



# CHALMERS

## Passengers' Experience of Travelling with a Full-Length Automated Bus and Expectations of the Future Public Transport System

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# Passengers' Experience of Travelling with an Automated Bus and Expectations of the Future Public Transport System

## Executive Summary

The report summarizes the findings of a user study conducted, in which passengers' experienced travelling with a full-length (12 metre), fully automated bus on a test-course that included nine simulated everyday traffic situations. The report also, based on the findings, disseminate how passengers' view automated busses in the future public transport system i.e. their positive and negative expectations of the public transport system after automated busses have been implemented.

**Method:** The users' experience was created by allowing 22 participants travel with a fully automated bus on a test course with nine simulated everyday traffic situations. Furthermore, the automated bus experience was also used to trigger the participants expectations on how automated busses in the future might or might not change the public transport system. Data on the participants' experience was collected post-experiment and included questionnaires and semi-structured interviews. The quantitative data was analysed using descriptive statistics and the data from the semi-structured interviews was analysed using a thematic analysis.

**Findings:** The findings show that most participants experienced the ride with the automated bus as very positive. Most participants also experienced the bus and its driving behaviour as trustworthy, mostly since they experienced the bus as being competent, handling the simulated everyday traffic situations in a positive manner. Some also felt that after a while the experience of riding with an automated bus became mundane i.e. it felt like riding with a human operated bus which in turn was positive, since according to one of the participants -no one rides a bus in order to experience fun, it is a mode of transportation. The findings also show that participants expected several positive effects, on the public transport system, by implementing automated buses but they did not believe that automated buses would change their traveling behaviour to a great degree. The main reason being that merely implementing automated buses would not better fulfil their travel needs; their needs were to a high degree already fulfilled by the current public transport system. Another main reason was that the positive effects of automated buses were expected to be counteracted by external influences such as other road users. Finally, although many participants did not expect that automated buses would affect their own public transport travel behaviour to any significant degree, many thought that the implementation of such a system could improve travel in other use areas and that the automated technology could work as an enabler of new services that could radically improve public transport. The most common use area for automated buses that the participants saw, was in rural areas where the distances are long, and the departures few. Thus, the implementation of automated buses could help to increase flexibility and efficiency within the public transport system.

**Conclusion:** The participants were in general positive to the idea of using automated buses in the public transport system. However, just implementing automated buses would not improve their traveling experience to a large extent. However, automated buses could be used as an enabler for new public transport system solutions that could have a great impact on how public transport commuting is used i.e. a more individually adapted, efficient and flexible public transport system.

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# 1 Introduction

The interest in automated vehicles (AVs) has increased over the recent decades, together with the concern for how the introduction and implementation of AVs will affect the transportation network (Azad, Hoseinzadeh, Brakewood, Cherry, & Han, 2019). One of the most important cornerstones for a successful introduction and implementation is acceptance, that is to what degree a user intends to use and adopt a system (Adell, 2010). According to Nordhoff, Kyriakidis, Van Arem, and Happee (2019) user acceptance is key for reaping the benefits of AVs, such as increased road safety.

However, in order to for a user to accept AVs, they must first trust the AV. Trust plays a significant role as a component of acceptance (Molnar et al., 2018) as well as an integral part of creating a positive user experience (Waytz, Heafner, & Epley, 2014). During an interaction with an AV (a user's) trust is primarily affected by the performance of the AV. In other words, how predictable, reliable, and able the AV is to fulfil the user's goals (Lee & See, 2004).

Research within the area of acceptance of AVs has mostly focused on automated technology related to the car industry (Pessaro, 2016). Even though some studies have been conducted on shuttles i.e. small busses (Nordhoff et al., 2018) there are few studies conducted on public transport users' acceptance for larger sized automated public transport busses (Azad et al., 2019). Thus, the aim of the study is to investigate how passengers' experience a full-sized public transport bus in everyday traffic situations.

In order to fulfil the aim, three research questions (RQ) were posed:

- I. How do passengers of a full-length (12m), automated bus perceive the performance of the bus itself and in relation to everyday traffic situations?
- II. How do passengers of an automated bus experience and trust an automated bus to take the passenger from one destination to another?
- III. How do public transport passengers expect the introduction and implementation of automated busses to affect the individual passenger's future commuting, and the public transport system in general. Hence, do users expect any useful effects of the implementation of automated busses?

## 2 Method

The experiment was conducted over the course of two days on a test course with a route, involving nine everyday traffic situations often encountered in everyday traffic. It encompassed twenty-two participants from two different cities in Sweden (Gothenburg and Borås), divided into three groups, who experienced an automated bus (henceforth only designated as 'the bus') (SAE Lvl 4).

### 2.1 Set-up

The bus was a Volvo 7900 electric-diesel hybrid bus that looks like a regular bus both internally and externally (see figure 1). The bus incorporated a self-driving system that consisted of five lidar sensors with which a three-dimensional map of the test course had been created pre-experiment. The system navigated by comparing the data from the sensors with the earlier created map and predefined route. Thus, the bus was only self-driving for the specific test route (SAE Lvl4), but for the participants experienced as a fully automated bus, since it handled all situations (within that specific traffic environment) without any user involvement. During the experiment there were three test leaders. One was controlling the self-driving system i.e., activating/deactivating and monitoring the system (see figure 2), sitting in the middle part of the bus behind a partly concealed computer screen. The second test leader acted as a safety-driver in case of emergency i.e., ready to take over the driving task if the self-driving system failed, was seated in the frontmost, right hand side

passenger seat. No personnel were seated behind the steering wheel. The third and last test leader was seated among the participants in the rear half of the bus, observing any noteworthy behaviours and/or comments related to the experience. The observing test leader and all participants were facing forward.



Figure 1 - Volvo electric-hybrid bus using a self-driving system. Photo from actual experiment.

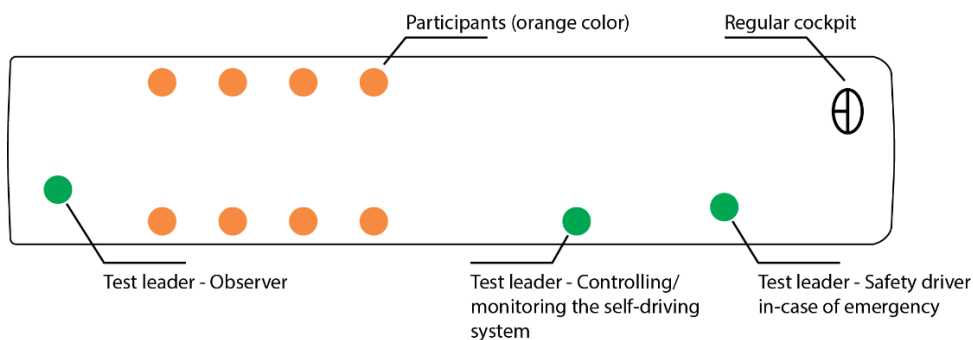


Figure 2 - Placement positions of all participants (orange) and test leaders (green). No one was seated in the cockpit.

## 2.2 Test Route & Traffic Situations

The route driven on the test course revolved around one section: a simulated city area with some longer stretches of road, where the bus reached speeds of circa 35 km/h. The city area consisted of one building, a four-way intersection including road signs and a zebra crossing, covering an area of around 8,000 square meters. The building was designed to simulate a bus terminal from which the participants embarked and disembarked the bus. The city area had normal road standards for bi-directional (right-hand) traffic.

The route driven, for two laps, included nine everyday traffic situations designed specifically for the experiment (see figure 3). The route was 3.3 km, and it took circa 15 minutes to go through all nine traffic situations.

**#1) Embarking bus at bus terminal** – Here the participants waited in the simulated bus terminal (two walls and a roof) that was connected to the building in the city centre, for the bus to arrive and to embark. Traffic delineators and chalk were used to create a temporary bus stop at which the participants stood until the bus arrived.

**#2) Reversing bus out of bus terminal** – After the participants had embarked the bus, it reversed out of the terminal and then started to drive forward.

**#3) Stop at intersection for pedestrian with baby stroller** – A pedestrian with a baby stroller waited at a zebra crossing and the bus slowed down and stopped, allowing the pedestrian and baby stroller to pass the road.

**#4) Picking up a passenger at bus stop** – First the bus drove through a roundabout then the bus slowed down and drove into a small bus stop, whilst a soon-to-be passenger runs to the bus, from a car parked further away, to not miss the bus.

**#5) Empty bus stop at rural turning point** – At the end of one of two longer stretches of road, further away from the city centre, a temporary bus stop turning point was created. At this bus stop turning point the bus slowed down without stopping since there were no passengers waiting at the bus stop.

**#6) Stop for cyclist at intersection** - A cyclist approached perpendicularly. The bus came to a full stop to allow the cyclist to pass.

**#7) Stop for car at intersection** – First the bus drove through a roundabout and whilst the bus was closing in on the intersection, a car was approaching. Therefore, the bus needed to slow down and stop to allow the car to pass.

**#8) Dropping of passenger at bus stop** – The bus stopped at bus stop to allow the passenger to disembark.

**#9) Disembarking bus at bus terminal** – The bus arrived at the simulated bus terminal and the participants disembarked the bus.

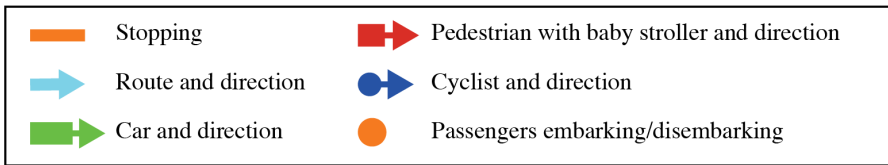
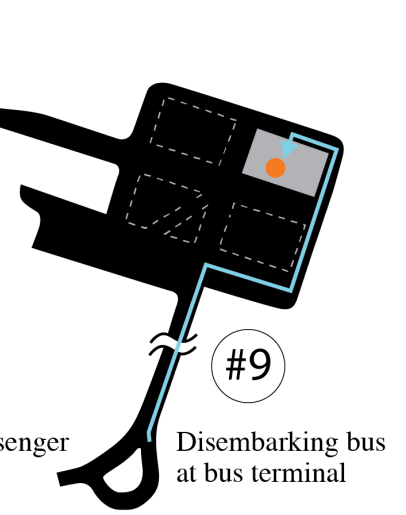
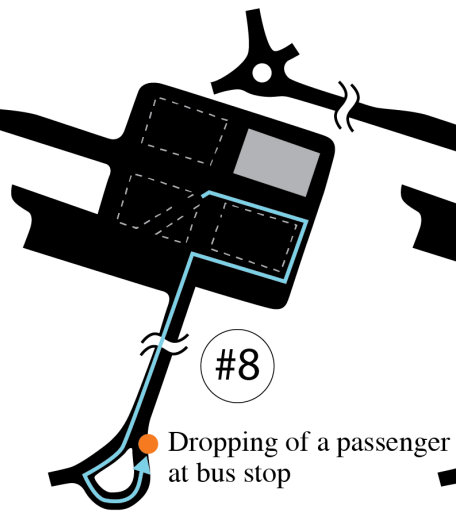
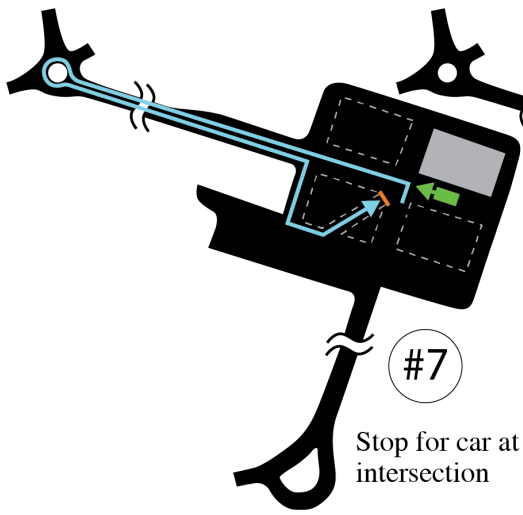
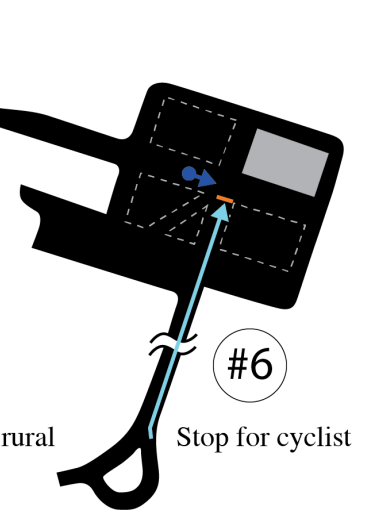
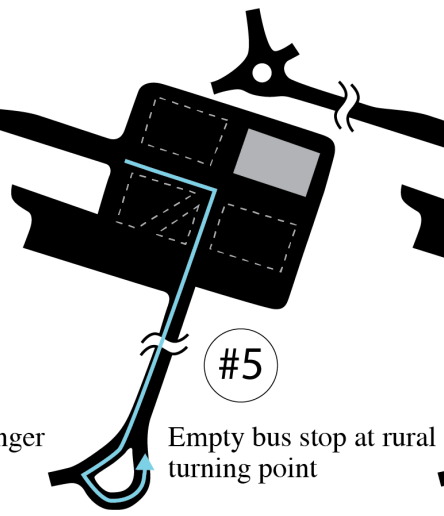
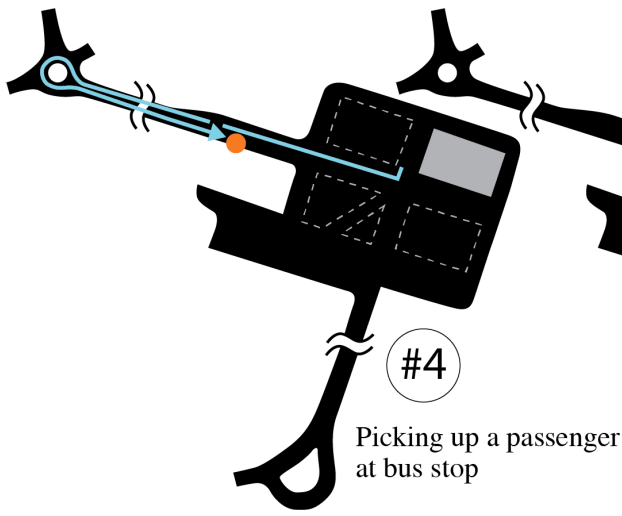
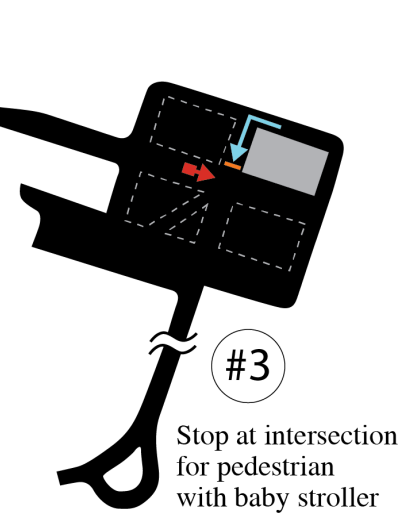
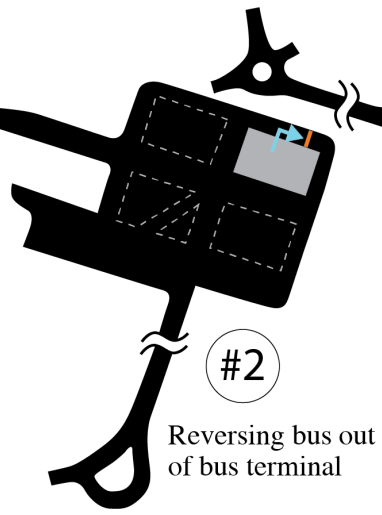
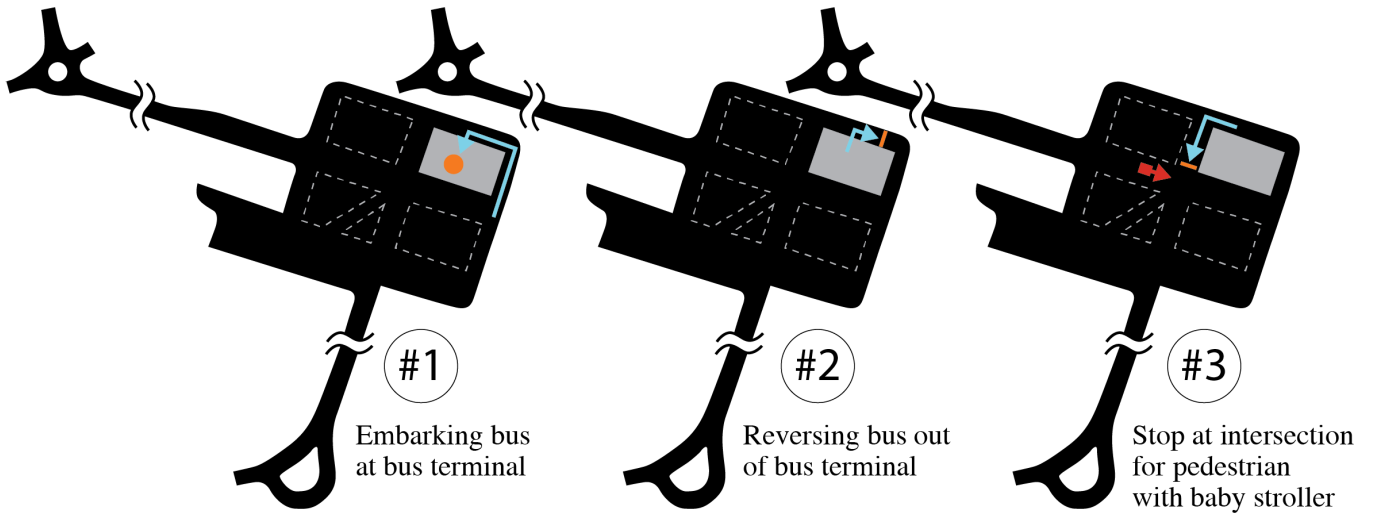


Figure 3 - Traffic situations

### 2.3 Participants

Twenty-two participants<sup>1</sup> took part in the study, twelve male and ten female, aged 21-70 ( $M=40.5$ ,  $SD=16.5$ ). The participants were recruited from the cities of Gothenburg and Borås. To find the participants a written invite was distributed through Västtrafik's (The regions public transport service provider) monthly letter as well as via their Facebook page to find participants that all used buses to commute daily, as well as had a positive attitude towards public transport in general. That the participants were screened based on positive attitude toward public transport, is explained by the aim of the study i.e., on how automated functions in buses may or may not change commuting experiences and/or behaviours instead of having participants focusing on what is negative with the public transport as of today. The participants partaking in the study were compensated with lunch and a voucher for 1000 SEK.

### 2.4 Procedure

The experiment was divided into three parts: pre-experiment questionnaire, a test-drive and a post-experiment phase.

In the first part, **the pre-experiment questionnaire**, the participants got to, individually, fill in a questionnaire about their attitudes and perceptions of automated technology in transportation and the public transport system.

The second part of the study included **the test-drive**, where the participant got to experience the bus and traffic situations. The participants were brought from the test-track indoor facilities to the test course with a regular coach and disembarked at the simulated bus terminal. At the simulated bus terminal, they waited for the bus to arrive (between 5-15 minutes). However, for one of the groups, there were some technical difficulties and the participants had to wait for circa 60 minutes until the bus arrived. After embarking the bus, the participants got to experience the nine different and everyday traffic situations. After the participants had experienced the traffic situations, they embarked the bus.

The third part of the study included the **post-experiment phase**. After the experience with the bus and the nine everyday traffic situations, the participants were all interviewed individually at the simulated bus terminal. The post-experiment phase included first an acceptance and a trust questionnaire. The following interview included questions relating to how the participants' experienced travel with an automated bus, how they perceived the automated bus in the everyday traffic situations as well as how they perceived the bus itself. After the post-experiment interview the participants were shuttled back to the test-track indoor facilities with the same regular coach, from which they travelled home.

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<sup>1</sup> Based on recommendations for studies relying on qualitative data by Eatough and Smith (2008) the sample size can be considered sufficient if between 1-30 participant, especially if the sample is for example homogenous in nature. Furthermore, when saturation has been reached i.e. no new patterns emerging from interviews, the collected data is considered sufficient (Francis et al., 2010). The sample (participants) in the conducted experiment was homogenous in nature (avid users that were in general positive towards public transport), and the qualitative data collected (from semi-structured interviews) was considered to have reached saturation, i.e. the same aspects and patterns reemerged. The sample size is therefore deemed as sufficient.

## 2.5 Data Collection

Data were collected before and after the experiment. However, one test leader also acted as an observer, joining the participants during the test-drive to observe if any relevant comments were voiced and/or behaviours took place during the test-drive. The data collection before and after the test-drive included questionnaires and semi-structured interviews i.e., an interview in which a combination of open and closed questions is used.

**Questionnaire data** was collected; before the experiment on the participants' technology acceptance, perceived safety, and trust and after on the participants' experience of traveling with the bus, perceived performance of the bus, and perceived usefulness of an automated bus. Furthermore, to what degree they trusted the bus was measured using a questionnaire developed by Ekman, Johansson, Karlsson, Strömberg, and Bligård (2021). The questionnaire was used to complement the semi-structured interview.

**Semi-structured Interview data** was collected after the experiment and focus was on how the participants' perceived the bus e.g., driving style and appearance, how the participants' experienced travelling with the bus e.g., how did the bus conduct everyday traffic situations and finally, what did participants believe would be the effects on commuting, if the implementation of automated buses in the public transport system would become a reality in the future. All semi-structured interviews were conducted in Swedish except for one, which was conducted in English due to insufficient Swedish language skills.

## 2.6 Analysis

A descriptive analysis was conducted on the pre-experiment questionnaire data to understand to what degree the participants experienced the bus as capable, trustworthy, and safe. Furthermore, descriptive statistics was also performed on the data from the post-experiment phase (questionnaire) focusing on the participants perception of their own acceptance towards the idea of implementation of automated buses into the public transport system, perceived usefulness (if implemented into public transport system), and trust.

A thematic analysis of the qualitative interview data was performed to get a deeper understanding about the participants' experience of using an automated bus as a mean of transport as well as how they think automated buses will affect their commuting in the future. Thus, the automated bus was used to both extract data on how the participants experienced the bus itself and the bus in different everyday traffic situations, but the bus was also used as a mediating artefact to trigger the participants into thinking about future scenarios using automated buses for their everyday commuting.

The thematic analysis is an analytical approach which aims to identify themes and patterns in qualitative data (in this case the interview transcripts). The analysis had partly an inductive character, i.e., without any predetermined themes (only broader categories), where the themes were created during the analysis process. The initial broader categories were related to the research questions and here used a means to cluster the data into the different areas of interest. Next, a second round of analysis were conducted of the broader cluster, in order to identify patterns and themes within these broad categories.

## 3 Findings

The findings are divided into two main sections: (i) experience of traveling with the automated bus and (ii) expectations of the future public transport system. The first section describes how the

participants experienced traveling with the bus and perceived the behaviour of the bus. The second section describes how the participants believed that the kind of automated bus that they experienced, if/when implemented in a public transport system, would affect their commuting and the future public transport system in general.

### 3.1 Automated Bus Experience

#### 3.1.1 Experience of Traveling with the Bus

Most participants experienced the ride with the automated bus as very positive and felt that it was exciting and interesting. Some participants expressed that it felt strange in the beginning, especially seeing the steering wheel turning without having a driver behind it, but that after experiencing traveling with the bus for a while it did not feel strange anymore. Participants even expressed that, in the end it felt as traveling with a human operated bus and that it felt quite mundane; a few even thought it was a bit boring. One participant explained it as: *“The bus ride itself was quite boring and that is what I expect a bus ride to be like. I do not travel with public transport because I expect something fun to happen, but rather the opposite. In that sense, it lived up to my expectations”* (P20).

The participants’ overall positive experience of traveling with the bus is also reflected in the results of the acceptance questionnaire (see figure 4). The questionnaire items regarding if traveling with the bus was... pleasant/irritating, safe/unsafe, and fascinating/boring all rated very positively (Note: a lower score corresponds to a more positive score).

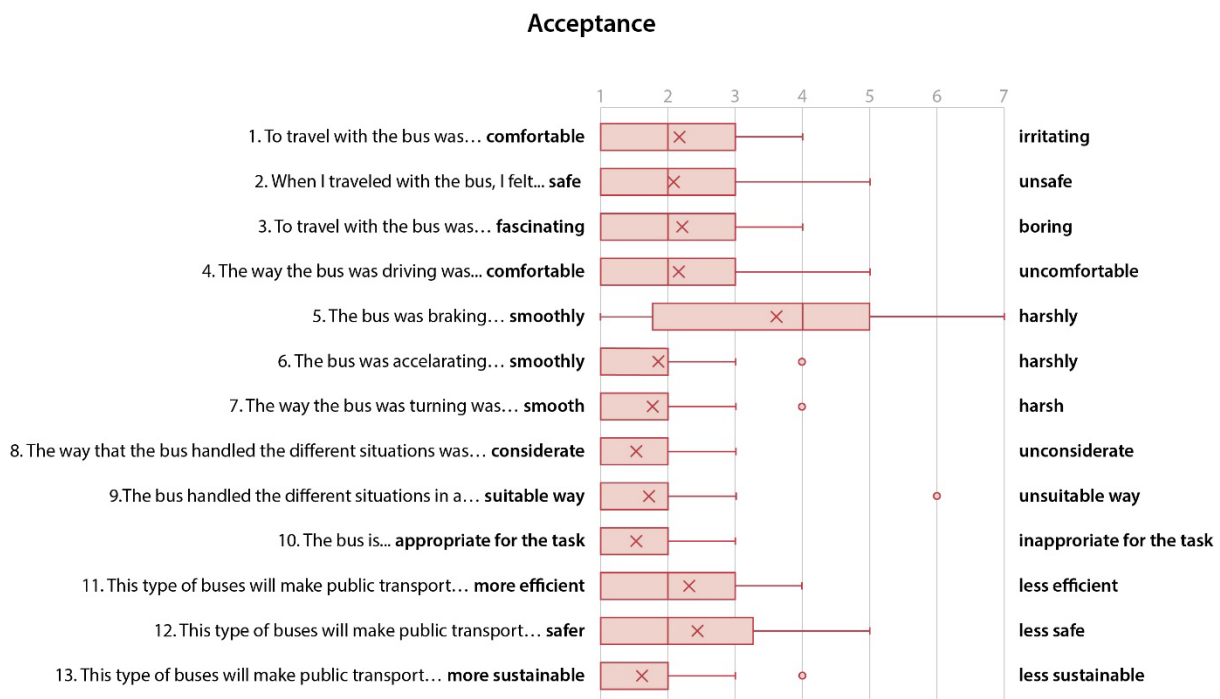


Figure 4 - Acceptance-questionnaire results. A lower score corresponds to a more positive score, on a scale from 1 to 7.

In the interviews, the participants also stated that they trusted the bus to a high degree, mostly because they perceived that the bus drove in a competent way and that the bus handled the different situations well, but also because they had high confidence in the developers (Volvo) and because of the test setup, with the secluded test track and test leaders present. The high levels of trust are also reflected in the trust questionnaire (see figure 5).

## Trust

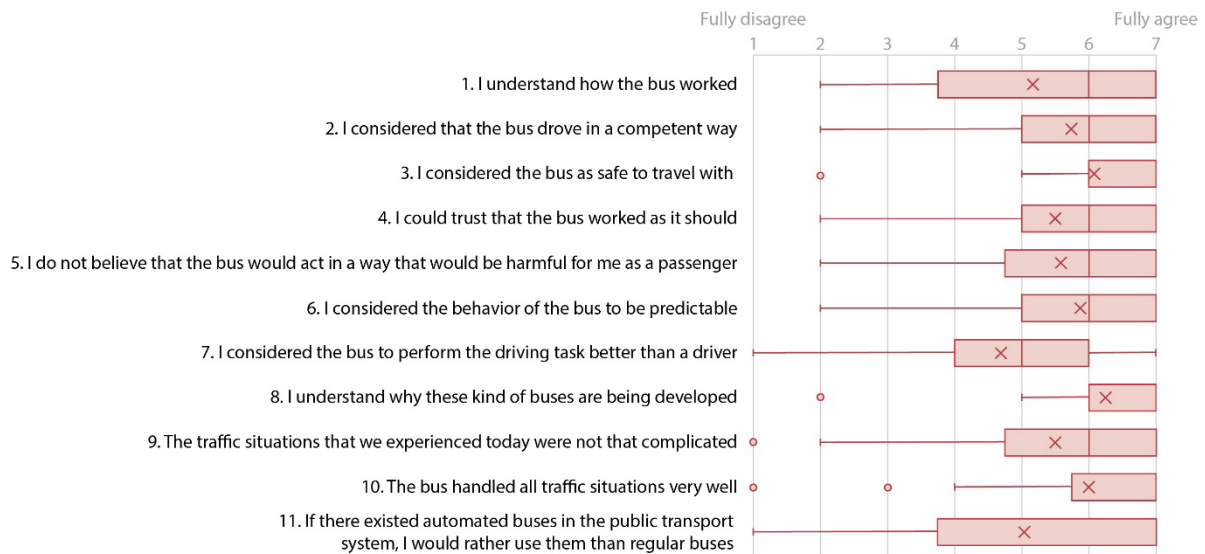


Figure 5 – Trust-questionnaire results. A higher score corresponds to a more positive score, on a scale from 1 to 7.

### 3.1.2 Perception of the Bus

The bus was considered by the participants to be very advanced, and most participants considered the bus to have a high ability to perform the driving task. This was to a high degree affected by the driving behaviour of the bus and its ability to handle many different situations, especially other road users. One participant explained that he was *“...impressed that it drove as fast as it did when the road was straight. Also, that the bus managed to drive as well as it did on the test course and that it turned smoothly and calmly. So overall, I was very impressed”* (P1).

#### 3.1.2.1 Driving Behaviour

Overall, the driving behaviour of the bus was generally considered to be calm and smooth; a few of the participants thought that the driving was sometimes too slow. A participant described the ride as *“...incredibly calm. It was the least jerky bus ride I had in a long time”* (P20)

The **turning** behaviour of the bus was considered to be smooth, careful but also sometimes drifting into the opposite lane. **Acceleration** was only mentioned in positive terms by the participants, mostly referring to it as smooth and calm. While the acceleration of the bus was only mentioned in positive terms, the **braking** of the bus received mixed comments. Most participants considered the braking to be either smooth or calm but some also referred to it as sometimes being jerky and harsh, especially when picking up the passenger at the bus stop (further explained in 3.1.2.2 *Situational Behaviour*). One participant explained that *“Most brakes were smooth but there was one, possibly at the bus stop, where it was a bit jerky but otherwise, I think it was very smooth and fine”* (P3).

Similar to the interview data, the data from the acceptance questionnaire (see figure 4) shows that the participants experienced the turns and acceleration as very smooth ( $Median_{Turns} = 1$ ,  $Mean_{Turns} = 1.7$ ,  $Median_{Acc} = 2$ ,  $Mean_{Acc} = 1.8$ ), but a mixed experience regarding the braking behaviour ( $Median_{Braking} = 4$ ,  $Mean_{Braking} = 3.6$ ), which scored most negatively of all items in the questionnaire. The overall driving behaviour was rated as rather comfortable ( $Median = 2$ ,  $Mean_{Braking} = 2.1$ ), even though not as positively rated as the acceleration and turning. This probably is an indication that, in the eyes of the participants, the sometimes harsh brakes affected their overall impression negatively, but only to a small degree, still perceiving the overall driving behaviour as comfortable.

### 3.1.2.2 Situational Behaviour

In relation to the context in which the bus operated and to other road users, the participants were generally impressed with how the bus handled the situations. For example, one participant stated, *“I have been working as a professional driver and I think that the bus is driving as one should”* (P11). The bus was experienced as very cautious, since its driving behaviour, as previously mentioned, was perceived as slow and calm, and because the bus braked early ahead of the situations and waited a long time to continue driving after stopping. The early braking and long stops were interpreted as the bus having good foresight, signalling that it has detected the road user, and as being watchful, waiting for the situation to be completely safe. Some thought that the stops were maybe too long sometimes, and one participant contemplated on the difference of being inside and outside the bus *“[it was good] that the distance was kept to the cyclists and pedestrians, I am just thinking if it would have been me on the street. But if I am sitting on the bus, I do not want it to stop for too long”* (P9).

The generally positive attitude regarding how the bus handled the situations were also evident from the acceptance questionnaire (see figure 4), where the items regarding if the bus handled the situations in an appropriate and considerate way scored very positively ( $Median_{Appropriate} = 1$ ,  $Mean_{Appropriate} = 1.7$ ,  $Median_{Considerate} = 1$ ,  $Mean_{Considerate} = 1.5$ ).

The situations that the participants thought the bus handled best were the embarkment and disembarkment at the bus terminal and stopping for the pedestrian with the stroller and cyclist. The reasons were that the embarkment and dis-embarkment at the bus terminal were considered as a complicated manoeuvre, with a tight space and physical objects around (e.g. pillars), that the bus handled smoothly. In the situations with the pedestrian and cyclist, the bus, as previously mentioned, braked early which was perceived by the participants as the bus having good foresight and being considerate by signalling that it has detected the road user. However, there were some situations that the participants thought that the bus did not handle as well. The most commonly mentioned situation was when the bus stopped to pick up the passenger at the bus stop. Many participants experienced the stop as quite jerky and slow before coming to a full stop, something that some interpreted as the bus being indecisive. Certain participants attributed this to the situation being dynamic, i.e., the passenger running towards the bus, and therefore complicated for the bus to handle. The second occasion that several participants thought the bus did not handle as well was the roundabout. Some commented on the positioning of the bus in the roundabout, that the bus took a short cut and that it drove into the wrong lane when exiting. One participant described the behaviour of the bus in the roundabout as *“Can it not handle the roundabout? Is it too big? ... I am myself driving a truck and that is also a big vehicle. I believe that I would have handled the roundabout better [than the bus] or planned it better. Maybe it was driving too fast, I do not know”* (P14).

## 3.2 Expectations of the Future Public Transport System

### 3.2.1 Expected Effects on the Public Transport System

The participants believed that automated buses would have many incremental effects on the public transport system. Ten different effects, grouped into five categories, were identified. The five categories are: (i) service, (ii) passenger, (iii) occupation, (iv) service provider, and (v) environment.

#### 3.2.1.1 Service

Many participants talked about potential effects on the public transport service. The two effects that were most commonly mentioned and considered to be most important to the participants were **efficiency** and **safety**. The public transport service was expected to become more efficient with automated buses, due to better traffic flow, punctuality, and navigation. However, since the bus that

the participants experienced was considered to be quite slow and cautious, some were also worried that the public transport system would be less efficient than it is today. Automated buses were also expected to reduce the number of accidents compared to today, due to less human related issues (such as tiredness) and shorter reaction times, making public transport services safer.

#### 3.2.1.2 Passenger

Participants expected effects that related to the passenger, how **easy it would be to plan** the trips, how **easy it would be to use** public transport, how **comfortable** it would be to travel with public transport, and how **secure** they would feel traveling with automated buses. Most participants thought that, the implementation of automated buses would not affect the travel planning since the planning is mostly influenced by other factors such as availability of timetables and tools for planning. Furthermore, participants believed that if the driver disappeared, it would no longer be possible to ask about the bus line and stops etc. and it would feel a bit less secure.

Regarding the ease for passengers to use automated buses, it was mentioned that public transport would be more inclusive for older passengers and people with disabilities since they thought it would overall perform the docking better than human drivers. Moreover, some participants also believed that automated buses would make the travel more comfortable since they thought that the buses would a calm and smooth driving behaviour.

#### 3.2.1.3 Occupation

The effect that automated buses would have on the **occupation** of the bus drivers was also mentioned by some participants. A few participants believed that the implementation of automated buses would result in a negative development by taking away a good job (bus driver) but most participants believed that the development would not necessarily be bad since it would create new professions.

#### 3.2.1.4 Service provider

Participants expected that the implementation of automated buses could lead to **economic benefits** for service providers but also a more sensitive system for them to handle. Some participants thought that not having to have a driver in all buses would decrease the cost of public transport and that the precision in the automated buses' driving behaviour would lead to less wear and tear on the buses. This could in turn lead to "*...more public transport for the same money*" (P1). Regarding the **sensitivity** of the system, participants thought that a system with automated buses would be more sensitive to for example, power failures and not having personnel onboard that could fix small issues.

#### 3.2.1.5 Environment

The last effect that the participants mentioned, was the positive effect they thought that automated buses would have on the **environment**. This mainly from an expected improved fuel efficiency due to a better driving behaviour.

### 3.2.2 Expected Effects on Public Transport Travel Behaviour

Even though most participants had a very positive experience traveling with the bus and saw benefits with implementing automated buses, many participants believed that automated buses would not drastically change their public transport traveling behaviour. One main reason was that they believed that merely implementing automated buses would not better fulfil their travel needs; their needs were to a high degree already fulfilled by the current public transport system. This positive assessment of the present system was anticipated since the study included participants with an overall positive attitude towards public transport. Furthermore, participants felt that the

transport mode (e.g. manually driven bus or automated bus) did not affect the fulfilment of their travel needs as much as other factors, such as the frequency of departures and placement of stops, which they believed to be affected by other factors in the public transport system. One participant explained that *“I do not think it would affect how I travel from A to B. If it is with a driver or automated, I would still have taken the bus or tram similarly. ... It depends if you only take the system that exists today, the routes and uses automated buses instead. That will not change anything since they will go to the same places, and I will need to change at the same places”* (P3).

Another main reason why participants believed that automated buses would not change their public transport traveling behaviour, was that they thought that the positive effects that could come with automated buses would be counteracted by external influence, such as other road users. Even if the automated bus would be driving more efficiently than a manually operated bus, the positive effect would be lost due to queues, caused by manually driven vehicle. Some participants also believed that automated buses would affect the behaviour of other road users, as they would either take advantage of the bus since it was perceived as cautious, or that they would have a harder time interpreting the driving behaviour of the bus.

However, the participants believed that automated buses could have a larger impact on their public transport travel behaviour if the entire transportation system became automated or if the automated buses would be separated into their own zones or roads, without interference from external influence.

### 3.2.3 Use Areas and Other Services

Although many participants did not expect that automated buses would affect their own public transport travel behaviour to any degree, many thought that the implementation of such a system could improve travel in other use areas and that the automated technology could work as an enabler of new services that could radically improve public transport. The most common use area for automated buses that the participants saw, was in rural areas where the distances are long, and the departures few. In these areas, participants believed that the accessibility to public transport could be improved by having a more dynamic system since the buses would not need drivers; this would lower costs and take away potential recruitment problems. One participant explained; *“I was thinking about the resources. You would not need as large buses in the rural areas if there could be smaller self-driving buses without bus drivers, that needs to sit in big empty buses which just goes back and forth”* (P9). Other areas which participants thought would benefit from automated buses were in depots, at airports, as replacement buses (which could always be ready) or during nights when it would be less safe for drivers or more expensive to have drivers.

As mentioned before, many participants believed that the technology that comes with automated buses (e.g. improved sensory capabilities) could lead to new functions and services that could create a more adaptable and efficient public transport system. The most common type of service that participants mentioned was some sort of on-demand service where the bus lines could be more flexible in the frequency of departures during different times of the day or how the buses drive, only going to bus stops where there are passengers making it more efficient. One participant suggested: *“floating bus stops where you can say that I want to go from here and it plans [the trip] in a more advanced way. But I do not think that has to do with the physical bus but the technology behind it. ...that would better meet my needs, because today public transport is going from one place where you are not to a place where you are not going, and that is something that one wants to change”* (P10).

Other services that were mentioned were bus trains, where several buses could be connected during

peak hour to make it more efficient, and more advanced information services since the buses would be able to provide more detailed and accurate information to passengers.

#### 3.2.4 Successful Implementation

Expectations about the implementation of automated buses were also brought up by the participants. Many participants thought that they would trust that the automated buses could transport them in a reliable way. The reason that they believed that they would have a high level of trust was twofold. First, many participants were very positive towards technology in general and believed that an automated bus would perform at least as well as a human driver. Secondly, participants thought that benefits of implementing automated buses, such as more accurate departure times and consistent public transport system, would make the public transport traveling more predictable.

However, Participants also discussed that all people may not be as willing to adopt the technology as fast as they and that the adoption of automated buses would differ between individuals. Concerns were also raised that the general public would have higher demands on automated buses than manually driven and that negative exposure in media would slow down implementation.

Furthermore, as mentioned before, many participants also saw difficulties of having a mixed traffic system, with both manual vehicles and automated buses. They expected this to initially slow down the implementation of automated buses if the buses could not be separated from the other traffic.

Lastly, some participants also mentioned that they were not that sure about the purpose of the implementation. Some thought it had to do with increased benefits for the passengers and a few thought that it is to benefit the companies and private interests. Some also thought that the implementation is an inevitable consequence due to technological progress.

## 4 Discussion

The aim of the study was to investigate how passengers' experience a full-sized public transport bus in everyday traffic situations. Participants had mostly a very positive experience traveling with the bus and felt that it was both exciting and interesting. Most participants also had a high level of trust in the bus, and some felt so relaxed that they, in the end, experienced traveling with the bus as almost boring. The participants did in general perceive the bus as very advanced and as having a high ability to perform the driving task. Overall, the driving behaviour of the bus was considered to be calm and smooth, with exception of some braking that the participants considered to be a bit harsh and jerky. Moreover, the participants were generally impressed with how the bus handled the different situations and other road users, since the bus was perceived as cautious. However, a concern was raised that a too cautious bus would maybe be too slow, stressing the passengers sitting inside the bus, even if it would at the same time be beneficial for other road users with slow and clear actions from the bus. This indicates that it is important to consider users' experience and perception of the bus - both from the inside and outside of the bus - and that there may be a trade-off between comfort and efficiency as well as efficiency and predictability for other road users, that need to be considered when developing the driving behaviour of the bus. Furthermore, some participants reacted to how the bus turned in some situations. They thought that the bus sometimes drifted into the opposite lane when turning and that it took short cuts, for example in the roundabout. This indicates that the positioning of the bus is highly important for the perception of the bus. Even if the bus was following the explicit rules some participants believed that there was an appropriate way of handling situations (implicit rules) which in turn affected their perception of how the bus handled the situations, as also seen in Ekman et al. (2021) and Johansson, Ekman, Strömberg, Karlsson, and Bligård (2021). All in all, the large number of comments relating to specific

situations or behaviours in situations show how important not only the driving behaviour is for users' perception of the bus but also how the bus behaves in relation to other road users. This demonstrates the importance to consider the bus's interaction with other road users.

The participants expected automated buses to affect the public transport system in several different ways, where increased safety and efficiency were the most common effects mentioned and perceived to have the biggest impact. Even though participants believed that automated buses would have mainly positive effects on the public transport system and had a very positive experience traveling with the bus, many participants believed that automated buses would not drastically change their public transport traveling behaviour. One main reason was that many believed that merely implementing automated buses would not better fulfil their travel needs since they were already satisfied with the current public transport. These comments indicate the importance of users' needs in how useful new technological systems are perceived, which in turn may affect users' intention to adopt. Another reason was that many participants believed that other, manually driven, vehicles would reduce the positive effects of the automated buses. Participants therefore believed that the full potential of automated buses could be reached if separated from other traffic modes or if "everything" is automated. This is also reflected in where the participants saw the most benefits of initially implementing automated buses, which are in secluded areas, without interference from manually driven vehicles, and areas with less developed public transport, where the passengers' needs could easier be fulfilled. The participants also believed that the technology that is used in automated buses could work as an enabler for other services that could radically improve the experience of public transport traveling. Hence, the participants believed that automated buses initially would be most useful in secluded and rural areas and by providing other services not directly related to the mode of transportation.

Lastly, some participants were unsure about the purpose of the development of automated buses and also concerned that negative publicity from media would slow down the rate of adoption. This suggest that it may be highly relevant to clearly communicate the purpose of the development and implementation of automated buses for the general public to accept them.

## 5 Conclusion

The findings show that the participants had a positive experience traveling with the bus and perceived the bus as trustworthy, highly capable, and cautious when interacting with other road users. Furthermore, the participants expected automated buses to affect the public transport system in several different, mainly positive, ways but did not believe that automated buses would drastically change their public transport traveling behaviour. However, participants believed that automated buses would be more useful if separated from other traffic, initially implemented in secluded or rural areas and as an enabler of new services, that could radically change the public transportation system.

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