits of the participants – online survey

	Daily or almost daily	1-3 days per week	1-3 days per month	Less than monthly	Never or almost never	Don't know/No answer
How often do you walk more than 0.5 km by foot per trip?	46.3%	33.5%	7.4%	2.3%	5.1%	5.4%
How often do you use a bicycle?	7.4%	14%	8.2%	12.5%	51.4%	6.6%
How often do you use a Moped or Motorcycle?	1.9%	3.1%	3.1%	3.1%	82.1%	6.6%
How often do you use a car as driver or passenger?	46.7%	30.7%	8.9%	4.3%	3.5%	5.8%
How often do you use public transport for trips under 100 km?	9.3%	8.6%	16.3%	22.6%	37.4%	5.8%
How often do you use public transport for trips longer than 100km per trip?	0%	1.9%	10.1%	38.9%	41.6%	7.4%

6.3.2 UAAD analysis

Consistency analysis of the UAAD was generally considered satisfactory. Cronbach's Alpha was at least acceptable (values > 60%) for most of the constructs (see Annex 9). The low number of participants that filled some of the user-stories may justify some of the lower values. A general presentation of the results can be seen in Figure 26, which depicts mean values and standard errors of the UAAD constructs per user-story and scenario.

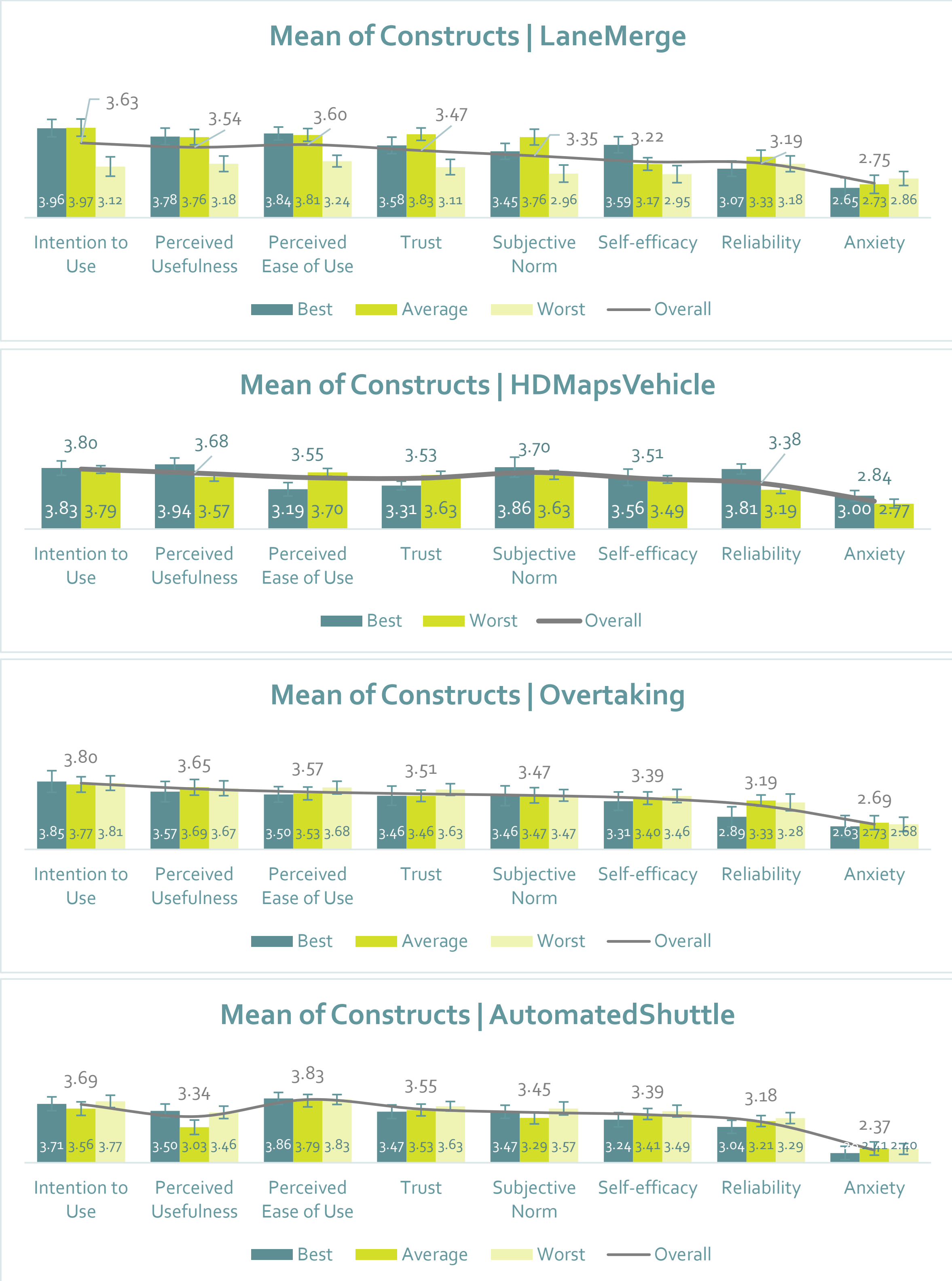


Figure 26: Mean and standard error of the constructs for each user story and scenario – Online Survey

Overall, participants made a positive evaluation of the acceptability of the several user stories. Mean ratings for the *intention-to-use* were generally positive (above three) for all user-stories (see Table 36). A significant effect of the scenario was found for ***LaneMerge***, with the WO scenario having substantially lower ratings compared to the BE and AV. This pattern of differences between the WO scenario and the others, for the ***LaneMerge*** was actually common, for most of the constructs except for *anxiety* (where the differences were non-significant for all constructs). Clearly the WO scenario in this user-story was distinctively negative. Based on the comments gathered from the online interviews, one can hypothesize that this happens because the vehicle stopped, which most participants viewed as a negative behaviour.

Some differences were also found for the ***HDMapsVehicle***. For the *perceived usefulness*, BE was marginally superior than WO. For the *perceived ease-of-use* BE was not superior and in fact observation of the plots in Figure 26 hints that it may have actually been considered inferior. Values for BE were also significantly higher for the *reliability* construct and marginally higher for the subjective norm.

Table 36: Statistical analysis of the constructs for the online survey

Construct	User-story	Statistic	*p*	Post-hoc comparisons	
				Pair	*p*
Intention to use	***LaneMerge***	$\chi 2(2) = 11$	**0.005****	BE-AV	*n.s.*
				BE-WO	**0.016****
				AV-WO	**0.016****
	Overtaking	$\chi 2(2) = 0.3$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	**Z** = -0.594	*n.s.*	-	-
	AutomatedShuttle	$\chi 2(2) = 0.9$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Perceived Usefulness	***LaneMerge***	$\chi 2(2) = 8$	**0.02****	BE-AV	*n.s.*
				BE-WO	**0.028****
				AV-WO	**0.028****
	Overtaking	$\chi 2(2) = 0.2$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	*Z* = -1.427	**0.08***	-	-
	AutomatedShuttle	$\chi 2(2) = 4$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	LaneMerge	$\chi 2(2) = 10$	**0.005****	BE-AV	*n.s.*
				BE-WO	**0.008****

Perceived Ease-of-use				AV-WO	**0.008****
	Overtaking	$\chi^2 (2) = 0.5$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	Z = 1.911	*n.s.*	-	-
	AutomatedShuttle	$\chi^2 (2) = 0.2$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Trust	***LaneMerge***	$\chi^2 (2) = 9$	**0.01****	BE-AV	*ns*
				BE-WO	*ns*
				AV-WO	**0.006****
	Overtaking	$\chi^2 (2) = 0.2$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	*Z* = -1.852	*n.s.*	-	-
	AutomatedShuttle	$\chi^2 (2) = 0.06$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Reliability	***LaneMerge***	$\chi^2 (2) = 10$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	Overtaking	$\chi^2 (2) = 0.5$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	*Z* = -2.539	**0.005****	-	-
	AutomatedShuttle	$\chi^2 (2) = 0.8$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Subjective Norm	***LaneMerge***	$\chi^2 (2) = 9$	**0.01****	BE-AV	*n.s.*
				BE-WO	*n.s.*
				AV-WO	**0.006****
	Overtaking	$\chi^2(2) = 0.09$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	Z = -1.517	**0.06***	-	-
	AutomatedShuttle	$\chi^2 (2) = 2$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Self-efficacy	***LaneMerge***	$\chi^2(2) = 6$	**0.06***	BE-AV	*n.s.*
				BE-WO	**0.03****
				AV-WO	*n.s.*
	Overtaking	$\chi^2(2) = 0.1$	*n.s.*	BE-AV	-

				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	*Z* = -0.372	*n.s.*	-	-
	AutomatedShuttle	$\chi 2(2) = 0.6$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
Anxiety	***LaneMerge***	$\chi 2(2) = 0.5$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	Overtaking	$\chi 2(2) = 0.2$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-
	HDMapsVehicle (BE-WO)	*Z* = -0.7	*n.s.*	-	-
	AutomatedShuttle	$\chi 2(2) = 1$	*n.s.*	BE-AV	-
				BE-WO	-
				AV-WO	-

6.3.3 Relations between constructs

Table 37 presents the correlations between constructs for the four user-stories. It is noticeable that *perceived usefulness*, *trust*, and *subjective norm* have the stronger correlations with the *intention-to-use*. The relation between *perceived usefulness*, *trust* with the *intention-to-use* is congruent with the observations in the online interviews (advanced manoeuvres) and the trials involving the shuttle. However, the strong relation with *subjective norm* comes as a particularly novelty of this method. Also congruent with the previous observations is the fact that *perceived-ease-of-use* does not seem to be strongly related with the intention-to-use. *Anxiety* does not appear strongly correlated with any other construct.

Table 37: Correlation matrices for the Online Survey, per user-story

LaneMerge	*Intention to Use*	*Perceived Ease of Use*	*Trust*	*Subjective Norm*	*Perceived Usefulness*	*Self-efficacy*	*Reliability*	*Anxiety*
Intention to Use	-							
Perc. Ease-of-use	0.66	-						
Trust	0.72	0.58	-					
Subjective Norm	0.75	0.53	0.68	-				
Perc. Usefulness	0.78	0.61	0.66	0.62	-			
Self-efficacy	0.65	0.65	0.73	0.64	0.63	-		
Reliability	0.58	0.37	0.67	0.66	0.54	0.51	-	
Anxiety	-0.44	-0.41	-0.49	-0.24	-0.39	-0.45	-0.24	-
Overtaking	***Intention to Use***	***Perceived Ease of Use***	***Trust***	***Subjective Norm***	***Perceived Usefulness***	***Self-efficacy***	***Reliability***	***Anxiety***
Intention to Use	-							
Perc. Ease-of-Use	0.58	-						

Trust	0.74	0.61	-					
Subjective Norm	0.66	0.41	0.70	-				
Perceived Usefulness	0.77	0.55	0.68	0.63	-			
Self-efficacy	0.67	0.62	0.70	0.55	0.62	-		
Reliability	0.52	0.38	0.74	0.74	0.56	0.51	-	
Anxiety	-0.47	-0.40	-0.46	-0.26	-0.37	-0.56	-0.27	-
HDMapsVehicle	***Intention to Use***	***Perceived Ease of Use***	***Trust***	***Subjective Norm***	***Perceived Usefulness***	***Self-efficacy***	***Reliability***	***Anxiety***
Intention to Use	-							
Perc. Ease-of-use	0.49	-						
Trust	0.62	0.60	-					
Subjective Norm	0.72	0.37	0.61	-				
Perc. Usefulness	0.76	0.33	0.50	0.58	-			
Self-efficacy	0.50	0.64	0.43	0.47	*n.s.*	-		
Reliability	0.47	*n.s.*	0.40	0.55	0.41	*n.s.*	-	
Anxiety	-0.40	-0.49	-0.40	*n.s.*	-0.39	-0.39	*n.s.*	-
Shuttle	***Intention to Use***	***Perceived Ease of Use***	***Trust***	***Subjective Norm***	***Perceived Usefulness***	***Self-efficacy***	***Reliabilit y***	***Anxiety***
Intention to Use	-							
Perc. Ease-of-use	0.48	-						
Trust	0.69	0.62	-					
Subjective Norm	0.77	0.47	0.72	-				
Perc. Usefulness	0.69	0.34	0.45	0.67	-			
Self-efficacy	0.66	0.45	0.62	0.63	0.48	-		
Reliability	0.65	0.31	0.69	0.70	0.56	0.65	-	
Anxiety	-0.36	-0.40	-0.44	-0.26	*n.s.*	-0.35	-0.25	-

6.3.4 User acceptance KPIs

The following tables summarize the mean values of the KPIs, for the different user-stories.

Table 38: Summary of KPIs for the *LaneMerge* user story

ID	Description	Results						
		Cond.	*Mean*	*SD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	BC	4.0	0.9	5.0	2.0	5.0	3.7 - 4.3
		AC	4.0	0.9	5.0	2.3	5.0	3.6 - 4.4
		WC	3.1	1.1	5.0	1.0	5.0	2.7 - 3.5
UA-M1.2	Perceived Technology Usefulness	BC	3.8	0.9	5.0	2.3	5.0	3.4 - 4.2
		AC	3.8	0.8	5.0	2.3	5.0	3.5 - 4.1
		WC	3.2	0.9	5.0	2.0	4.9	2.9 - 3.5
UA-M1.3	Perceived Technology Ease-of-use	BC	3.8	0.7	5.0	3.0	5.0	3.5 - 4.1
		AC	3.8	0.6	5.0	2.7	5.0	3.5 - 4.1
		WC	3.2	0.7	4.7	2.0	4.2	2.9 - 3.5

UA-M 1.5	Acceptability difference (higher – lower values)	-	0.9					
UA-M2.2	Perceived Trust	BC	3.6	0.8	5.0	2.3	5.0	3.2 - 4.0
		AC	3.8	0.6	5.0	2.7	4.7	3.5 - 4.1
		WC	3.1	0.9	4.7	1.3	4.5	2.8 - 3.4
UA-M2.3	Perceived Reliability	BC	3.1	0.8	5.0	2.3	4.0	2.7 - 3.4
		AC	3.3	0.7	5.0	2.3	4.3	3.0 - 3.6
		WC	3.2	0.9	5.0	1.7	4.7	2.9 - 3.5

Table 39: Summary of KPIs for the *Overtaking* user story

ID	Description	Results						
		Cond.	*Mean*	*SD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1	Acceptance Intention (Intention to use)	BC	3.9	1.2	5.0	1.0	5.0	3.3 - 4.5
		AC	3.8	1.1	5.0	1.0	5.0	3.3 - 4.2
		WC	3.8	0.9	5.0	1.7	5.0	3.4 - 4.2
UA-M1.2	Perceived Technology Usefulness	BC	3.6	1.2	5.0	1.0	5.0	3.0 - 4.2
		AV	3.7	1.1	5.0	1.0	5.0	3.2 - 4.2
		WC	3.7	0.9	5.0	2.0	5.0	3.3 – 4.1
UA-M1.3	Perceived Technology Ease-of-use	BC	3.5	0.9	5.0	1.0	4.4	3.0 - 4.0
		AV	3.5	0.9	5.0	2.0	5.0	3.1 - 3.9
		WC	3.7	0.8	4.7	2.3	4.7	3.4 - 4.0
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.1					
UA-M2.2	Trust	BC	3.5	1.1	5.0	1.0	5.0	3.0 - 4.0
		AV	3.5	0.8	5.0	1.0	4.7	3.2 - 3.8
		WC	3.6	0.7	5.0	2.7	4.7	3.2 - 4.0
UA-M2.3	Reliability	BC	2.9	1.2	5.0	1.0	4.7	2.3 - 3.5
		AV	3.3	0.8	4.3	1.0	4.2	3.0 - 3.6
		WC	3.3	1.0	5.0	1.7	4.7	2.8 - 3.8

Table 40: Summary of KPIs for the *HDMapsVehicle* user story

ID	Description	Results						
		Cond.	*Mean*	*STD*	*MAX*	*MIN*	*Perc 95*	*CI95%*
UA-M1.1		BC	3.8	0.7	4.7	2.0	4.7	3.3 - 4.3

	Acceptance Intention (Intention to use)	WC	3.8	0.7	5.0	2.7	5.0	3.5 - 4.1
UA-M1.2	Perceived Technology Usefulness	BC	3.9	0.7	5.0	3.0	4.8	3.4 - 4.4
		WC	3.6	0.8	5.0	2.0	5	3.3 - 3.9
UA-M1.3	Perceived Technology Ease-of-use	BC	3.2	0.7	4.3	1.7	4.1	2.8 - 3.6
		WC	3.7	0.7	5.0	2.3	4.6	3.4 - 4.0
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.0					
UA-M2.2	Trust	BC	3.3	0.5	4.0	2.3	4.0	3.0 - 3.6
		WC	3.6	0.7	4.7	1.7	4.3	3.3 - 3.9
UA-M2.3	Reliability	BC	3.8	0.5	4.7	3.0	4.5	3.5 - 4.1
		WC	3.2	0.7	4.7	1.7	4.2	2.9 - 3.5

Table 41: Summary of KPIs for the *AutomatedShuttle user story*

ID	Description	Results						
		Cond.	**Mean**	**STD**	**MAX**	**MIN**	**Perc 95**	**CI**
UA-M1.1	Acceptance Intention (Intention to use)	BC	3.7	1.0	5.0	1.7	5	4.12
		AC	3.6	1.0	5.0	1.3	5	3.97
		WC	3.8	1.0	5.0	1.0	5	4.14
UA-M1.2	Perceived Technology Usefulness	BC	3.5	1.0	4.7	1.0	5	3.91
		AV	3.0	1.1	5.0	1.0	4.75	3.46
		WC	3.5	1.0	5.0	1.0	5	3.82
UA-M1.3	Perceived Technology Ease-of-use	BC	3.9	0.9	5.0	1.3	5	4.22
		AV	3.8	0.9	5.0	1.3	5	4.17
		WC	3.8	0.8	5.0	2.3	5	4.12
UA-M 1.5	Acceptability difference (higher – lower values)	-	0.2					
UA-M2.2	Trust	BC	3.5	1.0	5.0	1.3	4.67	3.88
		AV	3.5	0.9	5.0	2.0	4.67	3.88
		WC	3.6	0.8	5.0	2.3	5	3.91
UA-M2.3	Reliability	BC	3.0	1.0	4.7	1.3	4.58	3.43
		AV	3.2	0.8	5.0	2.0	4.25	3.53
		WC	3.3	0.9	5.0	1.7	4.83	3.61

6.4 Discussion

Evaluations of the acceptability were consistent and positive in general, as one can see particularly in the scores of the *intention-to-use*. However, the ratings were in general lower when compared to the ones obtained with the other methods (this will be discussed in the next chapter). Differences between the scenarios were not substantial, with the notable exception of the ***LaneMerge***, where the WO scenario faired substantially lower when compared to BE and AV. This highlights the fact that differences in performance of enabling technologies may not exactly make-or-break the user perception depending on how the system's response is designed to deal with "less than ideal" situations. For the WO scenario in the ***LaneMerge*** the stopping behaviour may have been an important negative factor. Still, the less than ideal number of responses and the fact that the approach used an independent samples approach (each participant answered the survey only once to a single user story/scenario may hinder the capacity to find smaller differences between scenarios).

An observation can be made regarding the ***HDMapsVehicle*** user-story. The value of *reliability* for the BE scenario was significantly higher compared to the WO, pointing to a higher difference between the two than the ones occurring for the other user-stories. The fact that the system is unable to deal with the situation alone (the failsafe action is to handover control) may have substantially decrease the perceived *reliability* of the system, even if the *trust* was not affected in the same way. Other hypothesis is that the explanation provided to the respondents regarding the reason why the car had to request for the driver to take over, may have given the image of a complex system, that is not always able to deal with road situations [27].

Consistently with the observations in the other evaluation methods was the correlation between *intention-to-use* and *perceived usefulness* and *trust*, and the not-so-large correlation with *perceived ease-of-use*, against what one would expect from the literature. Again, one can hypothesize that, not giving participants the opportunity to actually try the vehicle, may not allow a proper evaluation of this construct.

7 GENERAL DISCUSSION

CAM refers to a set technological concepts that are increasingly regarded as the future of road transport. However, to ensure wide adoption of CAM it is important to understand the key elements that affect user acceptance, including the role of enabling technologies such as 5G connectivity, and particular contexts such as the borders between countries. Such was the main aim of the user acceptance activities reported here. Using different evaluation methods, a set of acceptability KPIs and a few additional indicators (other constructs of the model) were collected for different CAM user stories.

In terms of acceptability, two main hypotheses were defined in section 2.2, namely:

1) Acceptability of the proposed CAM concepts would in general be positive;
2) Network related technical issues at the border context could negatively impact acceptability.

Regarding the first hypothesis one can state that it was indeed verified. In general, all user stories were evaluated positively, even in the situations hindered by connectivity issues. This was consistently observed for different methodologies and user stories. Overall, participants stated both quantitatively and qualitatively that they would use the several proposed CAM use-cases. They considered them to be useful, easy-to-use and trustable/reliable. Additional indicators such as *subjective norm* and *anxiety* (this last one generally reported to be low) also support this conclusion. Two main advantages were pointed out regarding the CAM technological propositions: 1) They would increase free time (e.g. rest or work) by freeing the driver from the responsibility to drive. 2) They would increase safety, as automation can (or will be able to) in principle drive more safely than human drivers. Referring to the latter, participants appreciated the anticipatory information provided via 5G network (e.g. regarding approaching vehicles) although the network dependency and the unstable behaviour under bad network conditions has uneased some of them.

Regarding the second hypothesis the answer is more nuanced. On the one hand, in the shuttle-related user stories acceptability was evaluated more positively at border than at the local trials. However, the network functioned optimally during the border trials involving users. Thus, while it was a border context, the user experience had no influence of x-border issues. On the other hand, the online interviews seem to show that the degree to which x-border issues affect acceptability depends substantially on how the interaction is designed to respond to such issues. The more unpredictable behaviour of the vehicle under sub-par network conditions was evaluated more negatively then the clearer, safer-perceived behaviour presented in full network interruption. This is an important lesson for HMI design: systems should be designed to behave consistently and predictably [29]. In that sense, it may be worth considering that, under less than ideal conditions, it is best for the system to act as if in total network failure, or at least to design the system's communication (with the user) in such a way that its future actions are predictable.

The work reported has some limitations. One of them is that some of the evaluations were done with relatively small numbers of participants, which may limit the representativity of results. This was true mostly for the user stories related with the automated shuttle. On the other hand, the online survey allowed to complement these smaller numbers, providing additional support to the evaluation.

Another limitation of the evaluations was that the majority of the participants were from technological backgrounds, which may hint that they were prone to interact with technology. Congruent with this is the fact that the ATI assessments resulted in generally high values. Thus, and overall, some positive bias in absolute values of acceptability may exist. However, the comparative approach that was pursued (BE-AV-WO or local vs x-border) should ensure that the differences between conditions that reflects the border context are less likely to be biased.

Next, five key KPIs are individually analysed in detail and compared across user stories and data collection methods.

7.1 Individual Analysis of KPIs

This section analyses the five main KPIs, that are comparable across user-stories and methodologies, namely:

- UA-M1.1 – Intention-to-use
- UA-M1.2 -Perceived usefulness
- UA-M1.3 – Perceived ease-of-use
- UA-M2.2 – Trust
- UA-M2.3 – Reliability

For each construct, a forest plot is presented that depicts the mean and 95% Confidence Intervals for the ratings given by participants in the several user stories and scenarios. For the online interviews and online surveys, this means the BE, AV and WO scenarios. For the trials with ***LaneMerge***, ***Overtaking*** and ***HDMapsvehicle*** the data presented refers to the Pre-evaluation and the post-local trials evaluation. For the ***RCCrossing*** and ***CoopAutom***, local and x-border evaluations are presented. For the ***MediaPublicTransport***, online real usage evaluation is presented (normalized to the 1-5 scale).

7.1.1 UA-M1.1 – Intention-to-use

Figure 27 depicts the intention to use KPI. A few observations can be made. First of all, the overall acceptability of the CAM proposals was positive, with all user stories being evaluated above 3 in almost all methods. When compared to the other user stories, the ***MediaPublicTransport*** was the one that presented the lowest value on this KPI, which may be attributed to the low video quality, consequence of the connectivity limitations with the 5G MiFi and the tablet devices.

Secondly, the Online Survey method was the one that resulted in lower ratings. This may have been because this approach is the one that offers a less comprehensive experience of the user story. The textual description provided to readers does not allow exploration of interfaces and situations. On the other hand, the method implicitly requires participants to put themselves into the position of the user. However, given the novelty of the situation, it is difficult for these potential users to imagine what would be their impressions if the situation was real. As referred earlier in this document, being able to experience a technology is a factor that may lead to higher ratings of acceptability [30]. Another limitation of the method is that it does not provide the users with the opportunity to clear doubts that they may have in interpreting the events described or the functioning of the system.

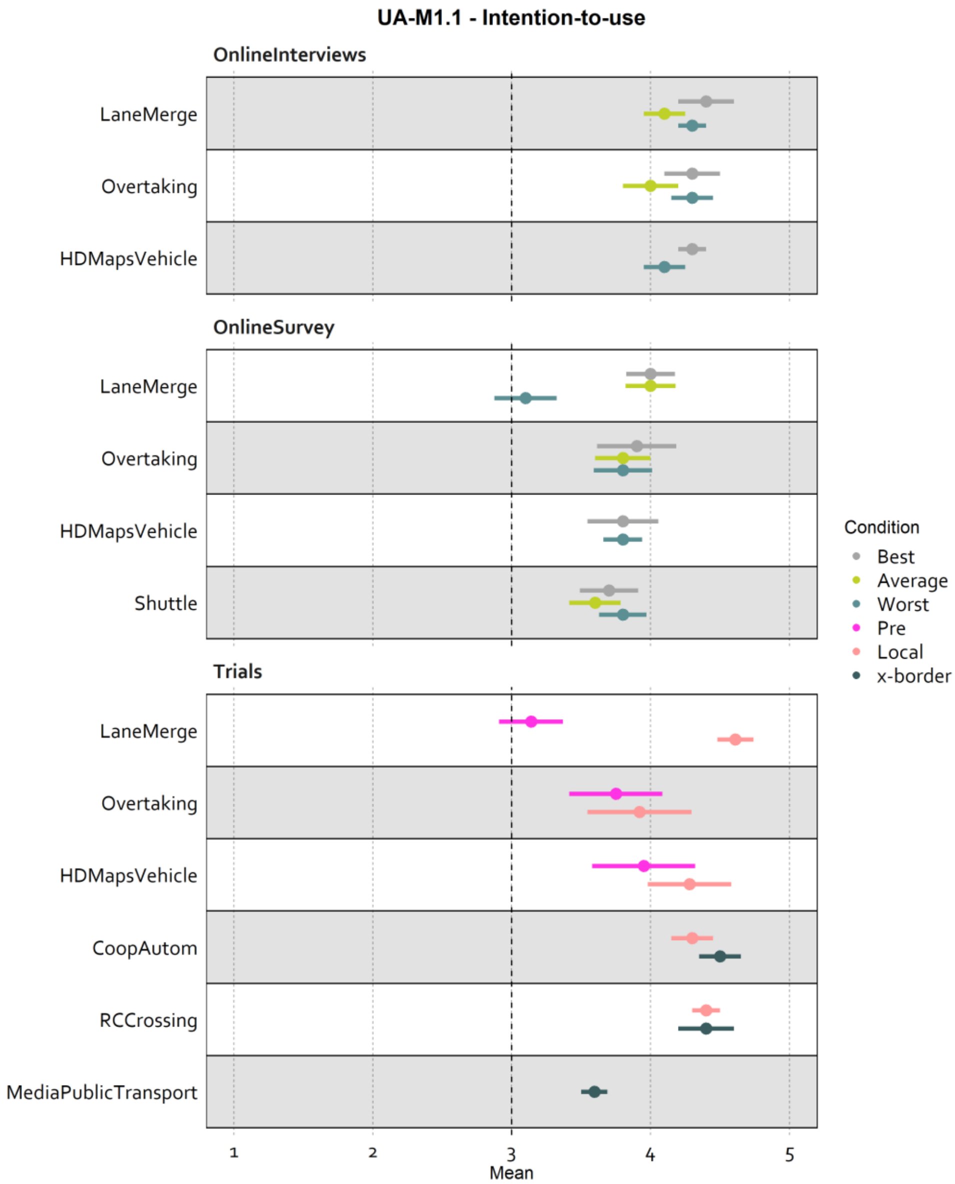


Figure 27: Forest plot depicting the evaluations of UA-M1.1 KPI – intention to use

A third observation is that, while in the online interviews there is a marked difference between the BE and AV scenarios, the same is not particularly noticeable in the online survey. One can hypothesize that this occurs because, in the online interviews, each participant was able to observe the three scenarios, and thus was in the position to rank them. On the contrary, on the online survey each participant was only able to evaluate a single scenario. This may have attenuated the differences between scenarios. While an increase in the number of respondents could have made potential differences clearer, from a statistical point-of-view, the online interviews may be a more powerful method to study differences in user perception.

A fourth observation refers to the trial-based evaluation. In this case, and contrarily to what was hypothesized initially, the x-border trials had the highest acceptability ratings. Being able to experience the technology, in a safe manner, in a more realistic context (low speed, controlled setting) seems to have contributed to increasing the rating of acceptability. This is visible for instance from the fact that in the few participants that made the ***LaneMerge***, ***Overtaking*** and ***HDMapsvehicle*** trials, there is tendency for an increase in the ratings between the pre-evaluation and the post-local evaluation.

On the other hand, participants experienced the user story with no hindrance from technical issues and were thus not affected by them (as these issues did not occur during the trials). Thus, the high acceptability ratings may be biased towards the perception of a full performing technology.

7.1.2 UA-M1.2 – Perceived Usefulness

Figure 28 depicts the *perceived usefulness* KPI. An observation that can be made that is similar to the one of *intention-to-use* is that ratings were generally high and higher for the Online Interviews and Trials compared to the Online Survey. However, in this case, the rating for the online interviews were generally higher compared to the trials. One can hypothesize that this occurred because the user stories were clearer in the online interviews, since the participants were able to ask questions (see section 5.2.1.1).

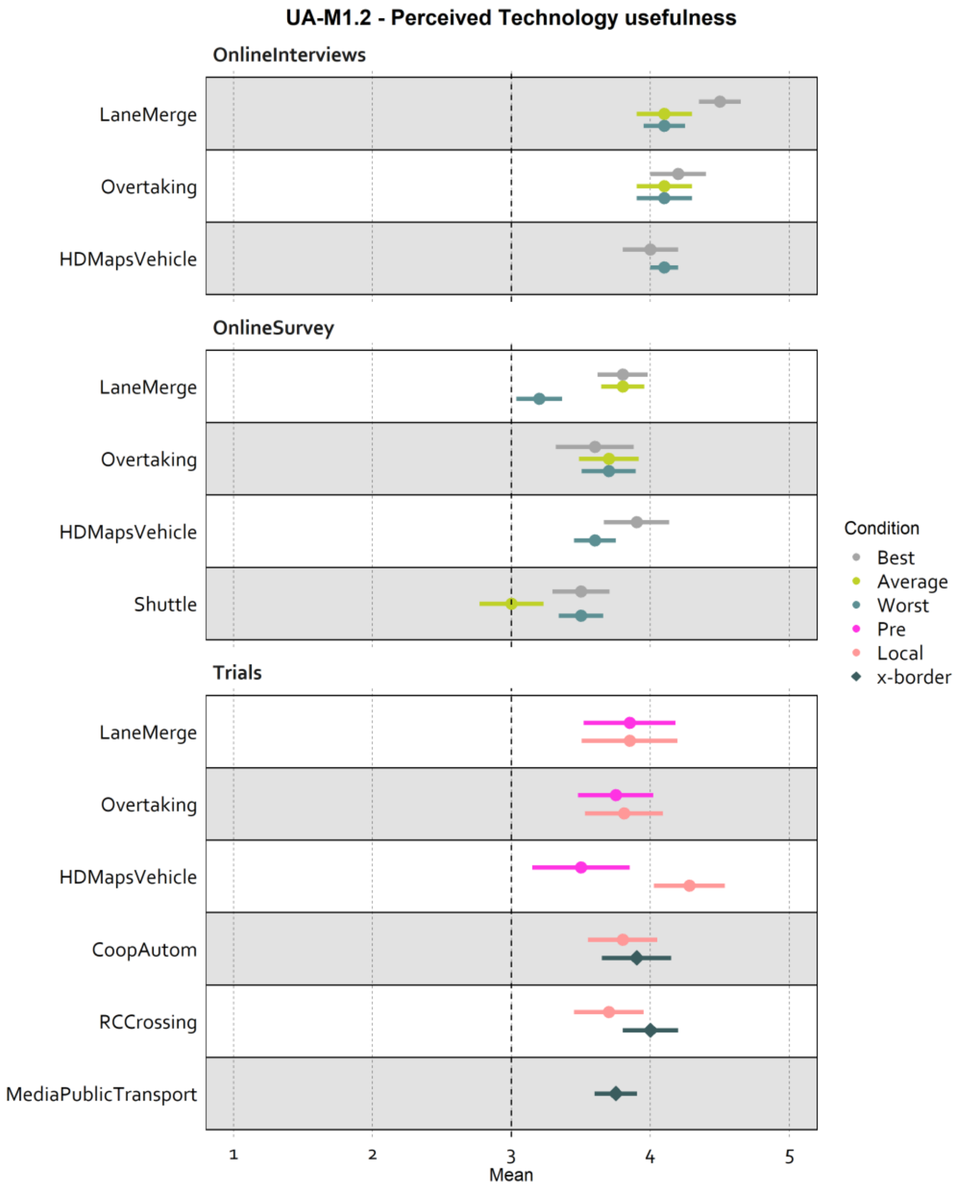


Figure 28: Forest plot depicting the evaluations of UA-M1.2 KPI – Perceived Technology Usefulness

7.1.3. UA-M1.3 – Perceived ease-of-use

Figure 29 depicts the perceived ease-of-use KPI. Again, the ratings were generally high, but values on the online survey were lower compared to the Online Interviews and Trials. An important difference in the ratings of the WO scenario for the ***HDMapsVehicle*** can be noticed between the Online Interviews and Trials and the Online Survey. While the reason for this is not easy to determine, it may have to do with the complexity of the user-story. In the Online Interviews, the interviewer had the opportunity to explain the concept and ensure that the participant understood it and the same was true for the trials. This did not occur in the online survey. The same difference was visible in the *trust* construct (which can be observed in the next section), hinting to a relation between these two constructs (also supported by the relatively high correlation between the two (Table 37).

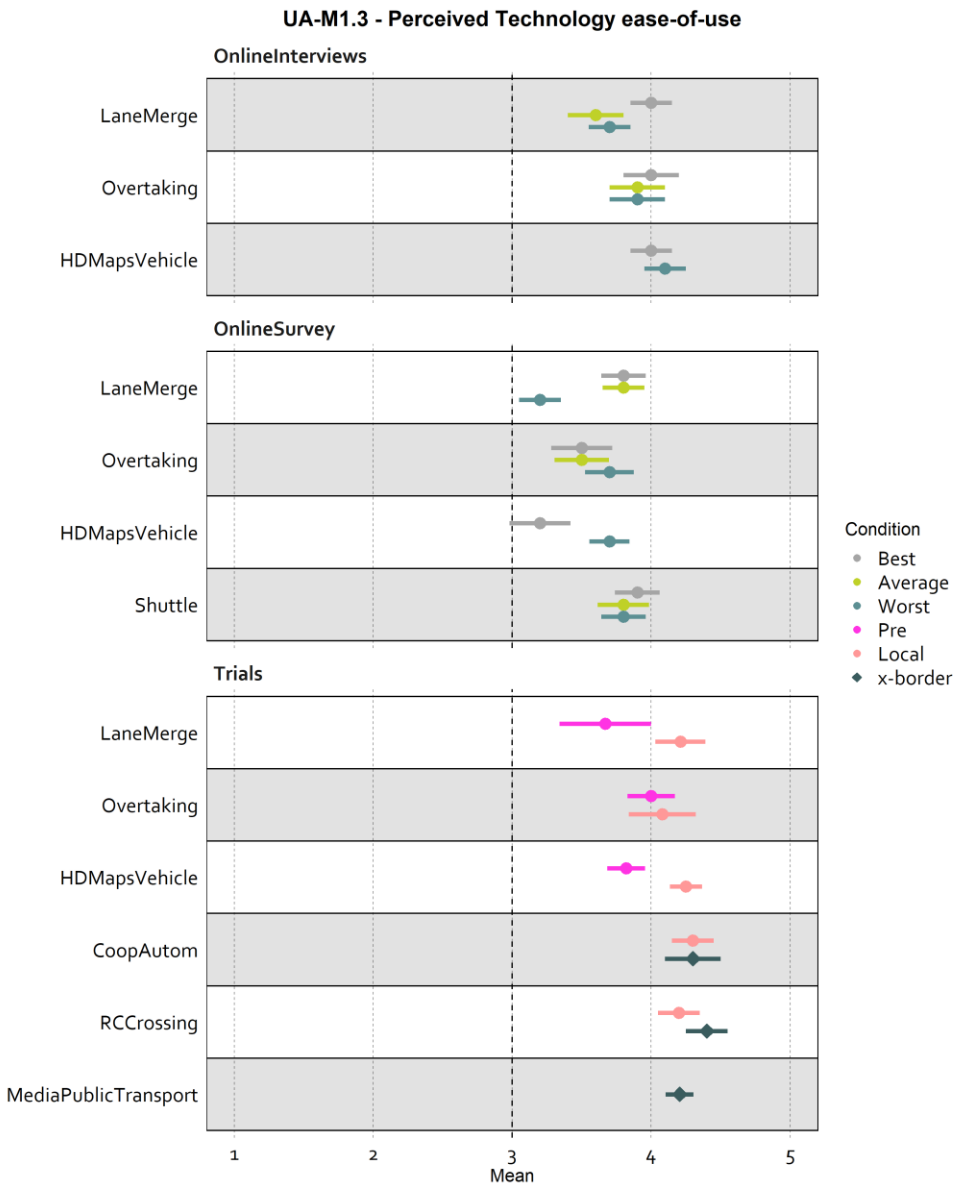


Figure 29: Forest plot depicting the evaluations of UA-M1.2 KPI – Perceived Technology Ease-of-Use

7.1.4 UA-M2.2 – Trust

Figure 30 depicts the trust KPI. Again, higher values are observed for the Trials, followed by Online Interviews and then the online Survey. It is remarkable the difference between BE and AV in the Online interviews, which supports the view that the less predictable behaviour of the vehicle in this scenario hindered the *trust* perception. Also, as already mentioned, for the ***HDMapsVehicle*** in the online survey, *trust* in the BE scenario had a lower rating than WO, following a pattern similar to the one of the *ease-of-use*.

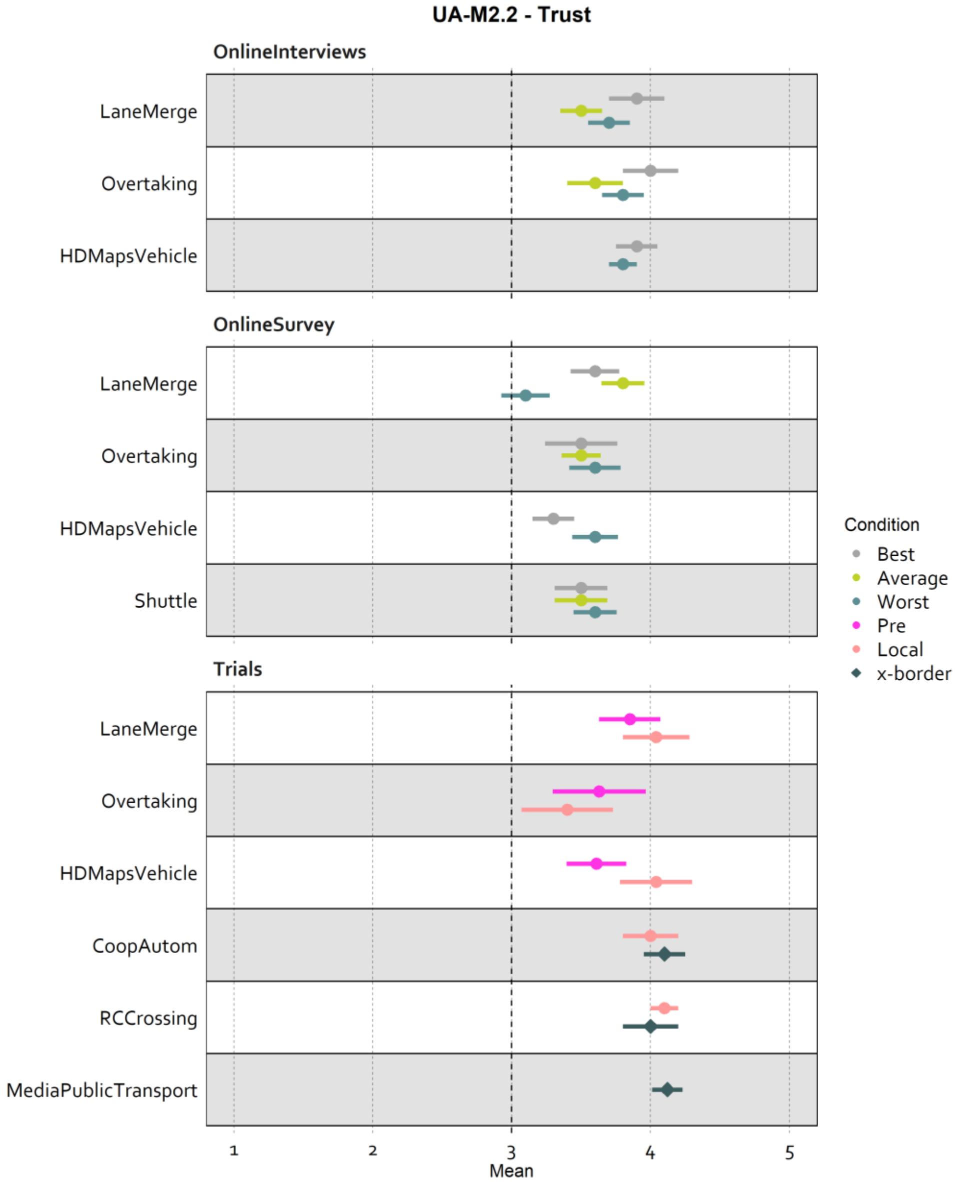


Figure 30: Forest plot depicting the evaluations of UA-M1.2 KPI – Trust

7.1.5 UA-M2.3 – Reliability

Figure 31 depicts the reliability KPI. Overall, the pattern is similar to the one of the previous KPIs, with the Online Interviews having slightly higher values than the Online survey. An interesting observation is that *reliability* in the ***Overtaking*** user story (trial-based evaluation) had almost negative evaluation. While it is not fully clear why this happens, it was noticeable during the interviews that participants considered this to be a particularly dangerous manoeuvre and several refer that they only performed it as drivers when they feel the risk is minimum.

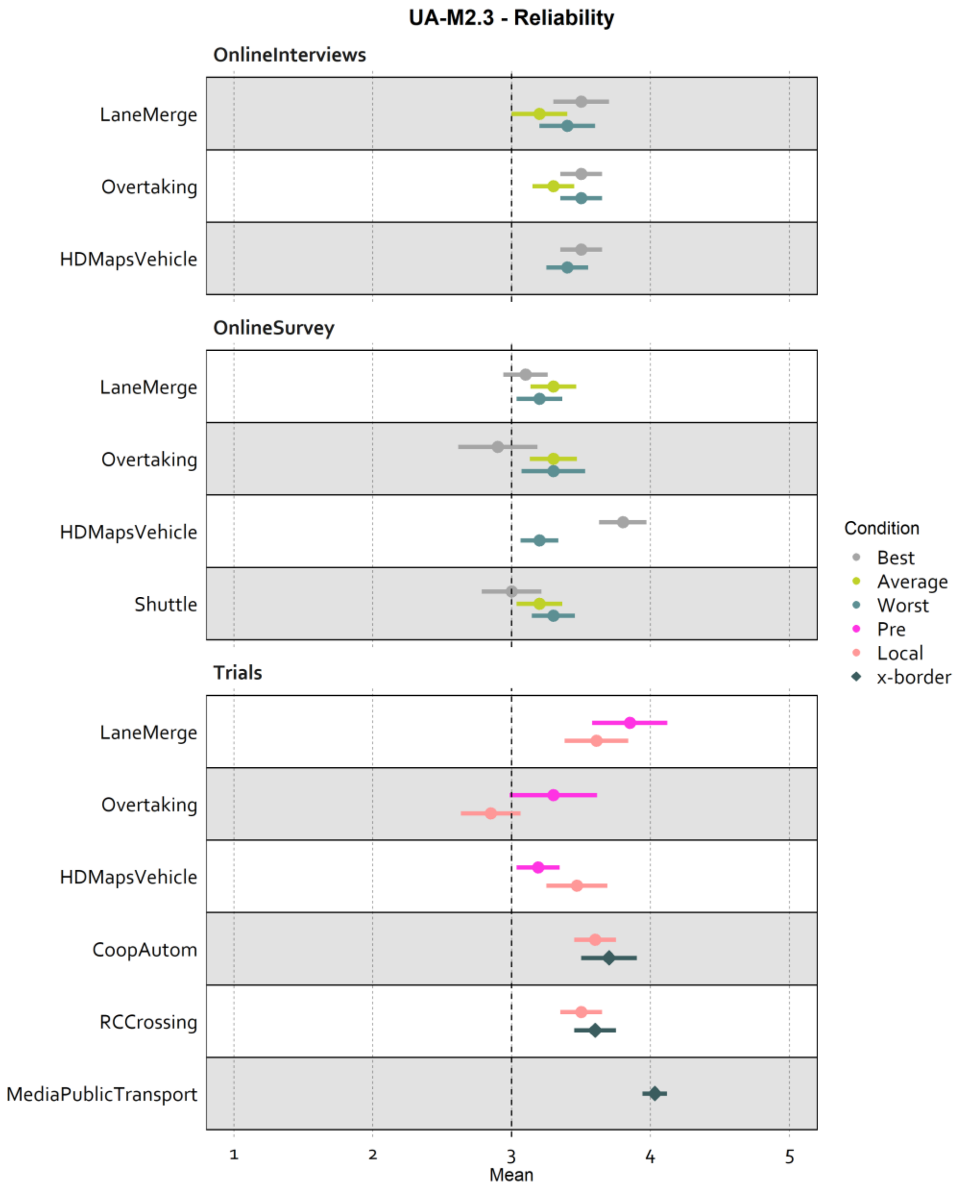


Figure 31: Forest plot depicting the evaluations of UA-M1.2 KPI – Reliability

7.1.6 Relation between KPIs

Congruently with the general views of the TAM model [5], strong correlations between the constructs *intention-to-use* and *perceived usefulness* were consistently found for all the user-stories and across the different evaluation methods used (see

Table 20, Table 31 and Table 37). On the other hand, correlations between *intention-to-use* and *perceived ease-of-use* were weaker. While this is not fully consistent with the technology acceptance literature, it is coherent with other studies of user acceptance of automated driving [23]. As already pointed in section 3.2.3, this may be because in most of the evaluations, users did not interact with the technology. They were provided with descriptions of events that depict a fluid interaction. During a real human-machine interaction with a new interface, it is common for users to struggle to perform some tasks until they are able to solve them or give up and search for assistance. In the evaluations reported here users never experienced that sort of difficulties and thus may not have been able to judge the usability of the systems.

Trust was also consistently highly correlated with the *intention to use*, which was to be expected given the safety-critical nature of the driving task. However, the same was not true for *reliability*. There were user stories in which the autonomous vehicle was perceived as less reliable, without that having affected trust. This may be interpreted as an indication that systems may be understood as unreliable, in the sense that they are unable to deal with a certain situation (as it happens in the HDMaps user story), but still be understood as trustable, in the sense that they ensure the safety of the passengers.

7.2 Lessons learnt regarding methodology

The work reported in this deliverable offered some important opportunities to compare data collection methods regarding user acceptance and how it is affected by technology limitations or malfunctions, in the context of CAM. Several differences in the number of participants, technological limitations and experimental designs prevent direct comparisons. However, the results hint to some considerations that may be important in future work.

First of all, while trial-based evaluation (compared to the others) should in principle produce the most reliable results, this will only be true if the experimental scenarios can produce a user-experience that is illustrative of the real-world operating conditions, including technology limitations and/or malfunctions. This may sometimes be difficult to achieve, especially when dealing with technologies (like 5G communications), that are influenced by hard to control factors (such as weather). To maximise experimental control, it is recommendable that trials are focused solely on user acceptance. It may be also useful to simulate several functioning conditions (e.g. to ensure that malfunctions are observed) and the corresponding systems' responses. This can provide participants with a more holistic perspective of the system functioning. Also, if possible, it is highly recommendable to provide participants with a hands-on experience, allowing them to actually interact with and fully experience the system. This is particularly important in the context of user acceptance research, since ease-of-use is often pointed as an important predictor of acceptability and for one to be able to evaluate this dimension, one must be able to actually interact with the technology.

Online (or physical) interviews supported by the simulations are a good way of obtaining user input. The method has the advantage of ensuring maximum control of participants' observations and it is possible to show examples of different functioning conditions. Also, it is relatively easy to plan and execute, since it depends solely on availability of materials, availability of the experimenter and participants' willingness to participate. Nonetheless, some attention should be taken to ensure that the experimenters are coherent in the information they provide to the different participants and that they do not bias the answers. However, the method has one big disadvantage: participants will not have (in principle) a hand-on experience, and they may be unable to evaluate ease-of-use. Also, they may not be able to fully evaluate dimensions such as trust and safety, since they know they are observing a simulation.

Survey-based evaluation has the important advantage that it can, in principle be used to collect data from a large number of respondents. However, and notably in the context of new technologies it may be hard for participants to fully understand the operation of the system, even if based in thorough textual and visual descriptions. It is also not easy to ensure that all respondents understand the descriptions in the same way, particularly when using multi-language surveys in which consistency is substantially harder to achieve.

Another important limitation of online surveys, is that while it is relatively easy nowadays to develop and disseminate a survey online (using for instance social networks), it is often very difficult to motivate respondents to answer it, especially in the case of long questionnaires. Additionally, it has the disadvantage that it is substantially more difficult to collect qualitative data in a survey, since even those respondents that answer quantitative questions tend to disregard those in which they have to write.

For the research reported in this deliverable, a comparison between the online surveys and the online interviews clearly favours the latter: Participants were motivated since they had committed previously to participating in the study, even knowing the temporal length of the session; Each participant visualized three scenarios of the same technology and evaluated those scenarios separately; they provided in-depth qualitative information and; the interviewer was capable of ensuring that the participant fully understood the sequences of events.

The trials were valuable in providing participants with the most realistic experience of technology usage (even considering the limitations in the use). However, they did not provide participants with the opportunity to experience different operating conditions. Eventually, this may be solved by simulating different conditions within the road trials, in controlled studies.

8 CONCLUSION

This document (D5.4) reports the user acceptance activities conducted in the scope of the 5G-MOBIX project. These were aimed at evaluating with potential users the acceptance of a set of CAM user-stories proposed by the project and to investigate how breaks in service continuity, and hand-over issues may impact acceptability.

Overall, acceptability of all CAM user stories was high, even when the experiences presented to the users were hindered by the sub-performing connectivity. This was generally observed for all evaluation methodologies. The user stories were considered useful, easy-to-use and trustable/reliable. Particularly strong correlations were found between the acceptability of the user stories and their perceived usefulness as well as the conveyed feeling of trust. This highlights the value of the 5G-enabled, CAM proposals and their potential to benefit a wide user-base, even if their operation is sometimes jeopardized by factors such as temporarily poor connectivity.

The second important consideration also resulting from this work is that performance of technologies and more concretely of the 5G-enabled technological proposals may indeed affect acceptability. However, this effect is not straightforward, but moderated by the automation behaviour response. The evaluation showed that degraded network performance may, from the user point-of-view be regarded as worse than a full network interruption, depending on the implemented fall-back mechanisms. Users may actually feel safer with the behaviour response of a full network interruption (e.g., avoid a manoeuvre) than with the one resulting from intermittent connection (e.g., a manoeuvre that is initiated and then aborted).

Overall, systems should be developed to behave consistently and predictably even under degraded conditions. They should be designed with the intention to convey trust, keeping in mind that perceived reliability and perceived trust are not necessarily directly related.

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ANNEXES

Annex 1. User-story Scenarios: Network KPIs, Threshold Values and Observable Behaviour

Table 42: Expert evaluation for user-stories: US#1.1.a - *LaneMerge* and US#1.1.b - *Overtaking*

Key-point Indicator	Test Condition	Worst-case scenario(s) (What does the user observe)	Threshold value (worst - average)	Average-case scenario(s) (What does the user observe)	Threshold value (average-best)	Best-case scenario (What does the user observe)
TE-KPI1.1 - User experienced data rate (UL / DL)	Speed --> 60km/h Speed -- 110km/h	car does not receive the connectivity info well in advance, and may perform a dangerous manoeuvre	0.1 / 0.1 Mbps	car receives the connectivity info well in advance to perform a safe manoeuvre, but may have to cancel the overtaking manoeuvre	0.2 Mbps	car receives the connectivity info well in advance to perform a safe and comfortable manoeuvre
TE-KPI1.3 – E2E Latency	Speed --> 60km/h	Connectivity info is not accurate enough. Car may perform a dangerous manoeuvre	300	Connectivity info is not highly accurate. Car performs a safe manoeuvre, but it may cause some hard braking	150	Connectivity info has high accuracy. Car performs a safe and comfortable manoeuvre
TE-KPI1.3 – E2E Latency	Speed -- 110km/h	Connectivity info is not accurate enough. Car may perform a dangerous manoeuvre	250	Connectivity info is not highly accurate. Car performs a safe manoeuvre, but it may cause some hard braking	100	Connectivity info has high accuracy. Car performs a safe and comfortable manoeuvre
TE-KPI2.3 - Mobility Interruption Time	Speed --> 60km/h	Car may perform a dangerous manoeuvre and cause a hard braking	1s	Car may cause an uncomfortable braking	0.5s	Car performs a safe and comfortable manoeuvre
TE-KPI2.3 - Mobility Interruption Time	Speed -- 110km/h	Car may perform a dangerous manoeuvre and cause an accident	0.8s	Car may cause a hard braking	0.3s	Car performs a safe and comfortable manoeuvre
TE-KPI2.2 - Application Level Handover Success Rate	Speed --> 60km/h	Car may perform a dangerous manoeuvre and cause a hard braking	99 - 100%	Car performs a safe and comfortable manoeuvre		
	Speed -- 110km/h	Car may perform a dangerous manoeuvre and cause an accident				

Table 43: Expert evaluation for user-stories US#3.1.a - *Complex Manoeuvres in Cross-Border Settings: HD Maps* and US#3.1.b - *Public Transport: HD Maps*

Key-point Indicator	Test Condition	Worst-case scenario(s) (What does the user observe)	Threshold value (worst - best)	Best-case scenario (What does the user observe)
TE-KPI1.1 - User experienced data rate (UL / DL)	Speed --> 60km/h roadworks --> 70m Distance between cars --> 500m	Second car does not receive updated HDmaps	350Mbps	second car receives updated Hdmaps and drives in autonomous mode through the roadworks
	Speed -- 110km/h roadworks --> 70m Distance between cars --> 500m	Second car does not receive updated HDmaps	250Mbps	second car receives updated HDmaps and drives in autonomous mode through the roadworks
TE-KPI1.3 - E2E Latency	Speed --> 60km/h roadworks --> 70m Distance between cars --> 500m	Autonomous driving system of the second car disconnects. There is not updated HDMAP	500ms	second car receives updated HDmaps and drives in autonomous mode through the roadworks
	Speed -- 110km/h roadworks --> 70m Distance between cars --> 500m	Second car autonomous driver system disconnects. There is not updated HDMAP	500ms	second car receives updated HDmaps and drives in autonomous mode through the roadworks
TE-KPI2.3 - Mobility Interruption Time	Speed --> 60km/h roadworks --> 70m Distance between cars --> 500m	Autonomous driving system of the second car disconnects. There is not updated HDMAP	2s	second car receives updated HDmaps and drives in autonomous mode through the roadworks
	Speed -- 110km/h roadworks --> 70m Distance between cars --> 500m	Autonomous driving system of the second car disconnects. There is not updated HDMAP	2s	second car receives updated HDmaps and drives in autonomous mode through the roadworks
TE-KPI2.2 - Application Level Handover Success Rate	Speed --> 60km/h roadworks --> 70m Distance between cars --> 500m	Autonomous driving system of the second car disconnects. There is not updated HDMAP	80%	second car receives updated HDmaps and drives in autonomous mode through the roadworks
	Speed -- 110km/h roadworks --> 70m Distance between cars --> 500m	Autonomous driving system of the second car disconnects. There is not updated HDMAP	80%	second car receives updated HDmaps and drives in autonomous mode through the roadworks

Table 44: Expert evaluation for user-stories US#1.5 - *Automated Shuttle Driving Across Borders: Cooperative Automated System*

US#4.1 - *Automated Shuttle Driving Across Borders: Remote Control*

Key-point Indicator	Test Condition	Worst-case scenario(s) (What does the user observe)	Threshold value (worst - average)	Average-case scenario(s) (What does the user observe)	Threshold value (average-best)	Best-case scenario (What does the user observe)
TE-KPI1.1 - User experienced data rate (UL / DL)	Constant Speed -> 10km/h)	information provided to Control centre it is not good enough to allow a remote driving	10 / 1 Mbps	Remote driving works ok but may not be completely fluent	0.2 Mbps	Remote driving works well and fluent
TE-KPI1.3 - E2E Latency	Constant Speed -> 10km/h)	Control centre does not receive live info and can cause an accident	100 – 200 ms	Remote driving works ok but may not be completely fluent	50 ms	Remote driving works well and fluent
TE-KPI2.3 - Mobility Interruption Time	Constant Speed -> 10km/h)	Remote control is disconnected and vehicle performs an emergency braking	0.3 s	Remote driving works ok but may not be completely fluent	0.1 s	Remote driving works well and fluent
TE-KPI2.2 - Application Level Handover Success Rate	Constant Speed -> 10km/h)	Remote control is disconnected and vehicle performs an emergency braking	99 - 100%	Car performs safely		

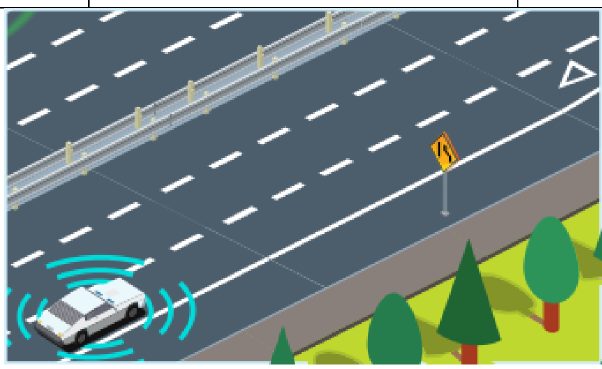
Annex 2. User Story Descriptions

All user stores referring to Complex Manoeuvres in Cross-Border Settings begin with the same common description:

"You are travelling on a highway in an autonomous vehicle. This vehicle is capable of driving itself from one destination to another, doing all required manoeuvres. If the vehicle finds a situation it is unable to deal with, it will request that you take over control. This vehicle is connected wirelessly to an ITS (Intelligent Transportation System) server. This is a cloud-based service that centralizes information received from all the vehicles connected to it, plus sensors installed in the road's infrastructure. It processes and shares the information it receives with all the connected vehicles, including your own. The information your vehicle receives can be, for instance, about road conditions and events (for example, accidents) on the road ahead or location of surrounding vehicles. It is used to improve the driving performance of your autonomous vehicle."

The description then continues depending on the specific user-story and scenario:

Table 45: US#1.1.a - Complex Manoeuvres in Cross-Border Settings: Lane Merge for Automated Vehicles

<table>
<tr><th>Best Case</th><th>Average Case</th><th>Worst Case</th></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">"At a certain point of the journey, your vehicle receives the information that the number of lanes will change from 3 to 2. Your vehicle detects that the lane you are travelling in will disappear and that you will need to move to the left lane."</td></tr>
<tr><td colspan="3">"At this time, your vehicle's autonomous system analyses the information received from the ITS server regarding the speed and position of the other vehicles and makes decisions about the best speed to safely enter the next lane.

If there is not enough space between the vehicles, the autonomous vehicle will slow down (stop if necessary) for safe and comfortable manoeuvring."</td></tr>
<tr><td>Normal behaviour</td><td>"It may happen that, there is a temporary failure in the connection with the ITS server. Your vehicle</td><td>"It may happen that, due to a temporary failure in the connection with the ITS server, your vehicle is</td></tr>
</table>

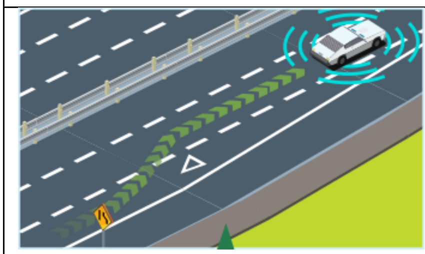
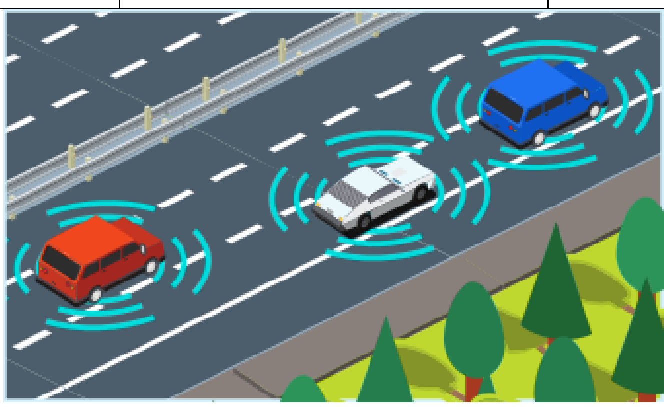
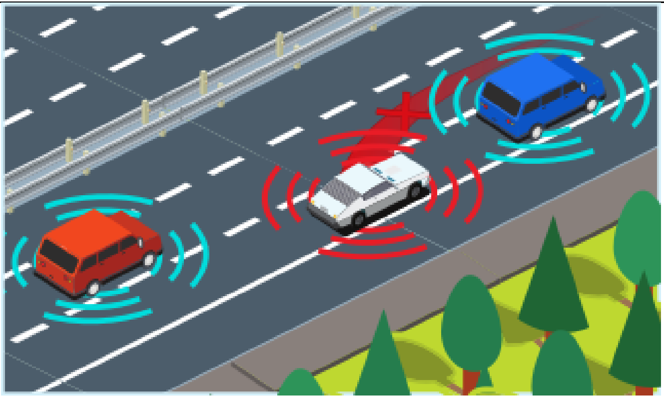
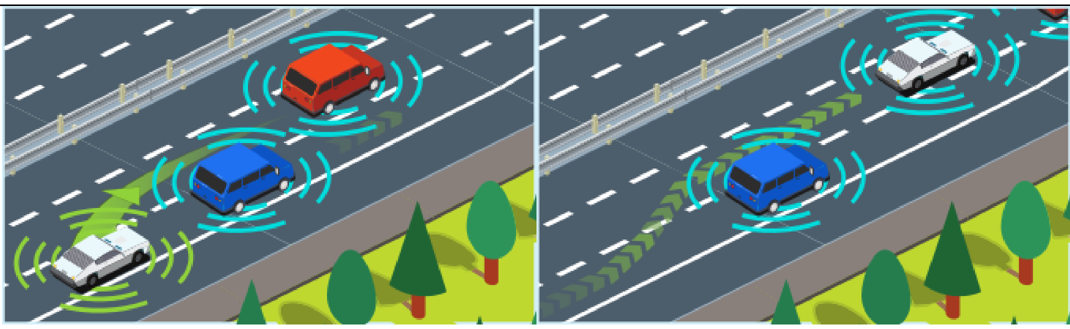
	*receives a **late warning concerning another vehicle in the target lane that reduced its speed abruptly**. There is a truck just behind you that blocks your vehicle's own sensors from noticing the vehicle. Your vehicle starts changing lanes but then detects the approaching vehicle through its sensors and decides to cancel the manoeuvre returning to its previous lane. If necessary, it will stop at the end of the lane until it recovers connectivity or has a clear view of the road."*	*unable to receive information concerning **other vehicles in the target lane**. There is also a truck just behind you that blocks your vehicle's own sensors. Your vehicle stops at the end of the lane until it recovers connectivity or has a clear view of the road."*
		
"The autonomous vehicle safely follows the predefined route."	*"From that point on your vehicle performs the lane change and safely follows the predefined route."*	*"From that point on your vehicle performs the lane change and safely follows the predefined route."*

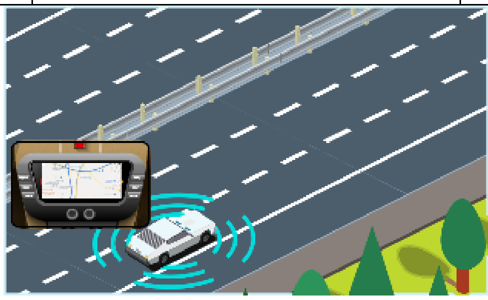
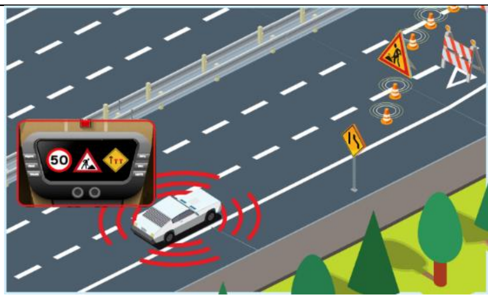
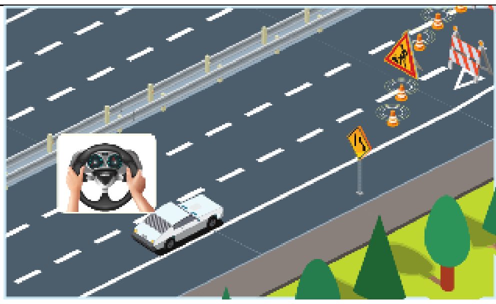
Table 46: US#1.1.b - Complex Manoeuvres in Cross-Border Settings: Automated Overtaking

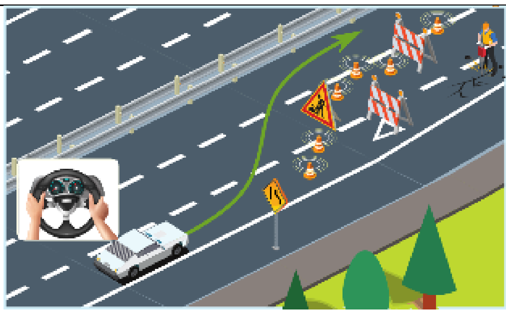
Best Case	Average Case	Worst Case
		
"Later, your vehicle is moving faster than the vehicles in the same lane in front of it. "		

		
"There is a vehicle following behind you that partially occludes your vehicle sensors. However, your vehicle receives information shared by other vehicles and analyses it together with information collected from its own sensors. It is thus able to make a decision regarding the safest moment to perform the overtaking manoeuvre. *If it determines that the manoeuvre cannot be performed safely, your vehicle will adapt its speed to drive behind the next vehicle until it identifies a safe condition for overtaking."*		
		
"In the moment this safe condition is identified, the vehicle triggers the automated overtaking manoeuvre, overtakes the vehicle in front and follows the predefined path."		
Normal behaviour	*"It may happen that, due to* ***temporary*** *failures in the connection with the ITS server, your vehicle receives delayed information regarding a vehicle on the left lane that was approaching. There is a truck just behind you that blocks your vehicle's own sensors from noticing the vehicle on the left.* *Your vehicle starts changing lanes but then detects the approaching vehicle through its own sensors and decides to cancel the manoeuvre returning to its previous lane. It then slows down and follows the front car*	*"It may happen that, due to* ***temporary*** *failures in the connection with the ITS server, your vehicle is unable to receive information regarding vehicles on the left lane.* *There is also a truck just behind you that blocks your vehicle own sensors. Your vehicle slows down and follows the front car until it recovers connectivity or has a clear view of the road and then performs the overtake."*

	until it recovers full connectivity or has a clear view of the road and then performs the overtake."	

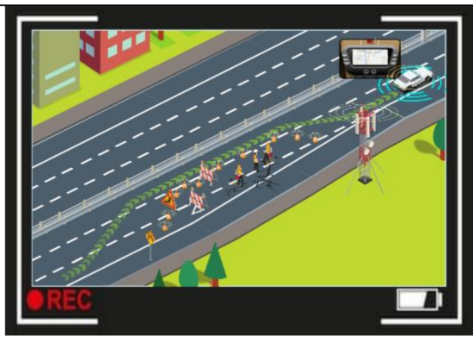
Table 47: US#3.1.a - Complex Manoeuvres in Cross-Border Settings: HD Maps

<table>
<tr><th>Best Case</th><th>Average Case</th><th>Worst Case</th></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">"As the journey continues, your car receives information about some roadworks ahead. To navigate within roadwork areas, your vehicle relies on High definition (HD) Maps. These maps have detailed information on the location of barriers and other obstacles and the most appropriate route to pass them safely."</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td colspan="3">"However, when your car examines the information received it verifies that, as the area was recently assembled, there is limited information about it."</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">"The vehicle then prompts you to take control of the driving."</td></tr>
</table>

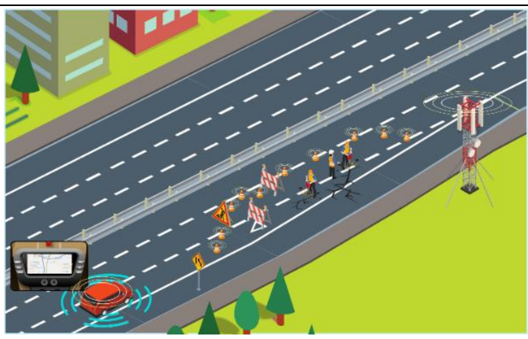


"You drive through the roadworks area and the autonomous system records the path you make based on the information from the car's sensors."

"When you completely pass the roadworks, the vehicle requests control again. You agree, returning to autonomous driving mode."



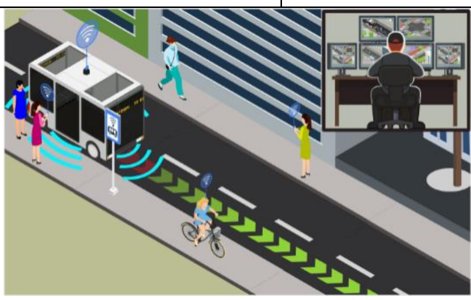
"The route you performed is recorded and made available through the ITS server to the other vehicles driving behind you."



<table>
<tr><td colspan="3">“This will allow the following vehicles to autonomously go through the roadworks area using the same path that you followed, thus avoiding the need to request their drivers to take over control. Conversely, it may happen that you go through a roadworks area following a route previously demonstrated by another driver in another vehicle.”</td></tr>
<tr><td>Normal behaviour</td><td>(No average case in this UC)</td><td>“It may happen that, due to temporary failures in the connection with the ITS server, your vehicle may not receive updated information and thus will request you to take control of the vehicle.”</td></tr>
</table>

The descriptions involving the automated shuttle are grouped in a single description. They were evaluated together in the online survey

Table 48: Description of the user stories “US#1.5 - Automated Shuttle Driving Across Borders: Cooperative Automated System” and “US#4.1 - Automated Shuttle Driving Across Borders: Remote Control”

<table>
<tr><td colspan="3">“Imagine that you are going on a trip inside an automated shuttle. It is a relatively large vehicle, like a small bus. The shuttle follows a predetermined path, going from location A to location B. The shuttle does not have a physically present driver, but it is connected to a remote-control centre. It drives mostly by itself, but in some cases, it may request that a human remote driver takes over control and drives it from the remote-control centre. The shuttle is also connected to an ITS (Intelligent Transportation System) server. This is a cloud-based service that centralizes information received from all the vehicles connected to it, from sensors installed in the road infrastructure and from other road users, like pedestrians carrying smartphones with a specialized app installed. This information is processed and shared with all the other connected vehicles, including the shuttle.”</td></tr>
<tr><td>Best Case</td><td>Average Case</td><td>Worst Case</td></tr>
<tr><td colspan="3"> </td></tr>
<tr><td colspan="3">“If the shuttle encounters an obstacle in its path that cannot be avoided without going off the predetermined path, the shuttle will alert the control centre.”</td></tr>
</table>

"An operator at the control centre will verify the obstacle through the vehicle's cameras and remotely control the shuttle, avoiding the obstacle and then returning the vehicle to the predefined route."

"The shuttle will then continue the journey by itself"

"It may happen, that due to some temporary connection issues, the ***remote driver receives delayed information from the shuttle and that their commands also reach the vehicle with a delay. This may cause the vehicle movement to be jerky, with some hard braking and late acceleration."***

"It may happen that due to some temporary connection issues, ***the remote centre is disconnected from the shuttle. When the obstacle is encountered, the vehicle brakes and comes to a still. When the connection is recovered the remote driver will take over and steer the shuttle around the obstacle."***

"In an urban setting, pedestrians may be walking nearby, carrying a smartphone with the dedicated ITS app. The shuttle is continuously updated about their position"

<table>
<tr><td colspan="3"></td></tr>
<tr><td colspan="3">"If the pedestrian moves towards the road, the shuttle will determine, based on the pedestrian's trajectory if he/she is going to cross the road, in which case the shuttle will reduce speed until stopping, allowing the pedestrian to cross the road safely."</td></tr>
<tr>
<td>"After the crossing, the shuttle will resume its course."</td>
<td>"It may happen, that due to temporary connection issues, the shuttle receives delayed information from the pedestrian. This may cause the vehicle to brake sharply when it receives the delayed information. However, it will not need to fully stop.

After the crossing, the shuttle will resume its course."</td>
<td>"It may happen that due to temporary connection issues, the shuttle fails to receive information from the VRU. This may cause the vehicle to perform an emergency stop when it detects the pedestrian through its own sensors.

After the crossing, the shuttle will resume its course."</td>
</tr>
</table>

Annex 3. Supporting material for the UAAD model validation

Table 49: Initial items of the UAAD for validation

Construct	Items (statements)
Intention to use	Assuming I have access to an automated vehicle, I intend to use it.
	If the automated vehicle becomes available in the next few months, I plan to use it.
	If I had such an automated vehicle, I would use it frequently during my trips.
	If available, I plan to use the automated vehicle in the future.
Perceived Ease of Use	I would find the automated vehicle easy to use.
	I would find it easy to get the automated vehicle to do what I want it to do. (It would be easy for me to become skilful at using the autonomous shuttle).
	Learning to use the automated vehicle would be easy for me.
	I think the automated vehicle would be simple to use.
Perceived usefulness	I would find the automated vehicle useful in my daily life/work.
	Using the automated vehicle in my life would increase my travel comfort.
	Using the automated vehicle would be useful in meeting my regular transportation needs.
	Using the automated vehicle would enable me to accomplish non-driving tasks more quickly.
Trust	The automated vehicle would be dependable.
	Overall, I could trust the automated vehicle.
	I would trust the automated vehicle while driving.
	I would feel confident using the automated vehicle.
Reliability	The automated vehicle would be reliable.
	I believe that I could depend and rely on automated vehicles.
	I believe that automated vehicles will perform consistently under a variety of circumstances.
	I believe that an automated vehicle would be free of error.
Perceived safety	Using the automated vehicle would require increased attention.
	Using the automated vehicle would decrease the risk of accidents.
	I'm worried about the general safety of such technology.
	I would feel safe while using the automated vehicle.
Subjective norm	I would be proud to say to people that are close to me that I use the automated vehicle
	I would feel more inclined to use the automated vehicle if it was widely used by others.
	People whose opinions are important to me would like the automated vehicle too.
	I would recommend the automated vehicle to my family or friends to use
Facilitating conditions	I have the necessary knowledge to use the automated vehicle.
	Generally, the roads I use can support the automated vehicle.

	If I had difficulties with the automated vehicle, there would be somebody I could ask for assistance
	The infrastructure needed to use an automated vehicle is readily available.
Self-efficacy	I could complete a task using the automated vehicle if someone showed me how to do it first.
	I would be able to handle whatever happens while using the automated vehicle.
	I would feel confident using the automated vehicle because I understand clearly how to use it.
	I could reach my destination using the automated vehicle even if I had no assistance.
Anxiety	I would be afraid of not understanding the automated vehicle.
	The automated vehicle is somewhat intimidating to me.
	Driving with the automated vehicle would make me feel nervous.
	I would hesitate to use the automated vehicle for fear of making mistakes.

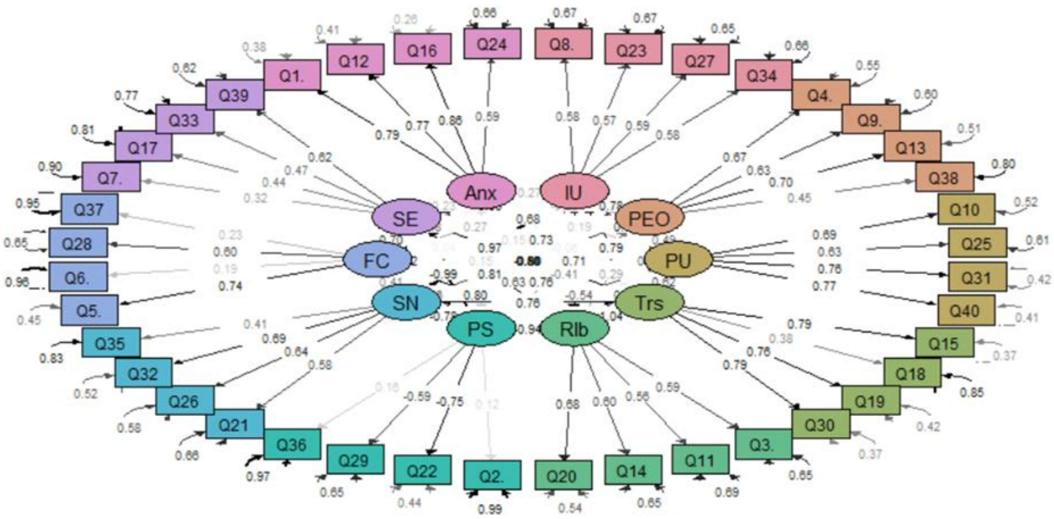


Figure 32: Calibration sample: CFA Estimations for first structure model (Validation study).

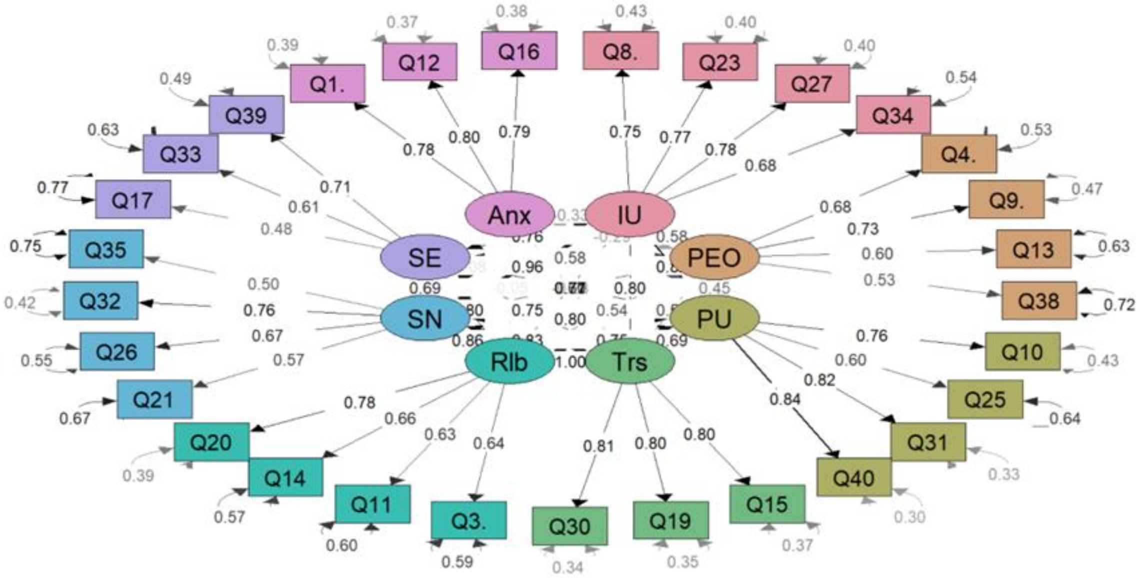


Figure 33: Calibration sample: CFA Estimations for second structure model (Validation study)

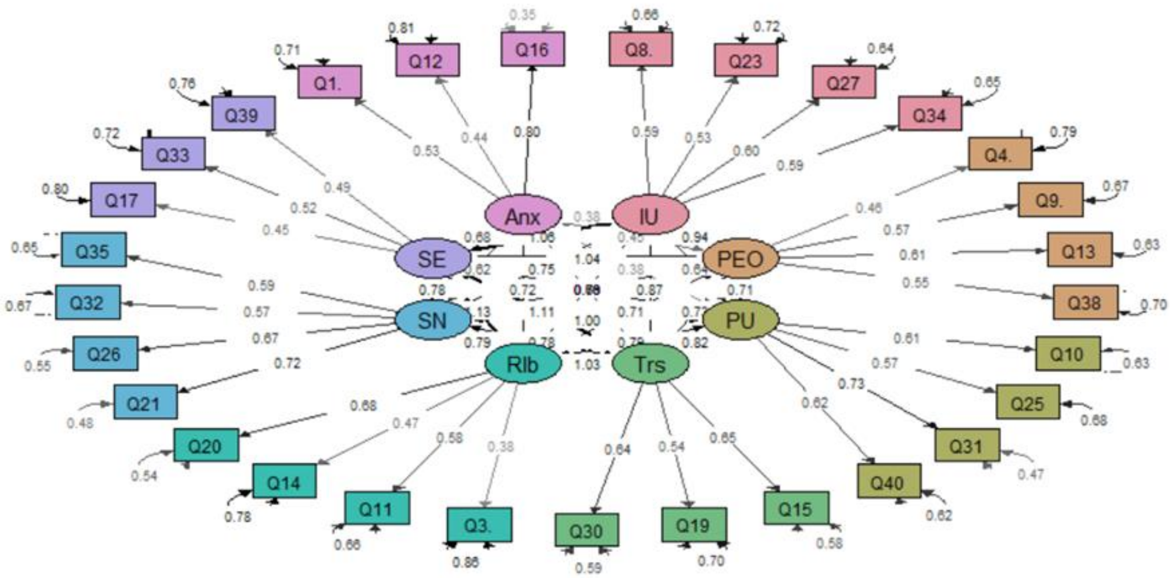


Figure 34: Validation sample: CFA Estimations for second structure model (Validation study).

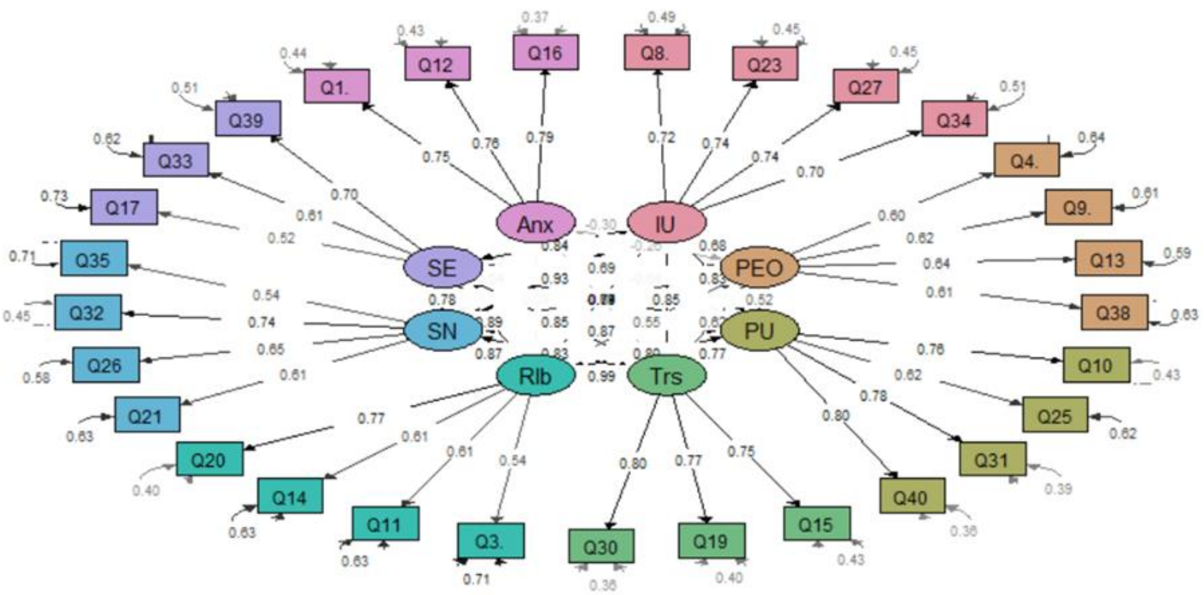


Figure 35: Validation sample: CFA Estimations for final structure model (Validation study).

Table 50: Summary of the Election of items from the Confirmatory Analysis - validation study

5G MOBIX QUESTIONNAIRE					
Item	Calibration Sample Load	Calibration Sample Load model 2	Validation Sample Load	Total Sample	Final decision
Intention to Use (IU)					
27. Assuming I have access to an automated vehicle, I intend to use it.	.59	.78	.60	**.74**	Maintain
34. If the automated vehicle becomes available in the next few months, I plan to use it.	.58	.68	.59	.70	
8. If I had such an automated vehicle, I would use it frequently during my trips.	.58	.75	.59	**.72**	Maintain
23. If available, I plan to use the automated vehicle in the future.	.57	.77	.53	**.74**	Maintain
Perceived Ease of Use (PEOU):					

9. I would find the automated vehicle easy to use.	.63	.73	.57	.62	Maintain
38. I would find it easy to get the automated vehicle to do what I want it to do. (It would be easy for me to become skilful at using the autonomous shuttle).	.45	.53	.55	.61	Maintain
13. Learning to use the automated vehicle would be easy for me.	.70	.60	.61	.64	Maintain
4. I think the automated vehicle would be simple to use.	.67	.88	.45	.60	
Perceived Usefulness (PU):					
40. I would find the automated vehicle useful in my daily life/work.	.77	.84	.62	.80	Maintain
10. Using the automated vehicle in my life would increase my travel comfort.	.69	.76	.51	.76	Maintain
31. Using the automated vehicle would be useful in meeting my regular transportation needs.	.76	.82	.73	.78	Maintain
25. Using the automated vehicle would enable me to accomplish non-driving tasks more quickly.	.63	.60	.57	.62	--
Trust					
18. The automated vehicle would be dependable.	.38	x	x	x	--
15. Overall, I could trust the automated vehicle.	.79	.80	.65	.75	Maintain
30. I would trust the automated vehicle while driving.	.79	.81	.64	.77	Maintain
19. I would feel confident using the automated vehicle.	.76	.80	.54	.80	Maintain
Reliability					
3. The automated vehicle would be reliable.	.59	.64	.38	.54	--
20. I believe that I could depend and rely on automated vehicles.	.68	.78	.68	.77	Maintain

11. I believe that automated vehicles will perform consistently under a variety of circumstances.	.56	.63	.58	.61	Maintain
14. I believe that an automated vehicle would be free of error.	.60	.66	.47	.61	Maintain
Perceived Safety					
2. Using the automated vehicle would require increased attention.	.16	x	x	x	--
29. Using the automated vehicle would decrease the risk of accidents.	.59	x	x	x	--
36. I'm worried about the general safety of such technology.	.75	x	x	x	--
22. I would feel safe while using the automated vehicle.	.12	x	x	x	--
Subjective Norm					
21. I would be proud to say to people that are close to me that I use the automated vehicle	.58	.57	.72	.61	Maintain
35. I would feel more inclined to use the automated vehicle if it was widely used by others.	.41	.50	.59	.54	--
26. People whose opinions are important to me would like the automated vehicle too.	.69	.57	.67	.65	Maintain
32. I would recommend the automated vehicle to my family or friends to use	.64	.76	.57	.74	Maintain
Facilitating Conditions					
37. I have the necessary knowledge to use the automated vehicle.	.23	x	x	x	--
5. Generally, the roads I use can support the automated vehicle.	.74	x	x	x	--
6. If I had difficulties with the automated vehicle, there would be somebody I could ask for assistance	.19	x	x	x	--

28. The infrastructure needed to use an automated vehicle is readily available.	.60	x	x	x	--
Self-efficacy					
7. I could complete a task using the automated vehicle if someone showed me how to do it first.	.32	x	x	x	--
17. I would be able to handle whatever happens while using the automated vehicle.	.44	.48	.45	.52	Maintain
39. I would feel confident using the automated vehicle because I understand clearly how to use it.	.62	.71	.49	.70	Maintain
33. I could reach my destination using the automated vehicle even if I had no assistance.	.47	.61	.52	.61	Maintain
Anxiety					
24. I would be afraid of not understanding the automated vehicle.	.59	x	x	x	--
16. The automated vehicle is somewhat intimidating to me.	.86	.79	.50	.79	Maintain
12. Driving with the automated vehicle would make me feel nervous.	.77	.80	.44	.76	Maintain
1. I would hesitate to use the automated vehicle for fear of making mistakes.	.79	.78	.53	.75	Maintain

Table 51: Final version of the UAAD instrument following the validation

Construct	Question
Intention to use	Assuming I have access to an automated vehicle, I intend to use it.
	If I had such an automated vehicle, I would use it frequently during my trips.
	If available, I plan to use the automated vehicle in the future.
Perceived Ease of Use	I would find the automated vehicle easy to use.
	I would find it easy to get the automated vehicle to do what I want it to do.
	Learning to use the automated vehicle would be easy for me.

Perceived usefulness	I would find the automated vehicle useful in my daily life/work.
	Using the automated vehicle in my life would increase my travel comfort.
	Using the automated vehicle would be useful in meeting my regular transportation needs.
Trust	Overall, I could trust the automated vehicle.
	I would trust the automated vehicle while driving.
	I would feel confident using the automated vehicle.
Reliability	I believe that I could depend and rely on automated vehicles.
	I believe that automated vehicles will perform consistently under a variety of circumstances.
	I believe that an automated vehicle would be free of error.
Subjective norm	I would be proud to say to people that are close to me that I use the automated vehicle
	People whose opinions are important to me would like the automated vehicle too.
	I would recommend the automated vehicle to my family or friends to use
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.
	I would feel confident using the automated vehicle because I understand clearly how to use it.
	I could reach my destination using the automated vehicle even if I had no assistance.
Anxiety	The automated vehicle is somewhat intimidating to me.
	Driving with the automated vehicle would make me feel nervous.
	I would hesitate to use the automated vehicle for fear of making mistakes.

Annex 4. Individual ATI scale Average Scores for Spanish Local Trials

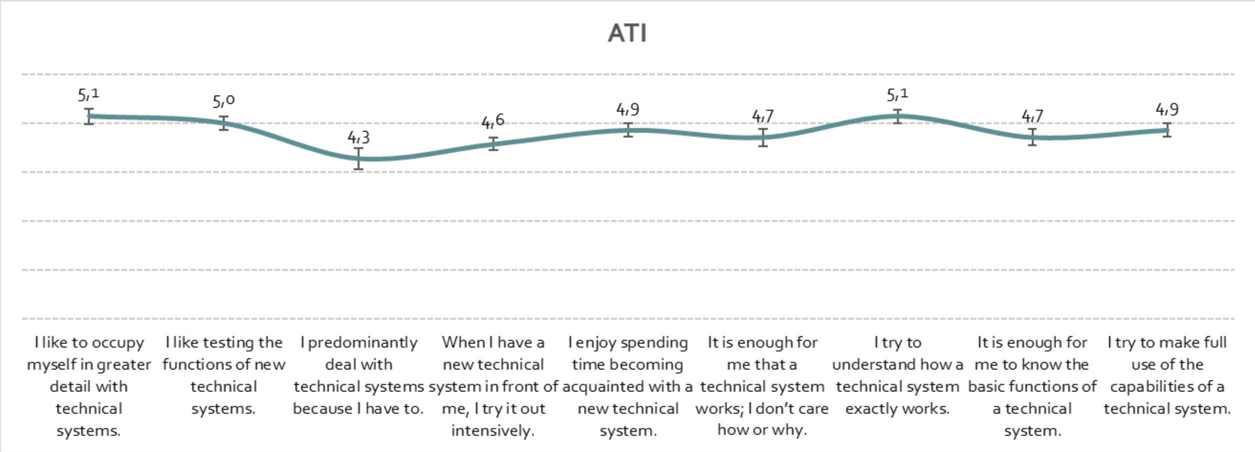


Figure 36: ATI SCALE Average values for *LaneMerge* (local trial)

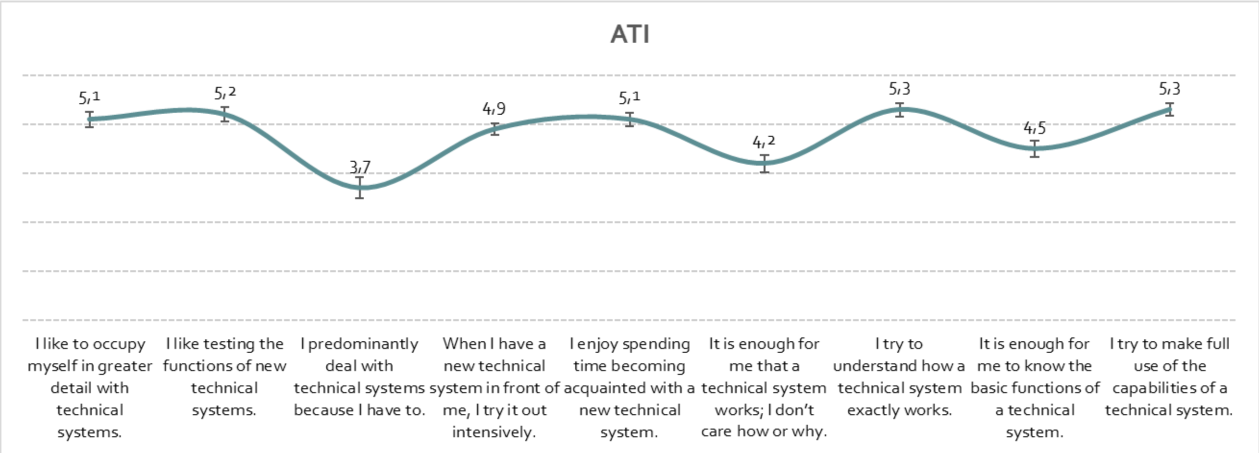


Figure 37: ATI SCALE Average values for *Overtaking* (local trial)

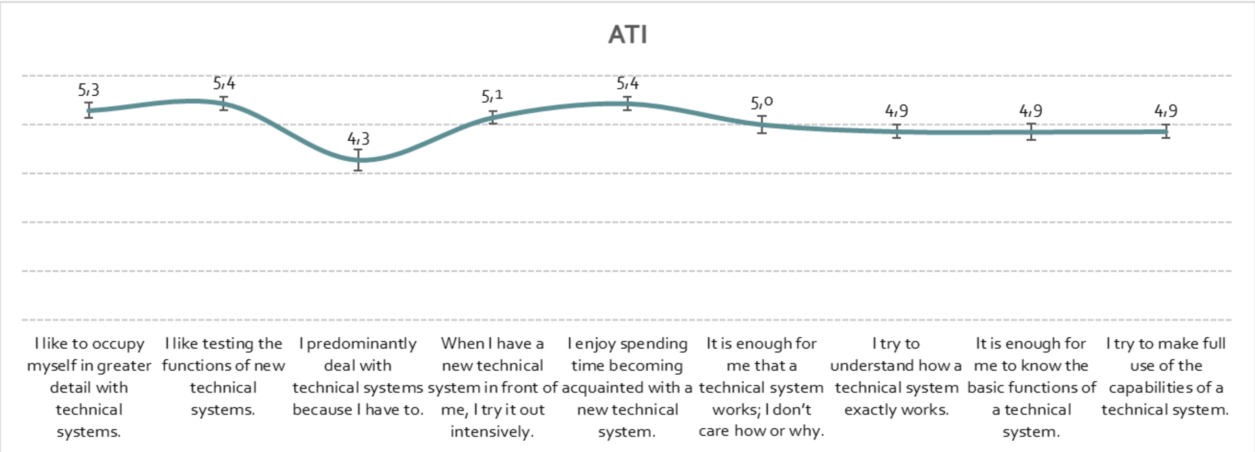


Figure 38: ATI Scale Average values for *HDMapsVehicle* (Local Trial)

Annex 5. Pre-test & Post-test Evaluation for Local Trials in Real World

Table 52: Summary of Pre-test Interviews for Local Trials

Pre-test Interview Summary	Question	Conclusion	Quotes
Lane Merge	Experience as driver	Between 1 and 18 years of experience as drivers	--
	Do you like driving?	3/7 like driving	"No, I don't like it, makes me waste time". "No, I don't like, I prefer to be a co-pilot. I would like people to have a better behaviour".
	Do you have experience with ADAS systems?	5/7 have experience with ADAS systems.	Experience with the next ADAS: CC, SL, Traffic Jam Assistant, ACC, Lane Keeping, BSD and FCW.
	And tell me a little about the responsibility of others when driving their cars? Do you think they are responsible?	7/7 think they are responsible as drivers. 2/7 consider that the others are not responsible when driving.	"Yes, I am. The majority of other drivers are responsible too".
	Do you see bad manoeuvres often?	3/7 see bad manoeuvres often. 3/7 see bad manoeuvres sometimes. 1/7 don't see bad manoeuvres	"Drivers who do not use the blinkers, people who do not yield".

	Do you avoid anything else as driver?	6/7 avoid situations such as driving in the city, at night, with rain or snow, tired or in roundabouts with several lanes.	"I avoid driving at night".
	Do you remember an unexpected manoeuvre as lane merge?	4/7 remember an unexpected manoeuvre such as lane merge mainly when merging at highways.	"I remember a merge lane in the highway and without good visibility, then I had to accelerate if not there was the possibility that I would crash".
	What abilities do you consider are most important for drivers to cope with bad manoeuvres?	2/7 indicated the ability to evaluate distance and speed. 4/7 pointed out the ability to pay attention around (safety situation). 1/7 said that it is very important to collaborate with others.	"You should be quickly taking the best decision because of the speed and the distance"-
	Have you driven an autonomous car sometimes?	3/7 have experience with autonomous vehicles.	--
	Do you consider that the autonomous vehicle would help to deal with this manoeuvre?	3/7 are sure 4/7 are not sure about.	"Yes, the autonomous would always helps".
	What could help in this manoeuvre?	4/7 pointed out BSD system. 3/7 don't know.	The BSD System it a good help to ensure there are no other cars.

Overtaking	Experience as adriver	Between 5 and 21 years of experience.	--
	Do you like driving?	4/4 like to drive very much.	"Yes, I like to drive. I don't like the behaviours of other drivers".
	Do you have experience with ADAS systems?	3/4 have experience with ADAS systems.	They have experience with the following ADAS systems: ACC, Lane keeping, FCW, SL or BSD.
	And tell me a little about the responsibility of others when driving their cars? Do you think they are responsible?	4/4 consider themselves to be responsible but claims that several others on the road are not.	"Yes, I am responsible but the others aren't. Sometimes there are even drivers who use the mobile phone while driving".
	Do you see bad manoeuvres often?	4/4 see bad manoeuvres sometimes.	Yes, people sometimes are very nervous when driving and therefore aggressive.
	Do you avoid anything as driver?	3/4 avoid something such as driving close to other cars or traffic congestion.	"I avoid driving to close to the next car".
	Do you remember an unexpected manoeuvre as overtaking?	4/4 observed unexpected manoeuvres when overtaking, mainly manoeuvres done with little time or space to finish it.	"Once I was with a friend who overtakes in the last moment, and he performed a dangerous manoeuvre, overtaking several trucks. One of the trucks had to go to the shoulder and we were three vehicles in parallel."

	What abilities do you consider are most important for drivers to cope with bad manoeuvres?	2/4 indicated that it was very important to anticipate the situation. ¾ highlighted the importance of fast decision making and low time reactions. 2/4 related the importance of having a global view of the situation. ¼ pointed out the stability and power of car as a factor to consider.	"Short reaction time and the car stability and the power of the car to finish the manoeuvre as soon as possible".
	Have you driven an autonomous car sometimes?	2/4 have tried and autonomous car sometimes.	--
	Do you consider that the autonomous vehicle would help to deal with this manoeuvre?	2/4 are sure that autonomous car could deal with the situation. 2/4 are not sure about.	"Sure, it has more and better information than a driver".
	What could help in this manoeuvre?	¼ pointed out BSD system. ¼ indicated that autonomous car has a global vision about the situation. ¼ was not sure about what could help.	"Yes, they (AV) could help to avoid an accident, only performing it when safe. It's very difficult manoeuvre from a technical point of view".

		¼ said that it could avoid accidents because safety is the key.	
HD-Maps	Experience as driver	From 2010	
	Do you like driving?		
	Do you have experience with ADAS systems?	Yes, ACC, SL, FCW and BSD.	--
	And tell me a little about the responsibility of others when driving their cars? Do you think they are responsible?	Yes, I am responsible. I don't know in general because sometimes one see dangerous manoeuvres.	"Yesterday, a truck was in the middle of my lane because driver wanted to change the direction in a forbidden place".
	Do you see bad manoeuvres often?	Yes, as I explained before, every day one can see bad manoeuvres.	Mainly when drivers do not stop in a "Stop signal".
	Do you avoid anything else as driver?	I try not to interfere with other drivers	--
	Do you remember an unexpected manoeuvre near roadworks or	I can remember a situation dangerous for such case	"Most turnouts are well signposted"

	anything similar?		
	What abilities do you consider are most important for drivers to cope with bad manoeuvres in these situations?	"Low time reactions and not being nervous".	You need to react as soon as possible.
	Have you driven an autonomous car sometimes?	No, never	--
	Do you consider that the autonomous vehicle would help to deal with this manoeuvre?	It could help with its own navigator could manage it with a new route proposal.	--
	What could help in this manoeuvre?	A good navigation system.	--

Table 53: Summary of Pre-test Focus Group for Overtaking (Local Trial)

<table>
<tr><th colspan="2">OVERTAKING USER STORY</th></tr>
<tr><th colspan="2">Introductory questions</th></tr>
<tr><td colspan="2">Because we will be discussing the possibility of you inside an automated car, I would first like to know how you feel when you are not driving a car, when you are the passenger.</td></tr>
<tr><td colspan="2">• Do you feel comfortable being a passenger, or you prefer to be the one driving? Safe?
• Do you think you are a good driver?</td></tr>
<tr><td>Summary</td><td>2/6 depends on who is driving could feel comfortable if they are not the driving
4/6 feels comfortable when they do not drive. They feel they could sleep.

Quotes:
• "Definitely, yes, I could even sleep, without problem. With my father no, because we don't allow him to drive because. he has now problems to drive. But for example, with my best friend I did long trips without problem, he even could drive in trips of 700kms, I am the co-pilot I only select the music".
• "With most of the people, I trust in their driving, so I even sleep. If it is necessary, I close the eyes and I sleep, in this way travel is short".</td></tr>
<tr><td colspan="2">• I am just going to give you a couple of minutes to think about your experience with autonomous features or ADAS inside your cars. Is anyone happy to share his or her experience?</td></tr>
<tr><td>Summary</td><td>6/6 have experience with ADAS systems.
Participants tried the next systems: CC, ACC, Lane Keeping, Parking assistants and SL. Half of the respondents are not comfortable using this kind of features.

Quotes:
• "I have experience with cruise control and keeping lane warning. My car has not speed limiter. I like to drive with cruise control mainly with long trips because I don't need use foot only hand for driving".</td></tr>
<tr><th colspan="2">Guiding questions Overtaking</th></tr>
<tr><td colspan="2">• Do you see bad manoeuvres often?
• Do you remember an overtaking manoeuvre that you considered as dangerous or difficult to perform or that you remember because something unexpected happened?
- Explain the situation. What happened?
- Who was involved? How did they respond?
- How was it resolved?
- What did you do next?
- Was there anything else you could have done?
- Was this situation unique? Repeated?
- How would you have liked overtaking manoeuvres to have happened?
- What was the best support in that situation?</td></tr>
</table>

Summary	6/6 remembered dangerous or difficult to perform manoeuvres due to the involvement of heavy vehicles (as trucks) or motorbikes or other PTV. The conditions of the environment are important, for example, if you find a child or an animal crossing. Quotes: • *"I have an example with motorbike, I was driving in well signalled road. I found an emergency car driving in my way in a curve, it scares me, although it has the emergency lights it was dangerous, I stopped when I found a place next to other car. When you drive a motorbike, you have not much alternatives, it depends on the speed, if you are speeding in the curve you can have problems. In a car, you can turn the steering wheel but anyway, it can be dangerous. When I think about it, I believe I was lucky. In this case, only the other two cars could help, the car being passed could steer further onto the shoulder and the emergency car brake or avoid the manoeuvre. I consider that not all the drivers do not help in this situation, it is the same when you are merging in a highway, there are more selfish, they think "I am here, I was first". I believe they are not aware of the danger there is. A lot of people only think in their driving, they are not aware about what is happened in the environment, around they car".* • *"I consider that the driver of motorbikes or other PTV vehicles with two wheels, they are disrespectful with the other drivers or VRU (as for example when a cyclist enters the roundabout without yielding the right-of-way".*
• **Subject's stories about abilities to cope with stressful manoeuvre during lane merge/overtaking manoeuvres.** *If driver has shared a story involving the stressful coping with, you should continue the conversation on this topic.* • Why did you choose to do what you did? • What was this experience like for you? • How supportive were the ADAS system in helping you? *If subject chose to do nothing* – try to find out why	
Summary	2/6 pointed out anticipation 1/6 said experience 1/6 indicated low time reactions. 1/6 told distances or speed. 1/6 suggested determination, not hesitation when overtaking Quotes: • *"Mainly to have control of the environment, to be conscious about what is happening on the road".* • *"You should have determination, you cannot doubt the manoeuvre you are performing, once you start it you must finish it with the safety margins you have".*
• **Subject's Experience with Autonomous car** • Have you ever tried an autonomous vehicle? • What kinds of issues have you had with this experience? • How do you envision that an autonomous car could help you with the lane merge manoeuvre?	
Summary	2/6 have experience with autonomous cars. They considered that the autonomous car could help in situations with low visibility.

	Quote: • *"Maybe in situations when you are overtaking a truck when it's raining it could help me. Perhaps when I am performing an overtaking when it is foggy it could help me to be sure that there is not car in my lane".*
• What do you think of these situations? • During our conversation have you ever considered the issue of connectivity as something that might affect the experience inside an AV?	
Summary	4/6 considered the connectivity will be positive, the cars which are connected in the manoeuvre have an extra, it is a good thing. 2/6 are not sure about it. Quotes: • *"The biggest advantage is to have real information for all the cars, and it helps. It will be safer, but of course, everyone should use these systems".* • *"The problem is if you have a car which is not connected. If all of them have the information, it would be safer".*
Of all the things we have discussed today, what would you say are the most important issues you would like to express?	
Summary	4/6 participants have doubts or considered that it is not clear about the future of autonomous vehicle (e.g., infrastructure is not ready). 2/6 are on favour of autonomous car and their functionalities as an extra helping in the overtaking manoeuvre. Quotes: • *"After this focus group, I was thinking that the infrastructure is no ready for this kind of cars. It is necessary to have clear if I can trust in this technology".* • *"Personally, I would be very thankful for everything that could help me, a car connected and autonomous would be very positive. Let's go to trust on it. You flight in a plane without problem. Nothing/nobody is perfect, you can have an error".*

Table 54: Summary of Pre-test Focus Group for HDMapsVehicle (Local Trial)

HDMapsVehicle USER STORY	
Introductory questions	
• Do you feel comfortable, or do you prefer to be the one driving? Safe? • Do you think you are a good driver?	
Summary	3/6 prefer to drive by themselves. 3/6 feel comfortable when others drive. Quote: • *"I feel comfortable, but I'm usually more alert in the intersections."* • *"I have some friends drive a bit dangerously."* • *"I could sleep in the car".* • *"I also prefer to drive. I like it. When I am not driving, I pay attention what is happening around".*

• I am just going to give you a couple of minutes to think about your experience with autonomous features or ADAS inside your cars. Is anyone happy to share his or her experience?	
Summary	3/6 participants have experience with ADAS systems (ACC, SL, CC, FCW) 3/6 never tried these kinds of features. Quotes: • *"I have used sometimes the limiter speed, but I only have some advice, but when I tried the CC, I did not used more the Speed limiter".* • *"My car is old and it has not this kind of functions".*
Guiding questions HD maps	
• Do you see bad manoeuvres often? • Do you remember a manoeuvre that you considered as dangerous or difficult to perform or that you could remember because something unexpected happened when arriving to a road works area or another difficult area on the road? - Explain the situation. What happened? - Who was involved? How did they respond? - How was it resolved? - What did you do next? - Was there anything else you could have done? - Was this situation unique? Repeated? - How would you have liked overtaking manoeuvres to have happened? - What was the best support in that situation?	
Summary	6/6 pointed that the most usual situation is to find roadworks without proper signalling. When using navigation systems, they sometimes get confused, but none pointed out dangerous situations Quotes: • *"I spent more than an hour in a roadworks, it was crazy, because I was using a navigation system, but the course it suggested made no sense".* • *"I found road works on a tunnel, and it was horrible because the alternative took more time, and the suggested road was not very good".*
• **Subject's stories about abilities to cope with stressful manoeuvre during lane merge/overtaking manoeuvres.** *If a driver has shared a story involving coping with a stressful event, you should continue the conversation on that topic.* • Why did you choose to do what you did? • What was this experience like for you? • How supportive were the ADAS system in helping you? *If subject chose to do nothing* – try to find out why	
Summary	2/6 pointed out the need to be attentive to the road. 1/6 said experience is the best help in this situation. 1/6 told to adapt the driving to the environment where you drive. 2/6 expressed low reaction times. 1/6 highlighted good decision making and more anticipation. Quotes:

	• *"The best ability is to pay attention to the situation, the perception is the most important, mainly to perceive what is happening before and react soon".* • *"Adapt the driving style to the zone where you are driving".*
• **Subject's Experience with Autonomous car** • Have you ever tried an autonomous vehicle? • What kinds of issues have you experienced? • How do you envision that an autonomous car could help you with the lane merge manoeuvre?	
Summary	2/6 tried the autonomous vehicle Quotes: • *"I have experience testing autonomous vehicles in the test track. My experience was very positive, and the autonomous car managed properly the traffic lights phases, e.g. reducing the speed when traffic light is changing to red".*
• What do you think of these situations? • During our conversation have you ever considered the issue of connectivity as something that might affect the experience inside an AV?	
Summary	6/6 considered that the autonomous car would be a help understanding what happens. 2/6 were not fully confident in the car. 6/6 expressed that 5G connectivity is a positive extra: you have more information in less time. Quotes: • *"I would be confident in the autonomous car behaviour; it would be very comfortable to drive with this car in a road work situation".* • *"With 5G you could share more information, you have more nodes more users using it, and you can manage more amount of information".*
Of all the things we have discussed today, what would you say are the most important issues you would like to express?	
Summary	All participants considered that although it is a useful technology it is necessary to work more in this technology. 3/6 expressed that they were worried that machines could replace humans. Quotes: • *"It is a very useful technology, but it is necessary to work more on it. Anyway, I think the most important is not the autonomous car, the most important is the connected vehicle".* • *"I think it is important to have in mind that people are worried about the machines could replace the persons. Some persons are not right with that. Each time we interact more with machines. Even now you exchange a lot the information with the mobile (phone)".*

Annex 6. Qualitative data of the Advanced Manoeuvres Evaluation - online interviews

Table 55: Summary of Online interview

Interview Summary	Question	Conclusion	Quotes
Lane Merge	Experience as a driver	Between 2 and 32 years of experience as drivers	
	Do you like driving?	14/19 like driving 3/19 do not like driving 2/19 drive by necessity	
	What you don't like about driving?	6/19 do not like long journeys 4/19 do not like traffic jams 2/19 do not like bad behaviour of other drivers 1/19 do not like the constant attention needed 1/19 do not like manual gears	*"I don't like to spend my time in traffic jams"* *"I find long journeys monotonous"*
	What ADAS you usually use?	8/19 use ACC / Cruise Control 8/19 use parking assistant 4/19 use LKA 2/19 use BSD 2/19 do not use ADAS 1/19 use rear parking camera 1/19 use speed limiter 1/19 use automatic emergency braking 1/19 use forward collision warning 1/19 use remote parking	
	What ADAS you didn't like to use?	3/19 do not like to use ACC 1/19 do not like to use LKA 1/19 do not like to use pre-collision sensors 1/19 do not like to use fatigue sensor 13/19 did not answer	

	Why did you not like the ADAS?	2/19 because it is very sensitive to any event on the road, unnecessarily active 2/19 because it can be more distractive 1/19 because it looks like the car comes to life 1/19 because it detects unnecessary things 1/19 because I don't like the lack of control 12/19 did not answer	*"Cruise control makes me a little insecure, the car is dominating me"* *"Sometime leaves too much space to the front car"*
	Do you avoid anything as a driver?	6/19 avoid exceeding speed limits 5/19 avoid none 3/19 avoid driving close to ahead vehicles 2/19 avoid dangerous overtaking 1/19 avoid unknown routes 1/19 avoid driving on central lanes 1/19 avoid complex roundabouts / crossings 1/19 avoid risk behaviours 1/19 avoid overtaking on national roads 1/19 avoid drive at night 1/19 avoid Driving in poor visibility conditions (rain, fog, etc.)	*"I do not like to drive very close the other cars"* *"I try to keep the road speed limit"*
	Have you ever tried an autonomous car? (as a driver or as a passenger?)	9/19 never tried an autonomous car 10/19 already tried an autonomous car	
	How was it? (the experience of driving/be a passenger in an autonomous car)	6/19 said that it was a good experience 2/19 said it was in a controlled scenario 1/19 expressed confidence in this technology 1/19 had no worries 1/19 were curious	*"it was fine because was only a demo"* *"I like, I did a Tesla test drive"*

		1/19 war for C-streets Project tests 1/19 performed overtaking manoeuvres 1/19 considered the ride smooth. 1/9 considered the ride a bit strange	
	Do you think an autonomous car could help you with the manoeuvre in question?	17/19 said yes 2/19 have doubts	
	Why? How?	3/19 consider vehicle-to-vehicle communication important 2/19 have confidence when in typical situations 1/19 think this (AV)s is the future 1/19 think the transition to autonomous driving must be phased 1/19 think it will be better due to the ability to predict 1/19 will free me to do other things 1/19 like to move around without having to be paying attention 1/19 think will help at longer journeys 1/19 think the connection with infrastructure can help reduce stops at traffic lights 1/19 believe that AV has more information than a driver 1/19 believe it could adapt the speed to the one of other (surrounding) cars	*"I think so, if they are able to communicate with each other"*
	Advantages Autonomous vehicles	9/19 believe that AVs are safer and can reduce the number of accidents 6/19 think that AV will allows to spend time with other activities 4/19 believe in increased comfort 3/19 believe in fatigue reduction	*"We walk towards a much better world"* *" It will come to a point that maybe, let's look back and think, how well we drove cars, wasted our time of the day driving"*

		2/19 believe in stress reduction 2/19 believe in increased driver convenience 2/19 said about human error elimination 3/19 consider that AD requires less driver attention 2/19 believe that AV make decisions faster than human drivers 1/19 believe that AVs will increase mobility for people with difficulties 1/19 thinks it can optimize parking 1/19 believes the improvement of quality of life 1/19 imagines better traffic management / better fluidity 1/19 believes at road event predictability 1/19 believes at anticipation and information sharing between vehicles 1/19 likes to have feedback about the road status	*"The autonomous cars will be safer, we will have less accidents"*
	Disadvantages of autonomous vehicle	5/19 referred problems with the 5G connection, if it doesn't work properly 2/19 are afraid of too much dependency on databases / information containing errors 2/19 is worried about reduce driving practice/skills 2/19 believe at technological distrust 1/19 worried about philosophical questions 1/19 think there will be an initial barrier for acceptance 1/19 think more complex contexts without 5G network would be difficult	*"The drivers can be more inattentive in unforeseen circumstances"* *"I'm worried that vehicles will make decisions fuelled by wrong information"*

		1/19 worried about driver distraction	
	After manoeuvres videos		
	Were any of the situations unexpected?	11/19 said yes 8/19 were not surprised	
	Which one?	8/19 none 7/19 worst condition 3/19 average condition 1/19 worst and average condition	
	Why? When?	3/9 when the car stopped 2/19 when the vehicle seems to hesitate 1/19 thought that when the vehicle could not drive by itself, it would ask for a retake, but that did not happen 1/19 was surprised by the behaviour without 5G network 1/19 when AV was conditioned (unstable 5G network) and errors could occur 1/19 believe that the vehicle behaviour preserved passenger safety 1/19 with the total loss of the 5G network, the AV seems unable to make decisions safely 1/19 when the 5G network became unstable and the vehicle tried to do the manoeuvre anyway 1/19 when AV was able to predict the approach of a vehicle even without visibility	*"Even without 5G network, the vehicle managed to solve itself"* *"It has enough connection to make the decision to change lanes, albeit hesitantly, and in a situation like this it increases nervousness"* *"For me it's safer to stop than to hesitate when there is a weak 5G network"*
	Do you consider that it would be easy to use this autonomous car?	13/19 yes 5/19 it depends 1/19 no	
	Why, why not?	5/19 believe it will be easy / simple / Intuitive	*"It's hard at first, but with practice it gets easier"*

		2/19 think that in an urban environment it may not be easy 2/19 consider that it depends on who will use it / it will be easier for new drivers 2/19 believe it will take some getting used to 1/19 think technology is getting better 1/19 people get used to what's good 1/19 worried about be conflicting expectations from the driver 1/19 do not know how it will work. 1/19 believe that it is only need to pay attention 1/19 considers that the vehicle manages all the situations 1/19 imagines that information will be clear	*"I don't know, it depends on the car's interfaces"* *"For people used to technology it will be easy, but for the other people I don't know"*
	Do you think that an autonomous vehicle like this would be useful for you?	16/19 yes 2/19 it depends 1/19 no	
	Why? Why not?	4/19 believe it will be useful on long journeys / on highways 3/19 consider that will be useful because is safer 3/19 would like to enjoy free time / to work /to rest 1/19 would not like it if constant attention is required 1/19 move mainly in urban areas 1/19 does not like to drive 1/19 thinks that it will be more convenient 1/19 thinks that with unstable 5G network it will be complicated in urban contexts 1/19 liked the comfort	*"I find it useful when I need to make long trips"* *"I take long daily trips and it would be nice to rest"*

		1/19 appreciated the idea of having anticipatory information through the5G connection 1/19 would use only if all vehicles were autonomous 1/19 thinks that the vehicle would provide very good support for difficult and dangerous manoeuvres, avoid surprises 1/19 thinks he/she would feel calmer using the vehicle 1/19 would need to try it first	
	If it would be accessible, would you like to use this autonomous car?	17/19 yes 2/19 No under current (road/legislation, technology readiness) conditions	
	Why? Why not?	3/19 would use it without any problem 3/19 depends on how much it costs 2/19 would use it if the test drive goes well 2/19 prefer to wait for more technology evolution 1/19 would use it parsimoniously 1/19 lack of trust in the urban environment 1/19 would like to take advantage of this in the future 1/19 if you can turn it off 1/19 only if the vehicle is fully autonomous	*"I have to try it several times it"* *"The autonomous car is here to stay" (Will eventually be adopted)*
	Would you trust in an autonomous car?	13/19 yes 2/19 Not currently 2/19 don't trust 100% 2/19 no	
	Why? Why not?	8/19 would trust after experiencing the vehicle / after some time 3/19 would trust without problems 2/ 19 would not be totally convinced	*"Because I like the reaction of the car in the videos although I need some extra information for example in a tutorial"* *"How you are not driving you feel more unsafety, I prefer to drive by myself"*

		1/19 would always be alert to take control of the vehicle 1/19 States that it would depend on the technology maturity 1/19 would trust only on highways 1/19 would not trust because he/she knows that machines can make mistakes 1/19 thinks the focus of vehicles will be on safety 1/19 thinks it is necessary to diminish the number of error occurrences 1/19 thinks the vehicle has access to more information	
	Do you consider this to be a reliable vehicle? The AV will perform consistently under a variety of circumstances?	10/19 yes 7/19 I have doubts 2/19 no	
	Why? Why not?	3/19 would only accept if most vehicles were also autonomous 2/19 have doubts whether the vehicle will be able to react to all varieties and unexpected situations 2/19 fears that if the 5G network is not stable, it may not be consistent 2/19 believe the vehicle is able to handle unexpected situations 1/19 believes that the AVs have enough redundant systems to avoid failures 1/19 would use only on highways because in an urban environment it is more complex 1/19 would use if the premise is always that safety comes first 1/19 said it will depend on how fast the system learns	*"It is a very new technology and we need more experience with it"*

		1/19 thinks it will be reliable because it seems able to fix a glitch 1/19 thinks it will make better decisions than human drivers 1/19 thinks more testing and research is needed	
	When compared with a manual vehicle how safe do you think this autonomous vehicle would be?	16/19 thinks AV is safer 2/19 stated that it depends 1/19 think it is similar in both	
	Why? Why not?	7/19 think that will be safer because eliminates human error / human behaviours 2/19 think that using more AVs will reduce accidents 2/19 think that AV have more information processing capacity 2/19 believe the more autonomous vehicles on the road, the safer it will be. 1/19 believes that situations will be more controlled if there is no 5G network failure 1/19 thinks that technical errors are corrected over time 1/19 thinks that it will eliminates fatigue 1/19 believes it is necessary to test it more	*"Autonomous vehicle is the safer way to travel"*
	Would you recommend this car to your family or friends?	14/19 yes 4/19 no 1/19 it depends	
	Why? Why not?	7/19 recommend after using it and making sure it works well 4/19 recommend for people with limitations or elderly people, who can no longer drive 2/19 believe elderly people are not ready for this technology	*"Yes, I recommend if I try first and everything goes well"* *"I would recommend it to my grandparents, they can no longer drive"*

		2/19 Safer 1/19 It is necessary to improve it	
	Do you think the infrastructures are ready for having autonomous vehicles on the roads?	8/19 no 8/19 it depends 2/19 yes 1/19 do not know	
	Why? Why not?	6/19 would use only on highways 4/19 thinks that it is necessary to improve the infrastructure. 3/19 thinks that it is not ready if it depends on the 5G network 1/19 thinks that roads are better, but not ready for autonomous vehicles 1/19 thinks would use only if there were exclusive roads for autonomous vehicles 1/19 there is low offer of electric charging stations 1/19 thinks that there is a lack of signposted/lack of road line marks 1/19 thinks there is poor internet / 5G network 1/19 thinks it would be necessary to connect traffic lights with autonomous car. 1/19 would use mainly in urban areas because the different scenarios as roadworks with enough information	*"I think only the highways; the others roads need improvements"*
	Would you feel capable of doing a long trip using the autonomous vehicle without help?	17/19 yes 1/19 It depends 1/19 no	
	Why? Why not?	6/19 would need some explanation before / read the manual 4/19 think it will be easy to use / will be intuitive	*"Because the speed is high driving in highways and I will need more experience"* *"I think so, with some help"*

		2/19 would use it only highways 1/19 will explore the controls until he/she is able to understand them 1/19 concern is having to take control 1/19 will not feel capable at first 1/19 think it will not a problem for those who have contact with technology 1/19 thinks it will be easier if most vehicles on the roads are autonomous 1/19 thinks maybe he/she will have doubts if he/se is using the AV correctly 1/19 thinks he/she would be fearful at the first.	
	Would you feel anxious in driving an autonomous vehicle?	8/19 would feel anxious at first 7/19 no 3/19 yes 1/19 no, if able to take control	*"What causes anxiety is seeing the car driving, if we are distracted or behind, as if with a driver, it no longer causes me anxiety"* *"Knowing that I can take control gives me more security and less anxiety"*
Overtaking	Experience as driver	Between 0 and 37 years of experience as drivers	
	Do you like driving?	13/19 yes 4/19 no 1/19 drive by necessity 1/19 does not drive	
	What you don't like about driving?	3/19 do not like traffic jams 3/19 do not like that constant attention is needed 2/19 do not like bad behaviour of other drivers 2/19 do not like it because it is tiring 1/19 do not like manual gears 1/19 do not like long journeys 1/19 do not like to park 1/19 do not like to drive at night	*"I think everyone doesn't like traffic jams".* *"On long trips I get inattentive"* *"I don't like night driving because I don't see well"*

		1/19 do not like driving at the end of the workday 1/19 do not like having people with me while I'm driving 1/19 do not like motorcycles in the blind spot 1/19 do not like drivers to change lanes without paying attention 1/19 do not like how people use roundabouts 1/19 do not like narrow roads 1/19 do not like road risk	
	What ADAS you usually use?	9/19 use ACC / Cruise Control 5/19 use parking assistant 5/19 use speed limiter 4/19 use LKA 3/19 do not use any ADAS 2/19 use FCW 1/19 use rear parking cameras 1/19 use BSD 1/19 use fatigue sensor 1/19 use signal recognition	
	What ADAS you didn't like to use?	3/19 do not like to use parking sensors 1/19 do not like to use LKA	
	Why?	3/19 thinks that ADAs detect unnecessary things and is very sensitive 1/19 do not like the feeling of using ADAS	*"Very noise"* *"I like to have control of my car"*
	Do you avoid anything else as driver?	3/19 avoids driving close to ahead vehicles 3/19 avoids exceeding speed limits 3/19 avoids complex roundabouts / crossings 3/19 avoids traffic jam 1/19 avoids use cell phone 1/19 avoids drive at night	*"I try not to talk on the cell phone and not to exceed speed"* *"I avoid complex environments, very busy"*

		1/19 avoids national roads 1/19 avoids aggressive driving 1/19 avoids long journeys 1/19 avoids driving above 3000rpm 1/19 avoids being around vehicles that are doing something wrong 1/19 avoids driving in city centres 1/19 avoids driving in poor visibility conditions (rain, fog, etc.)	
	Have you ever tried an autonomous car? (as driver or passenger?)	15/19 no 4/19 yes	
	How it was?	2/19 said that it was a good experience 1/19 said it was in controlled scenario 1/19 said he/she feel unsafe 1/19 felt he/she had to pay attention to regain control of the vehicle 1/19 was a little afraid at first	*"First time I tried the autonomous vehicle was fine, it was perfect. It would be great to improve the icons for showing the information"*
	Do you think an autonomous car could help you with the manoeuvre in question?	13/19 yes 3/19 not sure 2/19 it depends 1/19 no	
	Why? How?	3/19 said that it could help if vehicle-to-vehicle communication is available 3/19 said that it could help if it's all autonomous vehicles 2/9 said that it could help due to the ability to predict 2/19 said that computer vision will help 1/19 said that it could help on highway 1/19 said that reaction times would be shorter	*"I think it will help making overtaking safer as it has more visibility than drivers"*

		1/19 said that driver action would still be required 1/19 if autonomous car has enough power to perform the manoeuvre fast 1/19 anyway overtaking manoeuvring is very dangerous	
	Advantages Autonomous vehicles	10/19 believe that AV will be safer and accident reduction 6/19 think that AV will allows to spend time with other activities 4/19 believe in increased comfort 3/19 believe they can improve sustainability / Optimization of energy consumption 2/19 consider that requires less driver attention 2/19 believe in fatigue reduction 1/19 believe they will increase mobility for people with difficulties 1/19 believe on human error elimination 1/19 believe in increased driver convenience 1/19 believe that AD decreases problems with human distraction 1/19 believe AD is useful on long journeys 1/19 referred to better traffic management / better fluidity 1/19 said it would be good for drunk drivers 1/19 believe it would be useful by increasing road event predictability 1/19 believe it would be useful for event anticipation and information sharing between vehicles 1/19 said one would not need to know how to drive 1/19 believe it would optimize traffic jams	*"Using autonomous car means forget to drive"* *"Autonomous car is feasible to overtake in a safe way"*

	Disadvantages of autonomous vehicle	2/19 referred technological distrust 2/19 referred driver distraction 1/19 referred the reduction of driving practice/skills 1/19 it will increase vehicle use unnecessarily 1/19 it will be worst in mixed traffic (autonomous, pedestrian and manual vehicles) 1/19 believe vehicles would be more expensive 1/19 believes it will be bad for those that like to drive 1/19 believes it will be mandatory the autonomous vehicles	*"Tt may increase the number of cars on the roads unnecessarily"*
	After manoeuvres videos		
	Were any of the situations unexpected?	10/19 yes 9/19 no	
	Which one?	9/19 none 5/19 average condition 3/19 worst condition 2/19 best condition	
	Why? When?	3/19 referred that when the vehicle hesitated, it gave them less stability 2/19 referred that the vehicle was able to predict the approach of a vehicle even without visibility 1/19 referred autonomous driving was conditioned (unstable 5G network) and errors could occur 1/19 referred that even with the unstable network, the vehicle was able to safely correct the trajectory 1/19 referred that the vehicle run out of 5G and move on 1/19 referred that it slowed down when it ran out of 5G network	*"The unstable network doesn't make me exactly confident"* *"This video with the unstable 5G network makes me feel more insecure"*

		1/19 referred the moment when the vehicle ran out of 5G network and decided to wait 1/19 referred the moment when the car waited for the other vehicle to pass first	
	Do you consider that it would be easy to use this autonomous car?	15/19 yes 4/19 it depends	
	Why, why not?	11/19 believe it will be easy / simple / Intuitive 2/19 consider vehicle manages all the situations 1/19 considers that depends on who will use it / it will be easier for new drivers 1/19 thinks good graphical interfaces should make it easier 1/19 believes it will be simpler than today 1/19 thinks in mixed traffic it will be complicated 1/19 believes it will look like a normal car 1/19 imagines the information will be clear	*"I think it will be similar to cell phones, computers, increasingly easier to use"*
	Do you think that an autonomous vehicle like this would be useful for you?	17/19 yes 1/19 it depends 1/19 no	
	Why? Why not?	8/19 referred that the AV would allow him/her to enjoy free time / to work /to rest 5/19 believe it will be useful on long journeys / on highways 2/19 consider that will be useful because is safer 1/19 does not like to drive 1/19 said it will not be useful be he/she uses public transport	*"it will be useful for me because then I can rest during my return home"* *"For me only on long trips, in the day I think it won't help much"*

		1/19 referred that it would provide very good support for difficult and dangerous manoeuvres, avoid surprises 1/19 would feel calmer	
	If it would be accessible, would you like to use this autonomous car?	18/19 yes 1/19 no under current conditions	
	Why? Why not?	2/19 would use it if the test drive goes well 2/19 would use it without any problem 2/19 would use depending on how much it costs 1/19 would prefer to wait 1/19 would use if one can turn it off 1/19 would use only if the vehicle is fully autonomous	*"I didn't mind clicking a button and letting the machine drive the car"*
	Would you trust in an autonomous car?	16/19 yes 2/19 not 100% 1/19 not currently	
	Why? Why not?	7/19 will trust after experiencing / after some time 3/19 will trust because it is a tested technology, if it is on the market I will trust it 2/19 believes AVs focus on safety 2/19 will trust without problems 1/19 will use depending on the technology maturity 1/19 will use only on highways 1/19 would use depending on the vehicle's communication with the driver 1/19 said it is something he/she has never seen 1/19 would trust only if all vehicles are autonomous	*" If you say that the car controls everything, it's already a reason for distrust"* *"It should always be possible for the human being to overcome the autonomous car"*

	Do you consider this to be a reliable vehicle? The AV will perform consistently under a variety of circumstances?	11/19 yes 5/19 have doubts 3/19 no	
	Why? Why not?	2/19 have doubts whether the vehicle will be able to react to all varieties and unexpected situations 2/19 said only on highways because in an urban environment it is more complex 2/19 said it depends on the system learning curve 1/19 said the AV has enough redundant systems 1/19 said the AV seems able to fix a glitch 1/19 said the AV makes better decisions than human drivers 1/19 said technology maturity must improve 1/19 said it will be tested until it works correctly 1/19 said that in bad weather conditions it would be difficult it works properly	*"If the autonomous vehicle always depends on the 5G network, I feel vulnerable"*
	When compared with a manual vehicle how safe do you think this autonomous vehicle would be?	16/19 AV safer 2/19 it depends 1/19 similar in both	
	Why? Why not?	6/19 thinks it will be safer because it eliminates human error / human behaviours 2/19 thinks AVs have more information processing capacity 2/19 thinks it will reduce accidents 1/19 thinks it will eliminate fatigue	*"I think safety is one of the key words when I think about autonomous vehicles"*

		1/19 thinks it will depend on the technology maturity 1/19 thinks the AV can handle a variety of situations / Unpredictability disappears 1/19 thinks the AV has a lot of sensors to control the road 1/19 thinks the AV can see 360ª around 1/19 thinks it depends on the sensors' quality	
	Would you recommend this car to your family or friends?	11/19 yes 4/19 it depends 4/19 no	
	Why? Why not?	6/19 would recommend it to everyone if he/she him/herself uses it. 2/19 would recommend after using it and making sure it works well 2/19 would recommend for people with limitations or elderly people, who can no longer drive 2/19 would first have to be convinced 1/19 thinks elderly people are not ready for this technology 1/19 thinks it is safer 1/19 thinks that at first it will be necessary to try it a bit more 1/19 thinks it is less risk to use an autonomous car 1/19 referred it would recommend to his/her mom because, she should be free for go wherever she wants.	*"I don't know, maybe after I try it"*
	Do you think the infrastructures are ready for having autonomous	12/19 no 5/19 it depends 2/19 yes	

	vehicles on the roads?		
	Why? Why not?	8/19 thinks infrastructures are ready only highways 5/19 thinks there are poorly signposted/lack of road line marks 3/19 thinks infrastructures are not ready if it depends on the 5G network 2/19 thinks there is poor internet / 5G network 1/19 thinks roads are better than they used to be, but not ready for autonomous vehicles 1/19thinks it is necessary to improve the infrastructure. 1/19 thinks there is poor availability of electric charging stations 1/19 thinks improvements are needed.	*" Automation should be on dedicated lanes where there are only autonomous vehicles"* *"I think the roads are not ready to this type of vehicles"* *"Our road must by improved"*
	Would you feel capable of doing a long trip using the autonomous vehicle without help?	17/19 yes 1/19 it depends 1/19 no	
	Why? Why not?	9/19 think it will be easy to use / will be intuitive 5/19 think they will need some explanation before / Read the manual 3/19 would feel capable only highways 3/19 think it would not be a problem for those who have contact with technology 1/19 would not feel capable at first	*"It is a new car, at the beginning with the hands next the steering wheel and foot next of brake pedal"*
	Would you feel anxious in driving an autonomous vehicle?	7/19 at first yes 4/19 no 4/19 yes 2/19 do not know because they never tried it	*"Every novelty causes anxiety"* *"Maybe at the beginning without experience it could be a bit anxious if I had an icon that I don't know what means"*

		1/19 would feel anxious at first and be more attentive	
HD-MAPS	Experience as driver	Between 0 and 27 years of experience as drivers	
	Do you like driving?	21/24 yes 3/24 no	
	What you don't like about driving?	8/24 do not like traffic jams 3/24 do not like bad behaviour of other drivers 1/24 do not like long journeys 1/24 do not like constant attention needed 1/24 do not like to park 1/24 do not like discomfort inside the car 1/24 do not like truck traffic 1/24 do not like unforeseen events 1/24 do not like stressful situations 1/24 do not like using mobile phone or something that could distract me	*"I don't like heavy traffic or to park the car"* *"I like to drive, but I don't like long journeys"*
	What ADAS you usually use?	13/24 use ACC / Cruise Control 9/24 use LKA 5/24 use parking assistant 5/24 use BSD 4/24 use speed limiter 3/24 use FCW 2/24 use brake emergency assistant 1/24 use rear parking cameras 1/24 use automatic emergency braking 1/24 use fatigue sensor 1/24 use safety distance system 1/24 use traffic signal recognition	
	What ADAS you didn't like to use?	1/24 referred LKA 1/24 referred safety distance system	

		1/24 referred automatic parking 1/24 referred pre-collision sensor	
	Why?	1/24 referred that it looks like the car comes to life 1/24 referred that the ADAS is very sensitive, unnecessarily active 1/24 referred that the braking is very abrupt 1/24 simpley does not trust	*" The system is very sensitive, it activates unnecessarily and it bothers and distracts me"*
	Do you avoid anything else as driver?	3/24 avoids driving close to ahead vehicles 2/24 avoids exceeding speed limits 2/24 avoids use cell phone 2/24 avoids traffic jam 2/24 avoids drive tired 2/24 avoids driving in poor visibility conditions (rain, fog, etc.) 1/24 avoids risk behaviours 1/24 avoids drive at night 1/24 avoids distraction 1/24 avoids driving in city centres 1/24 avoids overtaking long vehicles 1/24 avoids stress me 1/24 avoids slopes on the road 1/24 avoids drive drunk	*"I avoid talking on the phone, but it's not always possible"* *"I don't drive at night even when it's raining a lot, I feel insecure with poor visibility"*
	Have you ever tried an autonomous car? (as driver or passenger?)	12/24 yes 12/24 no	
	How it was?	10/24 said that was a good experience 1/24 said it was in controlled scenario 1/24 said it was a test drive	*"It was simple, it was a demo with a shuttle"*
	Do you think an autonomous car could help you with	16/24 yes 5/24 not sure 3/24 it depends	

	the manoeuvre in question?		
	Why? How?	4/24 said it could help with vehicle-to-vehicle communication 2/24 said it would be able to predict 2/24 said it could help if the car has the correct information 1/24 said it could help people with difficulty 1/24 said it would be an updated GPS 1/24 said machines are not programmed to make bad decisions 1/24 said that the AV could manage the situation 1/24 said that the AV it has more information than a driver 1/24 said it depends on the navigation system information 1/24 said it depends on how far it could detect another car	*"These cars will be able to predict situations and anticipate manoeuvres"* *"It can help people with driving difficulties"*
	Advantages Autonomous vehicles	9/24 believe that AV will be safer and accident reduction 7/24 think that AV will allows to spend time with other activities 5/24 believe road event will be more predictable 4/24 referred human error elimination 4/24 believe it would allow anticipation and information sharing between vehicles 2/24 believe it would make decisions faster than human drivers 2/24 consider that it will require less driver attention 2/24 believe it would reduce stress 2/24 referred better traffic management / better fluidity	*"Cars being connected can help organize traffic, even in parking lots"* *"It is very interesting in low visibility conditions and I like it"*

		2/24 believe it would be able to manage different situations 2/24 mentioned one would not need to drive 1/24 mentioned it would increase comfort 1/24 believe will increase mobility for people with difficulties 1/24 believe it will reduce fatigue 1/24 believe it will optimize parking 1/24 believe it will be useful on long journeys 1/24 believe it will improve sustainability / optimization of energy consumption 1/24 believe time reactions will be lower 1/24 think it will advantageous to have feedback about the road status	
	Disadvantages of autonomous vehicle	3/24 referred driver distraction 3/24 referred overreliance on technology can be dangerous 2/24 referred the reduction in driving practice/skills 2/24 referred the excessive dependence on databases / information with error 2/24 referred the need to suddenly take control 1/24 referred the low acceptance of an older population 1/24 referred that infrastructure is not ready 1/24 referred the problems with the 5G connection, if it not properly working 1/24 referred that vehicles would be more expensive 1/24 referred problems with technology maintenance by OEMs	*There is a lot of scenarios to consider. It is very important to pay attention all the time.*
	After manoeuvres videos		

	Were any of the situations unexpected?	21/24 no 3/24 yes	
	Which one?	21/24 none 3/24 worst condition	
	Why? When?	2/24 referred to when when roadworks suddenly appears 1/24 expected a better management of 5G network and not a request for the driver to take control 1/24 referred the 5G network issues	*"I expected the car to be able to do everything by itself and not ask for my control"*
	Do you consider that it would be easy to use this autonomous car?	21/24 yes 3/24 it depends	
	Why, why not?	5/24 believe it will be easy / simple / intuitive 3/24 believe will take some getting used to 3/24 believe it will be easy because they has experience with the technology / understand how it works 2/24 stated it should be developed for all users 2/24 stated it should be easy to learn 1/24 consider that depends on who will use it / it will be easier for new drivers 1/24 think good graphical interfaces should make it easier 1/24 think cars will look like computers 1/24 stated that he/she would like to try everything 1/24 feared that if he/she had to take control it could be tricky	*"I think it will be very simple, more and more"* *"I think after using it a few times it will be easier"*

		1/24 think it is getting easier to drive 1/24 think it would be easy if reliable 1/24 referred he/she only needed to pay attention 1/24 believes the vehicle will manage all the situations 1/24 imagines that the information will be clear	
	Do you think that an autonomous vehicle like this would be useful for you?	22/24 yes 2/24 it depends	
	Why? Why not?	2/24 consider that will be useful because is safer 2/24 referred the opportunity to enjoy free time / to work /to rest 2/24 referred that with 5G connection provides predictive information 2/24 referred they would not need to pay attention to everything that happens on the road 1/24 believe it will be useful on long journeys / on highways 1/24 said he/she would not need to drive 1/24 said it would be more comfort 1/24 said it would reduce traffic stress 1/24 said it offers very good support for difficult and dangerous manoeuvres, avoid surprises 1/24 referred the need to pay attention if necessary 1/24 said he/she would feel calmer 1/24 referred it would drive by itself 1/24 believe he/she can rely on autonomous driving	*"It will be useful for me to make better use of my time, especially on work days"* *"I think it can help reduce stress, I will feel calmer"*

		1/24 said it is very interesting for him/her	
	If it would be accessible, would you like to use this autonomous car?	22/24 yes 1/24 no under current conditions 1/24 no	
	Why? Why not?	4/24 would use it without any problem 3/24 would use it depending on how much it costs 1/24 prefer to wait 1/24 would use it if you can be turned off 1/24 does not feel the need, but would have it 1/24 would like to use it in long trips 1/24 would use it only if the vehicle is fully autonomous 1/24 believes it would increase safety 1/24 for updated maps	*"I would definitely love to have a car like that"* *"I don't know yet, I think I'd rather wait and see other people using it first. I'm suspicious"*
	Would you trust in an autonomous car?	19/24 yes 3/24 not 100% 2/24 no	
	Why? Why not?	7/24 will trust after experiencing / after some time 2/24 will trust because it is a tested technology, if it is on the market I will trust it 2/24 will trust because it has sensors as a support 1/24 is not totally convinced 1/24 will trust but would always be alert to take control of the vehicle 1/24 would trust without problems 1/24 will trust because behind an autonomous system there is a human being who makes mistakes	*"It depends how it works, I will need feedback to have more confidence"* *"I still don't trust, but with time it is possible to trust"* *"I think if it's on the market for sale it's because we can trust"*

		1/24 will trust if the 5G network is working well 1/24 will trust because technology is getting more robust 1/24 will trust because he/she knows the limits of the car 1/24 will trust if he/she can take control when needed 1/24 will trust if he/she understands how it works	
	Do you consider this to be a reliable vehicle? The AV will perform consistently under a variety of circumstances?	10/24 yes 9/24 have doubts 5/24 no	
	Why? Why not?	7/24 have doubts whether the vehicle will be able to react to all varieties and unexpected situations 3/24 think more testing and research is needed 2/24 believe if the vehicle is on the market, it is able to adapt 2/24 believe the vehicle is able to handle unexpected situations 2/24 believe there could be problems with maps, with connection or last instant changes 1/24 stated it will depend on the system learning curve 1/24 said that if the 5G network is not stable, it may not be consistent 1/24 believes the system will make better decisions than human drivers 1/24 believes will perform consistently if has a robust database 1/24 believes will perform consistently if it is tested until it works correctly	*"If the data entering the system is good, there is no reason for the car to be unreliable"*

	When compared with a manual vehicle how safe do you think this autonomous vehicle would be?	22/24 AV safer 1/24 it depends 1/24 Manual vehicle is safer	
	Why? Why not?	12/24 believes will be safer because eliminates human error / human behaviours 2/24 believes will AV have more information processing capacity 2/24 believes AV will reduce accidents 1/24 believes it depends on the technology maturity 1/24 believes AV can handle a variety of situations / Unpredictability disappears 1/24 believes AV will be safe if they have a good database 1/24 believes it can anticipate the dangerous situations 1/24 believes it depends on the trust that drivers have on the system 1/24 believes humans are more intelligent than software and algorithmic	*Using 5G connection we can anticipate to dangerous situations when driving*
	Would you recommend this car to your family or friends?	19/24 yes 5/24 no	
	Why? Why not?	5/24 would recommend for people with limitations or elderly people, who can no longer drive 3/24 believes elderly people are not ready for this technology 2/24 would recommend after using it and making sure it works well 2/24 would recommend it to everyone if they use it themselves 1/24 still has doubts	*"I only recommend after using"*

		1/24 claimed to wish that his/her siblings used it 1/24 believe it is safer 1/24 stated that his/her family does not like to drive 1/24 would maybe not use it for daily life 1/24 believe it is the future of mobility	
	Do you think the infrastructures are ready for having autonomous vehicles on the roads?	16/24 no 4/24 yes 4/24 it depends	
	Why? Why not?	5/24 believe there are poorly signposted/lack of road line marks 4/24 believe it is necessary to improve the infrastructure. 3/24 believe only highways are prepared 3/24 believe it is not ready if it depends on the 5G network 2/24 believe it need to improve. 1/24 24 believes roads are better, but not ready for autonomous vehicles 1/24 believes ther could be roads for autonomous vehicles 1/24 thinks technology should adapt to the context 1/24 thinks there are well-paved roads 1/24 thinks there are well signposted roads 1/24 thinks there are poorly paved roads 1/24 thinks there is poor internet / 5G network 1/24 thinks there is good connection in most of the place	*"If we want a great adhesion to these vehicles, a good starting point would be to be with dedicated lanes that give more confidence that everything is under control"* *"Our roads need to improve a lot, they have little network and bad signage"*

		1/24 thinks the car would be ready to drive and adapt to any kind of road. 1/24 believes the infrastructure is prepared because there are lot of equipment and devices installed on the roads. 1/24 believes it is a very complex to have good roads for autonomous driving	
	Would you feel capable of doing a long trip using the autonomous vehicle without help?	17/24 yes 5/24 it depends 2/24 no	
	Why? Why not?	9/24 think it will be easy to use / will be intuitive 6/24 would need some explanation before / Read the manual 2/24 would feed capable only highways 2/24 refer it would not be a problem for those who have contact with technology 1/24 would feel capable if he/she know the infrastructure supports the trip 1/24 would feel capable if it is just entering the destination 1/24 would feel capable if able to take control 1/24 would need help if something will go wrong	*"I would be afraid of the 5G network failing and having to take over"*
	Would you feel anxious in driving an autonomous vehicle?	9/24 at first yes 8/24 no 7/24 yes	*"The more autonomous vehicles, the lower my anxiety"* *I would be safe, I would have more information, if I will feel nervous I prefer to drive by myself.*

Annex 7. Demographic Data and Questionnaire for the MediaPublicTransport User Story

GENERAL DATA:

Travel:

- **Departure:**
  - Vigo Bus Station
  - Tui
  - Valença do Minho
  - Braga
  - Porto Airport
- **Arrival:**
  - Vigo Bus Station
  - Tui
  - Valença do Minho
  - Braga
  - Porto Airport
- **Date departure:** ___
- **Hour departure:** ___

Profile sample:

- Gender:
  - Male
  - Female
  - Not answer
- Nationality:
- Age:
  - 18-24
  - 25-34
  - 35-50
  - 51-65
  - above 65 years old
- Level of education:
  - Not studies
  - Highschool Diploma
  - Associates Degree (2 years)
  - Bachelors Degree (4 years)
  - Graduate Degree (Master/PhD)
  - Some college
  - Other
- Occupation;
- Frequency of travelling:
  - Number of times Spain-Portugal/year:
  - Number of times Portugal-Spain/year:
- Experience with technologies (affinity, what gadgets, etc.)

	Poor										High
Experience with technologies.	0	1	2	3	4	5	6	7	8	9	10
Affinity with technologies	0	1	2	3	4	5	6	7	8	9	10

5GMOBIX

Figure 39: Depiction of the demographic data collected in the MediaPublicTransport User story

Passengers Questionnaire

	Totally disagree										Totally agree
I will find the entertainment system easy to use.	0	1	2	3	4	5	6	7	8	9	10
I would find the entertainment system useful in my daily life.											
Using the entertainment system in my life would increase my comfort.											
Assuming I have access to the entertainment system, I intend to use it in the future.											
If the entertainment system becomes available to me, I would be willing to pay for it.											
If I had such entertainment system, I would use it frequently during my trips.											
Overall, I can trust the entertainment system. Using the entertainment system, I feel confident.											
Entertainment system performance is satisfactory.											
The entertainment system is reliable.											
I believe that entertainment system will perform consistently under a variety of circumstances.											
I'm worried about the general security of such technology.											
I would feel more inclined to use the entertainment system if it was widely used by others.											
I would recommend my family or friends to use the entertainment system.											
I have the necessary knowledge to use the entertainment system.											

I consider that existing technology already supports entertainment system.											
I could make a long trip using the entertainment system even if there was no one around to tell me what to do as I go.											
I have all the information that I need to use the entertainment system.											
I have concerns about using the entertainment system.											
I hesitate to use the entertainment system for fear of making mistakes.											

5GMOBIX

Figure 40: Depiction of the passenger questionnaire applied in the *MediaPublicTransport* User story

Annex 8. Qualitative data of the Automated Shuttle User Stories

Table 56: Summary of the Pre-test Focus Group for Automated Shuttle

Automated Shuttle Focus group	
	What public transport do you use and what are its advantages compared to others?
Summary	The majority of the participants are not frequent passengers of the public transportation system. Mainly due to accessibility issues, they prefer using the car However, four participants referred that the train is preferable to travel longer distances and pointed out the comfort aspect of this vehicle when compared to others. The subway was also preferred by some participants for daily commutes. The bus was not considered as useful mainly because of the schedule and the delays they are subjected to because of traffic. Moreover, they considered that bus drivers run aggressively (e.g. sudden braking and acceleration) because buses should be on time and also because drivers are normally assigned to drive on the same routes. Quotes: • "We all use public transport as more as they are accessible and meet our goals." • "If it's cheaper, efficient and user-friendly, I choose public transport."
	Because we are going to discuss the possibility of you being inside an autonomous shuttle, first I would like to know how you feel when you are not driving a car, when you are passengers (for example on public transport). Do you feel comfortable/safe when you are a passenger without access to vehicle control? Have you had a bad experience or an unexpected situation being passengers? What happened? Do you often notice bad manoeuvres?
Summary	Participants feel safe when using public transport, even though some have mentioned abrupt manoeuvres or high-speed situations on buses. Quotes: • "Your state of mind and the inputs from the road environment can change your driving style and it can lead to discomfort if we realize that the driving is not being done right." • "I think, at least, from what I've seen that drivers are a bit aggressive because they have to be on time"
	What do you know about autonomous driving technology and its maturity level? What do you know about autonomous driving technology and its maturity level? Could you imagine the shuttle travelling in our environment?
Summary	Participants acknowledge that the available autonomous driving technology is still immature which has led to the non-adoption of some car systems. Two participants mentioned having bad experiences on the road due to ADAS technology. One participant also said that when buying a new car "they don't explain to us how these systems work" and added that "people are expected to read a two-hundred-page manual to understand how the car works". Other than that, cybersecurity issues were referred ("The autonomous car also has its weaknesses such as hacking, things that are not tested and doing something that is not expected") and others commented on the problems that could arise from the coexistence of autonomous and non-autonomous vehicles. Programming errors or the possibility of failure when technology has not been tested before were also mentioned by participants. Quotes: • "People are not trusting technology. (...) The ageing Portuguese population is not prepared for it." • "People are expected to read a 200-page manual to understand how the car works"

	• "People were not taught to use these systems" • "The autonomous car also has its weaknesses such as hacking, things that are not tested and doing something that is not expected."
	Shuttle experience [Video - best case] What happened? In this situation the shuttle had an obstacle on the predefined route and the situation was resolved by a remote driver. What's your opinion on remote control vs autonomous driving?
Summary	Participants understood the situation they were presented with, as they pointed out the obstacle and the shuttle needed to have external help from the control room. What wasn't clear is if the remote driver was granting permission to the vehicle to do the overtaking or if he was actually doing the manoeuvre from the control room Many participants mentioned that they would be more willing to trust a fully autonomous driving vehicle when compared to a vehicle that can sometimes be driven by a remote driver. They considered that if there is a need for having a remote driver, then it would probably mean that the technology is not totally prepared to face the road challenges. However, some pointed out that a driver inside the shuttle would provide more safety to passengers, even though that would be contrary to the idea of an autonomous shuttle. Finally, they also agreed on the risk of having just one remote driver monitoring many situations as presented in the video, and one participant pointed out a cost-related advantage of that scenario. Quotes: • "Either the person gives authorization or performs the manoeuvre" • "A driver inside does not make sense to me, if not that he already drives, having a remote person would seem good to me for very extreme situations that could act in an emergency" • "A person in a remote control would control several shuttles and that would reduce costs"
	In what context would you use autonomous shuttles? Why? What would you expect from a trip on an autonomous shuttle? What kind of information would be relevant to a good experience?
Summary	Participants consider that they would use a shuttle on regular commutes if available. Although they agreed on preferring to have an exclusive track for the shuttle, rejecting the existence of a mixed vehicle road environment, they did not agree on the information that would have to be delivered to the passengers for a good experience. Some participants suggested that maybe it would be better no to have information about the shuttle behaviour, while others would prefer to be given information. One of the participants pointed out that he would like to have access to risk data. Quote: • "This hybrid [road environment/context] issue is not going to work, ever" • "I don't trust having autonomous cars and humans driving on a common road" • "The coexistence between the railroad, the motorcyclist, the pedestrian, the bicycle is already a problem in itself. If we introduce an autonomous vehicle, it's one more problem" • "I don't know if I would prefer to see all the cameras with everything that was happening outside the vehicle or if I would rather not see it. Maybe I would prefer not to see it because if I were riding the shuttle that would mean that I have a certain confidence/ trust to be there (...) because being always aware would feel as if I was driving" • "The important thing would be for the shuttle to tell me what it is doing, to have information and inform" • "The information I would like to have is cameras inside the shuttles that show me the road ahead"

	• "What would be important is to deal with the risk through hard data about safety. There may be a risk threshold which I am willing to accept and above which I am not. People should be given statistics so they may or may not accept that risk"
	• Final comments
Summary	It was highlighted that the most important issue for this kind of public transport is safety. In general, participants agreed that autonomous shuttles would be the future of public transport but more research will need to ensure higher safety levels. Quotes: • "Autonomous shuttles are closer than we think" • "In a few years we won't have to drive" • "Autonomous shuttles are not yet ready" • "The shuttle and road safety in the future is the key" • "Autonomous shuttles are here to stay, they just need to improve" • "Autonomous shuttles will be the future of public transport"

Table 57: Summary of the Post-test Interview for the Automated Shuttle

Question	Conclusion	**Quotes**
I would like you to talk about your experience these days	All participants declared having had a good experience during the local and CB trials. Some noted that it was their first contact with this kind of technology and that they were glad for having the opportunity to participate	-
Talk about the environment (Track vs Bridge) ***Talk about scenarios (Remote Control and VRU)*** **How do you feel about the manoeuvres performed by the autonomous shuttle?**	Overall, they mentioned that the systems under testing performed according to their best expectations and that no problems arose. However, some participants noted an episode in which a more sudden break was experienced and reflected on the situation. Apart from that moment, the bridge trial was praised for the scenic scenery and regarding performance, no differences were noticed between trials. The remote-control concept was valued by many participants and on the downside, a very frequent comment from participants was in regard to low-speed in both scenarios. In what concerns the shuttle performance for the use cases derived from RCCrossing and CoopAutom user stories, no objective differences were pointed out by participants.	*"In both cases it stopped when it should stop"* *"I have not perceived problems of connectivity no test track neither bridge* *"On the bridge, there was an incident in which the pedestrian crossed at the last minute and the vehicle made a very sudden stop. Knowing it has this quick response-ability is encouraging"* *"On the bridge, all worked properly, [...] with a nice environment"* *" Maybe the use case of remote control is a bit slow but it is great to have the possibility to control it remotely"* *"I felt calm because the shuttle managed both use cases right, it has enough information to deal with that and even it has extra help with the remote control"* *"Disadvantages: the speed, it was very low"*

		"It managed fine, mainly the detection of the pedestrian"
Do you think it would be easy to use an autonomous shuttle? Why, why not?	20/22 think will be easy 1/22 think depend on demographic factor 1/22 all information needed inside the shuttle 1/22 in remote driving it needed more information. 1/22 maybe you need an App	
Do you think an autonomous shuttle like this, capable of avoiding obstacles and being driven remotely, would be useful for you?	17/22 think it will be useful 6/22 Daily/urban commutes 2/22 On demand 2/22 accessibility issues 2/22 Comfort 2/22 Free from the driving task 2/22 Not a public transport user 1/22 for leisure 1/22Tech maturity issues 1/22In the future between cities 1/22First and last mile. 1/22Allows to arrive on time 1/22Only if next to home	
Assuming you would have access to this autonomous shuttle, would you plan to use it?	19/22 plan use a shuttle 7/22 Daily/urban commutes 5/22 Schedule/frequency is important 4/22 Comfort 2/22 Not for long distances 1/22 No worries about parking 1/22 Pre-set route 1/22 Fuel gain 1/22 Tech maturity issues 1/22 First and last mile. 1/22 Free from the driving task 1/22 Novelty 1/22 Likes technology	"In the future it may be, but for now technology still requires work". "It also depends on the frequency of the shuttles"

Would you trust an autonomous shuttle? Why? Why not?	10/22 will trust 9/22 not trust 100% 4/22 good experience 3/22 trust depends on experience/time 3/22 prototype, needs more testing 2/22 Coexistence problem 2/22 Moderate trust 2/22 no risk 1/22 On pre-set routes 1/22 better than the traditional transport 1/22 low speed 1/22 right speed 1/22 controlled environment 1/22 remote control provided trust	"I don't know if it's because of my age group but I have complete confidence in this technology."
Do you think the autonomous shuttle would behave consistently under various circumstances? Do you consider it reliable?	7/22 it depends 7/22 not sure 6/22 yes 11/22 prototype, needs more testing 2/22Tech maturity issues 1/22 On pre-set routes 1/22The error is real 1/22 It was a controlled scenario (not real)	"Theoretically it could respond to various situations but it would have to be tested" "I believe that it is necessary more test to detect more errors" "I am not sure, it is necessary more communication among the shuttle and the environment using 5g connectivity".
When compared to a driver shuttle, how safe do you think this autonomous shuttle would be?	9/22 AS Safer 8/22 It depend 3/22 MS safer 2/22 Both 9/22 human factors 4/22shuttle deals with situation humans can't 4/22 driver has experience 4/22 Coexistence problem 3/22 trust depends on experience/time 2/22 fully autonomous vehicle would be better 1/22 Don't know if safer if with or without a driver.	"The human always has the emotional problem and other inherent problems that can endanger driving. When it's an autonomous thing that does mathematical calculations behind it, I always trust more"

	1/22 monitoring (how many) is relevant 1/22 AS safer on dedicated lane 1/22 in the future will be safer the autonomous driving	
Would you recommend this shuttle to family or friends? Why? Why not?	11/22 yes 4/22 it depends 3/22 safe 3/22 good experience 1/22 Less techie people have more resistance. 1/22 Tech maturity issues 1/22 efficient 1/22 comfort 1/22 novelty 1/22 on time 1/22 innovative 1/22 especially for the elder 1/22 if good for me, good for others 1/22 others like technology also 1/22 it works	
Do you think the infrastructures are able/ready to receive the autonomous shuttles? Why? Why not?	8/22 no 5/22 not sure 4/22 yes 3/22 it depends 1/22 only highways 4/22 improvement is needed 4/22Tech maturity issues 3/22 First on urban centres 3/22 pre-determined lane should be considered 2/22 Coexistence problem 2/22 No infrastructure yet 1/22 for the cross border it works 1/22 Highway ready 1/22 is has to be created from scratch 1/22 Acceptability issues	

	1/22 Only urban zones	
Would you feel capable of making a long-distance trip on an autonomous shuttle? Why? Why not?	13/22 not sure 5/22 yes 1/22 no 2/22 same as public transport 1/22 Just local for now 3/22 pre-dedicated lane should be considered 9/22 long distances are not viable due to speed 1/22 on leisure 1/22 Coexistence problem 1/22 It depends of the road conditions and traffic 2/22 prototype, needs more testing 1/22 easier to use it for long trips than for urban trips 1/22 on certain conditions	
Would you feel anxious about being on an autonomous shuttle?	18/22 no 1/22 it depends	

Annex 9. Cronbach's Alpha Analysis of the UAAD

1) **Online interviews:**

Table 58: Consistency analysis for the Advanced manoeuvres – Online interviews

Construct	Attribute	Cronbach's Alpha		
		Lane Merge	Overtaking	HD Maps
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	87.6%	87.6%	84.3%
	If it is available, I plan to use the automated vehicle in the future.			
	Assuming I have access to an automated vehicle, I intend to use it.			
Trust	Overall, I could trust the automated vehicle.	83.5%	85.8%	83.8%
	I would feel confident using the automated vehicle.			
	I would trust the automated vehicle while driving.			
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	71.6%	83.2%	57.1%
	I could reach my destination using the automated vehicle even if I had no assistance.			
	I would feel confident using the automated vehicle because I understand clearly how to use it.			
Reliability	I believe that an automated vehicle would be free of error.	70.5%	60.1%	77.9%
	I believe that automated vehicles will perform consistently under a variety of circumstances.			
	I believe that I could rely on automated vehicles.			
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	77.3%	78.9%	69.0%
	I would find the automated vehicle easy to use.			
	I would find it easy to get the automated vehicle to do what I want it to do.			
Anxiety	The automated vehicle is somewhat intimidating to me.	72.5%	69.1%	76.2%
	I would hesitate to use the automated vehicle for fear of making mistakes.			
	Driving with the automated vehicle would make me feel nervous.			
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	82.7%	82.7%	80.4%

	I would find the automated vehicle useful in my daily life/work.			
	Using the automated vehicle would increase my travel comfort.			
Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	67.7%	67.7%	67.9%
	I would be proud to say to people that are close to me that I use the automated vehicle.			
	I would recommend the automated vehicle to my family or friends to use.			

2) **<u>MediaPublicTransport</u>**

Table 59: Consistency analysis for the MediaPublicTransport – Real World trials

Construct	Attribute	Average	SD	Cronbach's Alpha
Intention to Use	Assuming I have access to the entertainment system, I intend to use it in the future.	8.3	2.8	97%
	If the entertainment system becomes available to me, I would be willing to pay for it.	5.0	1.6	
	If I had such entertainment system, I would use it frequently during my trips.	8.4	2.8	
Trust	Overall, I can trust the entertainment system.	8.4	1.8	77.2%
	Using the entertainment system, I feel confident.	8.1	2.8	
Self-efficacy	I could make a long trip using the entertainment system even if there was no one around to tell me what to do as I go.	7.9	1.7	80.4%
	I have all the information that I need to use the entertainment system.	7.4	1.3	
Reliability	Entertainment system performance is satisfactory.	8.5	1.8	64.9%
	The entertainment system is reliable.	8.3	1.8	
	I believe that entertainment system will perform consistently under a variety of circumstances.	7.4	1.8	
Perceived Ease of Use	I will find the entertainment system easy to use.	8.4	1.3	--

Anxiety	I have concerns about using the entertainment system.	4.1	1.6	78.1%
	I hesitate to use the entertainment system for fear of making mistakes.	3.4	2.0	
Perceived Usefulness	I would find the entertainment system useful in my daily life.	7.1	1.6	67.6%
	Using the entertainment system in my life would increase my comfort.	7.9	1.3	
Subjective Norm	I would feel more inclined to use the entertainment system if it was widely used by others.	8.0	1.7	51.2%
	I would recommend my family or friends to use the entertainment system.	8.7	1.8	
Facilitating conditions	I have the necessary knowledge to use the entertainment system.	8.3	2.0	61.7%
	I consider that existing technology already supports entertainment system.	7.9	1.3	
Perceived Safety	I'm worried about the general security of such technology.	5.5	1.8	--

3) <u>Online Survey</u>

Table 60: Consistency analysis for the LaneMerge - Online Surveys

Construct	Attribute	Average	SD	Cronbach's Alpha
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	3.6	1.2	90.4%
	If it is available, I plan to use the automated vehicle in the future.	3.6	1.2	
	Assuming I have access to an automated vehicle, I intend to use it.	3.7	1.1	
Trust	Overall, I could trust the automated vehicle.	3.4	1.0	76.6%
	I would feel confident using the automated vehicle.	3.5	1.1	
	I would trust the automated vehicle while driving.	3.5	1.0	
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	3.3	1.1	68.8%
	I could reach my destination using the automated vehicle even if I had no assistance.	3.0	1.2	
	I would feel confident using the automated vehicle because I understand clearly how to use it.	3.4	1.1	
Reliability	I believe that an automated vehicle would be free of error.	2.5	1.2	58.0%

	I believe that automated vehicles will perform consistently under a variety of circumstances.	3.6	1.0	
	I believe that I could rely on automated vehicles.	3.5	1.0	
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	3.8	1.0	52.3%
	I would find the automated vehicle easy to use.	3.6	1.0	
	I would find it easy to get the automated vehicle to do what I want it to do.	3.3	1.0	
Anxiety	The automated vehicle is somewhat intimidating to me.	2.8	1.3	69.7%
	I would hesitate to use the automated vehicle for fear of making mistakes.	2.5	1.0	
	Driving with the automated vehicle would make me feel nervous.	2.9	1.1	
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	3.4	1.1	75.0%
	I would find the automated vehicle useful in my daily life/work.	3.6	1.0	
	Using the automated vehicle would increase my travel comfort.	3.6	1.1	
Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	3.2	1.0	76.6%
	I would be proud to say to people that are close to me that I use the automated vehicle.	3.4	1.3	
	I would recommend the automated vehicle to my family or friends to use.	3.5	1.1	

Table 61: Consistency analysis for the Overtaking - Online Surveys

Construct	Attribute	Average	SD	Cronbach's Alpha
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	3.7	1.2	88.5%
	If it is available, I plan to use the automated vehicle in the future.	3.7	1.2	
	Assuming I have access to an automated vehicle, I intend to use it.	3.9	1.1	
Trust	Overall, I could trust the automated vehicle.	3.5	1.0	65.7%
	I would feel confident using the automated vehicle.	3.4	1.2	
	I would trust the automated vehicle while driving.	3.7	1.1	
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	3.2	1.3	61.3%
	I could reach my destination using the automated vehicle even if I had no assistance.	3.6	1.2	
	I would feel confident using the automated vehicle because I understand clearly how to use it.	3.4	1.1	
Reliability	I believe that an automated vehicle would be free of error.	2.5	1.3	70.7%
	I believe that automated vehicles will perform consistently under a variety of circumstances.	3.6	1.2	
	I believe that I could rely on automated vehicles.	3.5	1.2	
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	3.8	1.0	67.8%
	I would find the automated vehicle easy to use.	3.6	1.2	
	I would find it easy to get the automated vehicle to do what I want it to do.	3.3	1.0	
Anxiety	The automated vehicle is somewhat intimidating to me.	2.7	1.2	74.7%
	I would hesitate to use the automated vehicle for fear of making mistakes.	2.5	1.3	
	Driving with the automated vehicle would make me feel nervous.	2.8	1.2	
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	3.4	1.3	81.3%
	I would find the automated vehicle useful in my daily life/work.	3.6	1.3	
	Using the automated vehicle would increase my travel comfort.	3.9	1.1	
Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	3.3	1.1	76.5%
	I would be proud to say to people that are close to me that I use the automated vehicle.	3.4	1.3	

	I would recommend the automated vehicle to my family or friends to use.	3.6	1.2	

Table 62: Consistency analysis for the HDMapsVehicle - Online Surveys

Construct	Attribute	Average	SD	Cronbach's Alpha
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	3.7	1.0	72.2%
	If it is available, I plan to use the automated vehicle in the future.	3.6	1.0	
	Assuming I have access to an automated vehicle, I intend to use it.	4.1	0.7	
Trust	Overall, I could trust the automated vehicle.	3.4	0.8	51.7%
	I would feel confident using the automated vehicle.	3.4	1.1	
	I would trust the automated vehicle while driving.	3.7	0.9	
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	3.5	1.1	42.5%
	I could reach my destination using the automated vehicle even if I had no assistance.	3.3	1.1	
	I would feel confident using the automated vehicle because I understand clearly how to use it.	3.7	0.8	
Reliability	I believe that an automated vehicle would be free of error.	2.8	1.3	49.2%
	I believe that automated vehicles will perform consistently under a variety of circumstances.	3.6	0.9	
	I believe that I could rely on automated vehicles.	3.7	0.9	
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	4.0	0.9	64.1%
	I would find the automated vehicle easy to use.	3.5	1.1	
	I would find it easy to get the automated vehicle to do what I want it to do.	3.1	1.0	
Anxiety	The automated vehicle is somewhat intimidating to me.	2.8	1.3	48.8%
	I would hesitate to use the automated vehicle for fear of making mistakes.	2.7	1.1	
	Driving with the automated vehicle would make me feel nervous.	3.0	1.1	
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	3.3	1.2	66.0%
	I would find the automated vehicle useful in my daily life/work.	3.7	1.1	
	Using the automated vehicle would increase my travel comfort.	4.0	0.9	
Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	3.6	0.9	77.1%

	I would be proud to say to people that are close to me that I use the automated vehicle.	3.8	1.1	
	I would recommend the automated vehicle to my family or friends to use.	3.7	0.9	

Table 63: Consistency analysis for the Shuttle - Online Surveys

Construct	Attribute	Average	SD	Cronbach's Alpha
Intention to Use	If I had such an automated vehicle, I would use it frequently during my trips.	3.6	1.0	90.7%
	If it is available, I plan to use the automated vehicle in the future.	3.7	1.1	
	Assuming I have access to an automated vehicle, I intend to use it.	3.7	1.1	
Trust	Overall, I could trust the automated vehicle.	3.7	0.9	77.6%
	I would feel confident using the automated vehicle.	3.5	1.2	
	I would trust the automated vehicle while driving.	3.5	1.0	
Self-efficacy	I would be able to handle whatever happens while using the automated vehicle.	3.2	1.0	75.7%
	I could reach my destination using the automated vehicle even if I had no assistance.	3.4	1.2	
	I would feel confident using the automated vehicle because I understand clearly how to use it.	3.6	1.1	
Reliability	I believe that an automated vehicle would be free of error.	2.4	1.2	74.0%
	I believe that automated vehicles will perform consistently under a variety of circumstances.	3.6	1.0	
	I believe that I could rely on automated vehicles.	3.5	1.0	
Perceived Ease of Use	Learning to use the automated vehicle would be easy for me.	4.1	0.9	80.9%
	I would find the automated vehicle easy to use.	3.7	1.0	
	I would find it easy to get the automated vehicle to do what I want it to do.	3.7	1.0	
Anxiety	The automated vehicle is somewhat intimidating to me.	2.3	1.2	75.7%
	I would hesitate to use the automated vehicle for fear of making mistakes.	2.3	1.2	
	Driving with the automated vehicle would make me feel nervous.	2.5	1.1	
Perceived Usefulness	Using the automated vehicle would be useful in meeting my regular transportation needs.	3.3	1.2	87.3%
	I would find the automated vehicle useful in my daily life/work.	3.3	1.2	
	Using the automated vehicle would increase my travel comfort.	3.4	1.1	

Subjective Norm	People whose opinions are important to me would like the automated vehicle too.	3.2	1.1	78.9%
	I would be proud to say to people that are close to me that I use the automated vehicle.	3.6	1.3	
	I would recommend the automated vehicle to my family or friends to use.	3.6	1.1	