GATEway

TRL THE FUTURE OF TRANSPORT

GATEway: Public perceptions of a last-mile driverless shuttle

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Executive Summary

This research, undertaken as part of the GATEway project, represents some of the industry's first insight into public perceptions of driverless vehicles after a direct experience of this technology.

Method

A qualitative study design was used. This type of approach is particularly informative when exploring new and/or poorly understood topics, such as emerging technologies.

A total of 33 participants were interviewed before and after experiencing a shared driverless shuttle operating on a shared pedestrian and cyclist path in Greenwich, London. A semi-structured topic guide was developed to facilitate discussions with participants and thematic analysis was undertaken from the transcribed interviews.

Results

The participants interviewed were able to consider both the potential opportunities as well as the caveats relating to the wider use of driverless technology.

When describing the perceived advantages of driverless vehicles, participants spoke about the opportunities the technology provided for making journeys safer as well as more enjoyable. They recognised that the technology also offered time-saving opportunities - reclaiming time that would have otherwise been spent driving.

In terms of the perceived disadvantages, participants spoke about concerns over resolving problems when "things go wrong" and the potential implications for job losses associated with driverless technology.

The topic of private ownership also emerged in the interviews and participants showed an appetite for shared vehicle services as an opportunity to reduce living costs.

Implications of the findings

This research has generated a more in-depth view of public opinion of automated vehicles as a result of a direct interaction with the technology. The research has provided support for earlier findings (before opportunities to experience a driverless vehicle was possible) relating to safety, reliability and the importance of cost. It has also highlighted that perceptions of driverless vehicles are varied, even among those who reported an interest in the technology, and important differences may arise when considering the acceptance and trust in autonomy for private vehicles, buses, and taxis.

The research also showed that there are real concerns about the loss of the 'human' experience as a potential disadvantage of increased autonomy. Not only in terms of what increased automation will do to jobs and to the people who rely on existing transport systems, but also to the loss of the ability to drive.

1 Introduction

Connected and autonomous vehicles present new opportunities for individuals, businesses and society as a whole. In order to ensure that these opportunities are maximised, an understanding of how such vehicles might fit in within cities and how they might enable better, more inclusive mobility is vital.

Previous research has assessed users' perceptions of autonomous vehicles '*a priori*' (defined as "the evaluation of a technology before having interaction with it" by Payre, Cestac and Delhomme, 2014), this is before a direct experience of a fully autonomous vehicle (AV) was possible. The GATEway (Greenwich Automated Transport Environment) project has provided a unique opportunity for potential users to experience a ride on a prototype driverless shuttle. The purpose of this project (and the vehicles that have been developed as a part of it) is to assess the technical, legal and societal challenges of implementing autonomous vehicles in an urban environment. With a focus on the first and last mile of travel, an important element of this project was to understand the perceptions, attitudes and usage intentions to use of members of the public.

'*A priori*' research has identified that the public is generally positive about the advent of AVs and can easily identify personal and societal benefits when it comes to safety and accessibility (e.g. Kyriakidis, Happee and De Winter, 2015; Schoettle and Sivak, 2014). However, previous research has also identified that potential users of this technology share concerns and fears about the technology itself (and the risk to security) as well as apprehension about what an autonomous future might look like.

The research described in this report provides the first insights into members of the public's experience of this technology and, based on this, how these vehicles might fit in with their current and future transport needs. The research also aims to shed some light on more controversial topics, such as questions around the future of vehicle ownership and the perceptions of autonomy beyond the private vehicle. The former will be an important topic as improving vehicle technologies makes private ownership potentially less appealing unsustainable; particularly as vehicle ownership has been associated with wealth and social status.

The first and last mile of travel…

The focus on the first and last mile of travel has also enabled a credible and relevant experience where users have been able to draw from current experiences and envisage what these autonomous services could look like in the future. The focus on London, an already transport-rich environment, has also provided a context where users regularly face transport choices in efforts to balance safety, comfort, convenience, and cost (among other factors).

2 Method

2.1 Study design

A qualitative study design was used. The ultimate goal of qualitative research is to *"increase the understanding of a particular phenomenon from the perspective of those experiencing it."*(Vaismoradi, Turunen and Bondas, 2013, p.398).

Qualitative approaches can be particularly beneficial when exploring new and/or poorly understood topics, such as emerging technologies.

2.2 Participants

2.2.1 Recruitment

At the start of the GATEway project, a form was made available through the project website (www.gateway-project.org.uk) where members of the public could register an interest in taking part in workshops and research trials. Participants were recruited using this form.

A random selection of around 200 participants who had expressed an interest in taking part in research trials specifically (members of the public could tick for trials and workshops separately) were shortlisted. Once this list was compiled, the process involved the following stages:

- Initial recruitment email to introduce the upcoming trials. The email also contained the link to a short survey which would allow the project team to select a representative sample of participants.
- Invitation email. This contained details about the trial dates and times available.
- Confirmation email. This confirmed the booking for each participant and contained details about the exact location and arrival instructions.

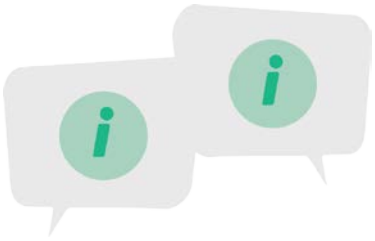
The recruitment target of 40 participants was achieved by applying the criteria described in Table 1.

Table 1: Recruitment criteria

Age	A mix of age groups
Gender	A mix of males and females
Driving status	A mix of drivers/ non-drivers (e.g. licencing status) and users of different transport modes
Relationship to Greenwich	Participants to have some relationship with Greenwich, this could be work, commute through or live in the area.
Affiliations	Members of the public who are likely to use these services to move around London (e.g. avoid recruitment of media or public with a professional interest in the technology)

2.3 Procedure

Participants could choose from two sessions per day, starting at 9:30am and 1:30pm. Once recruited, participants were then sent instructions regarding their arrival, parking (and/or journey options) as well as a schedule for the session (Figure 1)[1].



09:30 – 10:45
An initial interview with a TRL researcher to discuss the role of personal travel in your life (lasting around 60 minutes)

11:00 – 11:20
A short experience (around 20 minutes) of using a self-driving shuttle as a passenger

11:30 – 12:30
A final interview with a TRL researcher to discuss what you think about self-driving vehicles after this experience (lasting around 60 minutes)

Figure 1: Trials schedule (am session)

The sessions were scheduled to last around 3.5 hours and all interviews were undertaken in a private room in the Mitre Passage building (Greenwich).

Participants were provided with a £40 cash incentive for their travel and time.

[1] As part of the research, participants also completed a short questionnaire at the end of the second interview containing items on symbolic meaning and willingness to consider using an AV. As the resulting sample was very small, this data has not been analysed for the purpose of this report.

2.3.1 The driverless shuttle ride

All participants were able to experience a ride in a prototype automated shuttle developed as part of the GATEway project (Figure 2). The shuttle speed did not exceed 15 mph and could accommodate up to four passengers (including the safety steward[2]).

Figure 2: Test shuttle (April 2017)

The shuttle operated on a single lane route of approximately 1.6km in a pedestrianised riverside path around the Greenwich peninsula (Figure 3). In order to manage the schedule of operation, participants only travelled part-way along the route from the Emirate Air Line (Stop C) to the InterContinental Hotel (stop A) and back. This provided passengers with around 20 minutes of shuttle experience.

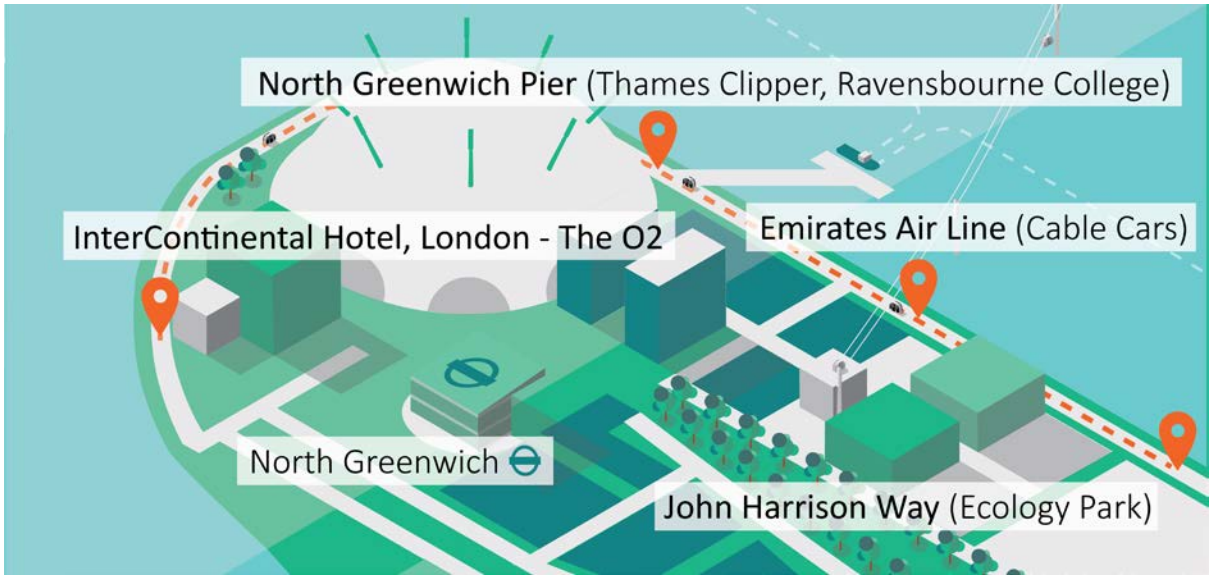


Figure 3: Route map for trial shuttle

2.4 In-depth interviews

Two one-on-one interviews were undertaken with each trial participants. A semi-structured topic guide was developed and used to guide the discussion. Each session was facilitated by one of four

[2] TRL has developed a comprehensive safety case for the safe operation of trial vehicles in the Smart Mobility Living Lab: London. The safety case stipulates that the driverless shuttles must be manned by an operator or 'safety steward' during automated operation. The safety steward is responsible for intervening if any risks to the occupants or those around the vehicle should arise. The safety steward also complies with existing UK practice regarding the operation of driverless vehicles.

experienced qualitative researchers on site; the same researcher undertook both interviews. The first (pre-experience) interview lasted between 30 and 45 minutes. The second (post- experience) lasted between 60 and 75 minutes.

All interviews were audio recorded (with participant's consent) and transcribed in order to facilitate the analysis.

2.5 Analysis

All interviews were analysed using thematic analysis. Thematic analysis is a widely used method in qualitative research given its flexibility and theoretical freedom (i.e. it is not grounded in a particular theory or epistemological approach; Braun and Clarke, 2006). As such, thematic analysis allows researchers to capture participants' own perspectives on the research topics.

The output of this type of analysis is usually in the form of key messages or 'themes'. These are best described as the broad understandings that participants draw on in discussing the research topics. Verbatim quotes will be used to demonstrate the major themes identified.

3 Results

3.1 Sample characteristics

A total of 33 participants were interviewed during the trials.

Table 2: Sample age groups

18-29	7
30-39	7
40-49	8
50-59	6
60+	11

The final sample included a fairly even distribution of males (n=22) and females (n=19). There was also good representation of different age groups, though about a third of participants were over the age of 60 years (Table 2). Most participants reported holding a valid UK driving licence (n=27).

As the first and last mile of travel is all about connecting existing transport hubs, it was also important that participants had some knowledge of the area so they could consider the shuttle experience in the context of other locally available transport options. As such, most of the trial participants lived, worked or studied in the Greenwich area (Table 4) and reported using a range of transport options on a regular basis (Table 3).

Table 3: Mode of transport most often used, as reported by participants

Car	10
Rail	7
Combination	6
Bus	5
Walking	3
Bicycle	2

Table 4: Participant's reported relationship to Greenwich

I live in Greenwich	21
I work/ study in Greenwich	10
I commute through Greenwich	6
I am a visitor/ tourist to Greenwich	4
I have business interests in the Greenwich area	1
None - I'm just interested in the trials	8

3.2 Qualitative findings

3.2.1 Pre-experience interview findings

This section presents some of the qualitative findings from the pre-experience interviews. It sets out participants' pre-exposure levels of knowledge, their understanding of how autonomous vehicle technology works and, based on this, their opinions on the technology.

3.2.2 Knowledge and understanding of self-driving vehicles

Knowledge of self-driving vehicles varied between participants. Some reported that they had 'followed' the technology since its inception and felt well informed about how it worked, while others explained that they knew very little about self-driving vehicles. Irrespective of the level of knowledge, all participants were interested in the technology.

"[I know] Absolutely nothing. No idea how they work. That's why I'm interested."

P20, Female, 60+

"I understand that there are a number of different kind of performance classes for self-driving vehicles and that there are currently, so semi-autonomous vehicles which are available to purchase kind of today and legal to drive, and I believe that those are … perhaps the greatest level of sort of press awareness is around Tesla self-driving products, but that other manufacturers such as BMW and Mercedes have comparable products which effectively operate around an advanced cruise control type of system, but that there's sort of intensive research with a view to making available, pretty much imminently, more advanced self-driving systems which are far more immediate location aware and are using artificial intelligence to interpret data from kind of visual sensors, radar sensors and a portfolio of sensors to provide a more comprehensive, autonomous driving service, and I guess that current autonomous driving use is, give or take motorway only, or that's what it's intention is for but that it's kind of imminent that a complete sort of door-to-door service is to be available."

P31, Male, 40-49

Irrespective of their levels of knowledge about autonomous vehicles and how they work, participants were still interested and curious about the technology (hence their participation in the research).

When asked whether their opinions about autonomous vehicles were positive, negative or neutral, there were a broad range of opinions. However, most respondents described their attitudes towards technology as being positive. Most of the benefits of AVs perceived by participants focused on the societal benefits offered by the technology and included:

- AVs providing transport options for non-car drivers

"It seems like a very enabling idea for all sorts of people. I mean, I can drive, but obviously, particularly if you're in the city, owning and running a car seems a little bit luxurious"

P18, female, 40-49

- Greater safety than human driven vehicles

"I think people drive incredibly badly and I think that automated cars would be able to find out what the road conditions are ahead of them and they would take different routes. I think they would drive much more consistently…I see this as the future."
P28, Male, 50-59

- Enabling greater independence for people with mobility issues

"Less able people, or disabled people being able to be more independent through the ability to get in a vehicle that will take them places"
P18, female, 40-49

- Reduced pollution and congestion

"I think they could reduce pollution in London. I think they could also potentially have the ability to reduce congestion."
P22, Male, 50-59

Neutral opinions were linked to a lack of knowledge; participants did not feel that they were able to express either a positive or negative opinion simply because they did not know enough about AVs.

"I need information before I can have an opinion, I don't have information so I'm not prejudging anything until I know."
P20, Female, 60+

"Right now I don't know because it feels like something that belongs to the future"
P7, Female, 18-29

The few negative opinions raised by participants seemed to stem from nervousness about the technology. Participants raised issues about how AV technology might be perceived by the public as well as raising concerns about the potential for technology failure or being out of control of the vehicles.

"As they stand there's a lot of work that needs to get done. I think the biggest barrier however to driverless vehicles is public perception."
P11, Male, 18-29

"I think they're scary. Well, because I think it's about being out of control as a driver, being in a vehicle that you've got no control over or you may not have much control because I don't know yet until I've been in it to know how much

control I'd have. I think it's the lack of control and the anxiety that would make it scary for me."
P4, Female, 50-59

3.2.3 Post-experience interview findings

The following subsections describe the major themes identified during the analysis. The themes that emerged related to different time points in participants' journey on the driverless vehicle and questions were asked regarding participants understanding of AVs and possible applications, the autonomous shuttle experience and perceptions/ attitudes of what an autonomous future might look like.

3.2.4 The journey experience

Participants described the ride as comfortable, saying that it felt safe, and that they enjoyed the vehicle design. However, the ride was not always thought to be as smooth as they would have liked and the travelling speed was deemed slow. Participants also demonstrated a preference for facing the direction of travel during their journey, and as such, lack of visibility was sometimes raised as an issue.

3.2.4.1 The journey generally felt comfortable and safe

When considering the journey they had just undertaken, many participants commented on the comfort and design of the vehicle. A number of respondents also reported feeling relaxed on the journey.

"It just felt comfortable and worry-free…"
P21, Male, 50-59

"It's nice inside. You can obviously fit a few passengers in there, which is good. And you're facing each other which is nice so you can have a chat while you're going along."
P1, Female, 30-39

"I felt comfortable; the seat was adequate enough. It felt, when it was moving, it felt quite stable."
P19, female, 50-59

"I felt like it was quite a smooth ride."
P33, female, 40-49

Feeling safe, particularly as the vehicle interacted with pedestrians and cyclists, was also highlighted as a positive feature.

"I think probably what I like the most was, a couple of cases [where] *someone came too close to the car and it just stops. I think that's quite reassuring from a safety perspective."*
P1, female, 30-39

"I did kind of like the fact that it did stop on a couple of occasions because people got too close to it, so that gave me an added comfort factor that it actually did what he [the safety steward] *said it was going to do."*
P3, female, 50-59

3.2.4.2 *Not all aspects of the journey were positively received*

Although some participants reported that the journey felt smooth, views on the ride itself were mixed and many participants described the vehicle as *"jerky"*. A few participants commented on the 'beeping' sound (this audible warning device is a safety feature to warn other road users of the vehicle's presence, as it is a quiet, electric drive shuttle), which they found to be an irritating feature.

"Obviously it was not a proper car so it was quite jerky, it wasn't a very smooth ride."
P8, male, 60+

"I understand it's got to make a noise so people know it's there, I mean like any electric vehicle, but you can't have that beeping, not for more than a minute or two... Oh, it's infuriating!"
P20, female, 60+

Although the inside of the cabin was generally perceived positively (i.e. in terms of space and seat configuration), some participants found themselves wanting to face the direction of travel. This was coupled with commentary around the lack of visibility toward the front of the vehicle

"I was sitting…with my back to the direction of travel, so I could see a little bit out of the back and obviously a little bit at the sides, but I would have preferred more visibility, I guess."
P17, male, 60+

"I didn't necessarily like facing the wrong way… So literally for the whole way I was turned in my seat like that."
P15, male, 40-49

Most participants commented on the speed of the vehicle. While not all perceptions were negative, for some participants, the vehicle was perceived as being too slow.

"What else did I like? Quite a lot, really. I mean it just seemed very, very calming, pootling along just letting the world go by on the outside without any other concerns."
P17, male, 60+

"It feels slow, it feels like it needs a lot more work on the software responsiveness."
P27, female, 30-39

3.2.4.4 *The vehicle/ journey did not meet expectations*

Some participants reported that the journey experience on the driverless shuttle was not as expected; there was typically a sense of disappointment.

"The ride didn't, to me, feel like any real exploration of what such a vehicle might do; the speed was very, very slow, the seaside ride element, the very restricted pathway on which it moved, none of these added up to what I think of as an autonomous vehicle…"
P17, male, 60+

"The whole thing felt very anticlimactic, I mean it felt like the guy who was there was a driver, so I didn't feel the vehicle was doing it on its own even though I knew it was."
Female, 60+

3.2.5 The advantages and disadvantages of a driverless future

3.2.5.1 *Advantages: The potential for safer and more enjoyable journeys*

When considering the potential advantages of self-driving vehicles more widely i.e. not just considering the first and last mile of travel), participants seemed to reflect most often on societal benefits.

Safer roads emerged as a prevalent theme among participants, who discussed the potential of AVs for reducing collisions including as a function of reducing the risk relating to driving behaviours, speeding, fatigue and other common road safety issues.

"[AVs would be] *Safer in general, less idiots, less road rage, one would think, because the vehicles could drive to a reasonable road safety level, that they were not going over the speed limit and wary of schools and obstacles, and there would be no lack of concentration or tiredness. That has got to be a great safety factor…"*
P3, female, 50-59

"With regards to public transport and with regards to having an automated operation as opposed to a human operation, I feel there's an increased safety factor there."
P11, Male, 18-29

The possibilities around increased safety were sometimes caveated, for example, as being confident in the autonomous technology.

"I actually think that it would be probably safer in a self-drive car once they've got the technology right."
P24, male, 60+

Reduced congestion (including parking) and emissions were often quoted by respondents as potential societal advantages; particularly if the vehicles were fully electric.

"Well, I think they're potentially huge. I mean firstly, the environment surely has to be at the forefront, the protection of the environment and avoiding catastrophic climate change through the burning of fossil fuels in particular. So, I'm hoping that driverless gives the opportunity for cleaner forms of energy."
P21, male, 50-59

"If you can reduce congestion and pollution I think it would be almost a necessity rather than an advantage..."
P27, female, 30-39

Many participants also commented on the "stress" of driving and how self-driving vehicles could help to reduce stress when travelling and make journeys more enjoyable.

"Well, it can be quite stressful driving, certainly in the city. If the driverless car could overcome that, that would be a definite plus, that."
P13, male, 60+

"[I] *Worry about people who are driving children, who might distract them from the back and it could be cause of an accident. I just think it'd be less stressful if they were able to go in a driverless vehicle."*
P19, female, 50-59

Similarly, the ability to multitask while on a journey was another stated benefit that could improve journey satisfaction. Participants were positive about the idea of being able to spend more time with family (sharing the experience with children was mentioned quite often) and using the time in the vehicle to work or rest.

"If I was with other people in it, then I can engage with them more freely because I wouldn't be focused on driving. Having children, that would be quite handy because I can sit and talk to them rather than them talk amongst themselves whilst I'm driving."
P5, female, 40-49

"That to me is the primary appeal, that I could do something else be that have a conversation with my kids, do something with them, watch something, read something, listen to some music, that would be a big difference, that's the sort of thing we do on a train [we] *don't really do it in the car."*
P10, male, 40-49

Although a less prominent theme, some participants also discussed the advantage of being able to drink alcohol without needing to worry about driving home.

"Well, if you were going out with your friends you wouldn't have to worry about having a designated driver, that's number one."
P16, female, 40-49

3.2.5.2 Disadvantages: a lack of confidence in the technology

Thinking about the disadvantages of automated vehicles, participants seemed to focus on the practicalities of running the vehicles and the possibility of things going wrong.

"I suppose there's the worry of if it doesn't work. It's technology that we're not very familiar with. So with cars now, you can generally work out sort of what's wrong with them, and get them to a garage, but with the automated system, there's just a lot more things that can go wrong with a car. So is there going to be issues of reliability, I suppose."
P12, female, 18-29

"What I do get is exhausted and I just want to get home, and finding myself stuck in a daft situation just because the software couldn't handle it would irritate the hell out of me when I was tired and grumpy."
P6, male, 60+

Participants also considered the role of driving in their everyday lives and the enjoyment they derive from this activity. Some perceived the inability to continue to be part of the driving task as a disadvantage, though this seemed to stem from the experience that driving offers rather than because of a lack of trust in technology.

"I enjoy driving so sometimes it is nice to be able to drive and you just discover everything around you as you want and not just as a passenger viewer of everything."

P7, female, 18-29

"I think I would probably miss [driving] actually"

P23, female, 60+

"For people who drive and enjoy driving I can't see that it [AVs] would be an advantage or that they would actually want to do it."

P8, male, 60+

In terms of the wider societal disadvantages to the advent of self-driving vehicles, the issues most often discussed by participants were around job losses for bus and taxi drivers. Some participants also considered the potential for disruption that such issues could bring, for example as a result of union action.

"I think we've got to be really careful about jobs and about how things are all implemented when it happens… it's important for people to have things to do."

P15, male, 40-49

"I do think bus drivers and taxi drivers, there's a massive disadvantage for them... I think buses would need to bring back conductors. I don't know what happens to poor taxi drivers."

P18, female, 40-49

Concerns over the loss of the 'human touch' were raised, particularly when discussing the possibilities around self-driving buses. For many participants the bus driver contributes to more than just the driving task and is seen as someone who can provide information, ensure the safety of passengers and make decisions under unexpected situations.

"There are a lot of socially isolated people out there as well, and speaking societally, some people, maybe the only human interaction they have in their day is talking to that bus driver."

P11, male, 18-29

"I'm not sure I would like that [self-driving bus] *as much purely because of the other people on the bus, from a safety aspect I like that there's someone in control of the whole situation, not just the driving."*

P5, female, 40-49

"I'd be nervous that somebody would get on without paying and that would bring the system to a halt and we'd just sit there at an impasse, there's no driver to eject the person."

P6, male, 60+

3.2.7 Uptake of self-driving vehicles

3.2.7.1 The driverless shuttle as a service

Although participants were not directly asked about their perceptions or potential uptake of the trial vehicle as a service, the speed of the vehicle was very often quoted as a potential barrier to uptake.

"It's pretty slow. I don't know if I'd bother with it if it was to usually go at that pace."
P12, female 18-29

"If the speed stays at that it wouldn't be a convenient form of transport."
P9, female, 60+

3.2.7.2 Driverless buses and taxis: driverless might not always be the deciding factor

Some differences emerged when considering self-driving buses and taxis. While participants seemed to prefer the idea of self-driving taxis, when it came to buses the difference was less clear cut. Participants did not seem to have a strong preference when asked to consider self-driven vs. human-operated buses.

"With a bus, it wouldn't really make a difference to me if there was a driver or there wasn't a driver as long as it went on the route that it was programmed to go on and it gets me where I need to go."
P1, female, 30-39

"I think a bus is a bus, so I'm not really sure that's ever going to ... If suddenly the 108 route became self-driving, I'd still use the 108."
P18, female, 40-49

"I would choose the bus that came along quickest, that came along first, more to the point."
P4, female, 50-59

"Whichever bus turns up at the bus stop I get on it, I really don't mind"
P10, Male, 40-49

When considering the use of self-driving taxis, the potential for cost saving was frequently commented on by participants. Many believed that the removal of the driver would reduce the overall cost of taxi travel, which is perceived as a more costly transport option.

"Assuming that prices came down, I think that'd be the biggest change, 'cause taxis are useful but they're expensive."
P30, female, 50-59

Although not a major theme, some participants also considered the safety aspects of using a taxi service particularly late at night. There was a general feeling that human driven taxis could be risky for passengers.

"Sometimes if someone's heading off and you're putting them in a taxi, then sometimes you feel a bit guilty that, you know, you can't trust the taxi driver or something... I think you feel more relaxed about leaving people to go home by themselves if they're going from A to B with no other people."
P30, female, 50-59

3.2.7.3 Private ownership

When asked about their preferences regarding vehicle ownership, most participants expressed an interest in either owning a self-driving vehicle or at least considering the purchase of one. Cost and the perceived readiness of the technology were often quoted as important factors in this decision, with higher costs being identified as a potential barrier to uptake.

"If I could afford it I'd bang go straight in, yes please. If I had the money 100 percent, right there."
P15, male, 40-49 (on uptake of fully self-driving vehicles)

"That would depend on my level of trust in them. At the moment I would say no I wouldn't do that now, you know, they're not ready for that yet."
P24, male, 60+ (on uptake of fully self-driving vehicles)

There was no clear indication of a preference for owning a fully self-driven vehicle compared to a vehicle that could switch between driverless/ non driverless modes. Some of the factors that seemed to influence participants responses to the questions "how likely would you be to choose [a fully self-driving and/ or part self-driving vehicle] as your own personal car, over a normal car that you drive yourself?" related to where they do most of their driving (e.g. motorway/ non-motorway) as well as whether they were drivers or non-drivers.

"Not very likely… Because now we don't go to the motorway anyway."
P25, female, 30-39 (on uptake of partially self-driving vehicles)

"I'd probably wait for one which can do the whole journey."
P28, male, 50-59 (on uptake of partially self-driving vehicles)

"I don't really do that much driving on motorways, so I don't really mind doing it once in a blue moon, 'cause I don't do it very often."
P29, male, 18-29 (on uptake of partially self-driving vehicles)

Many participants felt that private ownership may no longer be necessary with autonomous vehicles. Car sharing services (such as 'Zipcar') were often referenced by participants when considering the transport options of the future, particularly in large cities such as London.

"I mean if I sat down with a piece of paper and a pencil and worked out how much each journey cost me you know with fuel, depreciation, time, et cetera, I'd probably be appalled at how much my journey was costing using a private car. So using a public service like that, like a kind of Streetcar system where you pick up a car and it takes you somewhere that would save me a lot of money."
P14, male, 60+

"I do feel if it is driverless that it's kind of a waste if I just keep one just for myself. I'm quite happy to share the car with other people."
P25, female, 30-39

"I was looking forward to that being unnecessary to have my own vehicle. I was more looking at it to be able to hire for short periods."
P2, male, 60+

4 Implications of the findings

4.1 Discussion

The major themes identified in this report focus on the perceptions around the shuttle journey experience, and the aspects that participants identified as either positive, negative or simply unexpected. The themes also highlighted that the participants interviewed were able to consider both the potential opportunities as well as the caveats relating to the wider use of driverless technology for transportation, even when they reported a strong interest in the technology.

Research relating to the public perceptions and potential acceptance of self-driving vehicles has been available since the early 1990s. Although the research has yielded mostly survey (quantitative) data, it allows some comparisons to be made in relation to public perceptions before and *after* having a direct experience of undertaking a journey in a self-driving vehicle. These comparisons are important, particularly as public exposure to the technology becomes more widespread, as they allow researchers to progress the existing understanding of public perceptions and attitudes toward these technologies, and therefore create a smoother pathway to acceptance.

4.1.1 Comparisons with previous research

Our research identified a number of similarities with previous research findings.

4.1.1.1 Safety

Safety seems to be an important consideration for participants when thinking about automated vehicles. According to the work by Kyriakidis et al (2015) with around 5,000 respondents from over 100 countries, concerns over safety (including hacking and misuse) were among the top factors reported by participants. Howard and Dai (2014) found that 75% of respondents believed that safety was one of the most attractive features about automated driving. In this trial, safety emerged more strongly as a positive theme relating to the journey experience, rather than as source of concern. Participants reported a sense of comfort and trust in the vehicles having witnessed the shuttle stopping for obstacles (e.g. pedestrians, cyclists or stationary vehicles). This is an interesting finding as research by Shoettle and Sivak (2014) with a UK sample of respondents showed that over 65% of respondents were reportedly either “very concerned” or “moderately concerned” about self-driving vehicles interacting with pedestrians and cyclists. In contrast, this was not a common concern for participants in the current trial. This could be related to a number of factors. Firstly, this trial provided participants with a direct opportunity to experience driverless technology; participants were also able to experience the driverless vehicle interacting with pedestrians and cyclists. This opportunity has not been widely available previously and as such the current findings might reflect the role that exposure to the technology plays in removing some of the concerns relating to the safe operation of these vehicles. Secondly, the qualitative nature of the study meant that we were able to gather unprompted information about participants’ experience, which can be harder to achieve in a quantitative research design with limited response options. It could be argued that, given the fact that this is a new technology, the ability to provide an open platform for participants to discuss their views may provide better insight into participants’ views and opinions on this topic.

4.1.1.2 Cost

The role of cost has also emerged in the research literature as an important factor when considering the uptake of self-driving vehicles. While most prior research has asked consumers to indicate how much they would be willing to pay for owning a self-driving vehicle (this question was not directly assessed in the current study), it is clear that affordability of the technology is important to potential users. Market research by Power and Associates (2012) in the United States indicated that respondents were less positive about considering the purchase of driverless technology when informed about an estimated market price of $3,000, and the percentage of respondents who answered "would definitely" or "would probably" 'be interested in purchasing autonomous technology' dropped from 37% (before a market price estimate was provided) to 20%. The current study showed that although participants expressed an interest in the technology, and even in the purchase of a self-driving vehicle, cost was usually a factor that was perceived as a barrier to ownership and uptake.

Although cost was often perceived as a barrier to uptake when it came to owning a self-driving vehicle, others saw the potential to change the existing vehicle ownership model as an opportunity to reduce costs. Since the advent of vehicles, private ownership has been linked with social status, wealth and achievement. However, the advent of new technologies in autonomy could mark the end of the private vehicle as users embrace the possibility of car sharing services.

4.1.1.3 Ownership models

Although little published research has been done to assess the public appetite for increased options in car sharing services, particularly in the context of the introduction of self-driving vehicles, our research suggests that users are open to this concept particularly if there are financial benefits to be derived from such services.

It should be caveated that trial participants either lived or commuted through the Greenwich area, a location well known for its public transport options such as bus, rail, metro and even riverboat and cable car services. As such, participants' openness to shared driverless vehicles may just reflect their direct experiences of living and travelling through London, where the availability of transport choices may preclude the need to own (or regularly use) a private vehicle.

When thinking about driverless forms of other transport, such as buses and taxis, participants in this study expressed a high intention to use these modes of transport. However, some interesting differences emerged when considering buses and taxis in turn. For example, participants seemed to show a stronger preference for the application of autonomy in taxis, compared with buses. Participants did not show a particular preference for choosing a driverless bus over a human-driven bus, and participants seemed to believe they would board 'whichever comes first'. This may relate to a number of factors. For example, buses operate set routes with pre-determined stops. For this experience, a switch to driverless may not be perceived as having a large impact on passengers. With taxis, however, the experience is more personal (one-on-one) and passengers must interact with the driver. This may have influenced participants' stronger preference for driverless taxis, particularly as some respondents believed that taxis can feel unsafe under certain conditions (for example, late at night).

Another difference that emerged when comparing the possibilities of driverless buses and taxis related to the role of the driver. With buses, there was a stronger perception that the driver has a wider remit to provide information, collect fares and serves as an authoritative figure. Although not a

major theme, a small number of participants even believed that driverless buses might require a "steward" to provide information, safety and leadership if unforeseen events emerge.

The role of the 'human' operator not only emerged in relation to bus travel – it was a common thread throughout. The potential for job losses was seen as a clear disadvantage by participants who might prefer autonomy when considering the practicalities, but showed a good understanding of the implications for wider society. Although no clear indication on how job loss could be curtailed emerged, this is a topic that has been discussed widely and will be one of the most important challenges to overcome if autonomy is to become widespread (although this is a general issue in relation to automation, not just driverless vehicles).

Whether it be the potential for job loss (e.g. for taxi and bus drivers, as well as those in trades relating to these fields) or simply as a result of not being able to enjoy driving as a hobby, participants expressed concern about what an autonomous future might look like and the role that the human might play in such a future. Research by Kyriakidis et al. (2015) found that more than half of respondents believed that manual driving is the most enjoyable mode of driving (compared with partially, highly, and fully autonomous vehicles). These findings may suggest that if drivers are to be encouraged to take up vehicles with high levels of automation, it will be important to further understand the role of driving in people's lives and whether alternative activities could emerge as substitutes.

Lastly, and considering the direct experience of the driverless shuttle, while trial participants identified many positive features about the trial and the trial vehicle (such as comfort and vehicle design), not all features of the vehicle and the journey were positively received. The slow speed of the prototype vehicle seemed to emerge as a predominant theme among participants. The interview data showed that this was quite an important feature for participants, and many commented on how slow vehicle speeds could be a potential barrier for uptake. Although the vehicle speed was capped to ensure the safety of members of the public interacting with the shuttles and due to the location of the trials (e.g. in a public path, rather than a road), it is not surprising that users of public transport would need to consider the ability to get to their destination in a timely way. This is supported by research assessing journey satisfaction which has suggested that journey reliability (defined as the degree to which the customer experiences what they expect) is a key factor in user satisfaction, with travel time reliability being the most dominant factor (Hendren et al., 2015; Susilo & Cats, 2014).

The evidence gathered through this research indicates that autonomy might meet with increased public acceptance on some modes of transport compared with others. While decisions about private ownership of driverless vehicles might be influenced primarily by cost, and levels of enjoyment of manual driving , when considering implementing the technology more widely factors such as public safety and well-being will also need to be considered.

Overall, the findings provide support for research that has assessed the public's perceptions of AVs before direct exposure to the technology was possible. The findings have also provided much needed insight into users' perceptions, attitudes and acceptance of AVs in a number of different transport options. This is important as, although the classic notion of autonomy might relate to driverless versions of conventional private vehicles, there are also many potential benefits to introducing autonomy in public services. This needs to be balanced against the needs of those who use these services.

4.3 Limitations of the research

The research undertaken as part of these trials was designed to provide insight into the experiences and perceptions of autonomous vehicles of a group of people experiencing a ride in a driverless shuttle. As with any research involving innovative and developing technologies, a number of challenges were encountered during the trial period and that may have impacted participants' perceptions of the driverless shuttle, as well as their attitudes toward the types of services these vehicles could provide.

The most significant caveat was the shuttle operation. On some occasions, the driverless shuttle autonomous control system (ACS) malfunctioned (causing the shuttle to stop) with participants on board. Although this was sometimes easily addressed by the safety steward (and the vehicle was able to continue travelling on the route), sometimes the shuttle required manual operation to turn or move the vehicle back onto the correct path. This resulted in participants seeing the shuttle being driven manually, which was then commented on during the interviews.

Delays in the trial schedule also occurred and some participants had to wait for long periods of time before being able to board the shuttle. This may have affected their perceptions of journey time reliability. However, data gathered through the interviews suggested that participants were generally not deterred by delays and some participants seemed to accept this as part of the experience and/ or as a function of the novelty of the technology.

The composition of the participant sample may have also had an impact on participants' perceptions of the technology, and therefore the research findings. For example, the sample was self-selected. Therefore, it is possible that the people interviewed had a particular interest in autonomous technology (and vehicles) and were generally more receptive toward advances in this area. Similarly, although efforts were made to ensure the sample included users of a range of transport options, as all participants lived in Greenwich or the London area few seemed to use a private vehicle regularly (or for commuting purposes). This may have influenced participants' perceptions of car ownership and their receptiveness to car sharing, which may be less practical for those who use their own vehicle regularly each day.

Finally, although the sample included a well-balanced number of males and females, a third of participants were over the age of 60. This may be viewed as a limitation of the research as some of the research undertaken so far has focused on assessing age and gender differences in acceptance of the technology. However, the current research did not endeavour to make gender or age comparisons of users' perceptions.

4.5 Conclusions

Despite the limitations, this research has generated a more in-depth view of public opinion of automated vehicles. The research has provided support for 'a priori' findings relating to safety, reliability and the importance of cost. It has also highlighted that perceptions of autonomous vehicles are varied, even among those who report interest in the technology, and important differences may arise when considering the acceptance and trust in autonomy for private vehicles, buses, and taxis.

The research has also shown that there are real concerns about the loss of the 'human' experience as a potential disadvantage of increased autonomy. Not only in terms of what increased automation will do to jobs and (in public transport) to the people who rely on existing transport systems, but to the loss of the ability to drive.

The participants in this research seemed to be a very considered and well-informed segment of the population. They were able to demonstrate positivity toward the technology, while considering the potential impact on their lives and society as a whole. While the advantages to safety and current road travel were identified, participants were also cautious in their expectations of the technology. It is possible that these views were not representative of the general population and future research should focus on gathering the views of those who are less receptive (or simply less interested) in the technology in order to gather a more comprehensive view of the impact of autonomy on people's lives.

5 References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in* psychology, 3(2), 77-101.

Hendren, P., Antos, J., Carney, Y., & Harcum, R. (2015). Transit travel time reliability: shifting the focus from vehicles to customers. *Transportation Research Record: Journal of the Transportation Research Board*, (2535), 35-44.

Howard, D., & Dai, D. (2014). Public perceptions of self-driving cars: The case of Berkeley, California. In *Transportation Research Board 93rd Annual Meeting* (Vol. 14, No. 4502).

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. *Transportation research part F: traffic psychology and behaviour, 32*, 127-140.

Payre, W., Cestac, J., & Delhomme, P. (2014). Intention to use a fully automated car: Attitudes and a priori acceptability. *Transportation research part F: traffic psychology and behaviour, 27*, 252-263.

Power and Associates (2012, April). U.S. Automotive Emerging Technologies Study.

Schoettle, B., & Sivak, M. (2014). A survey of public opinion about autonomous and self-driving vehicles in the US, the UK, and Australia.

Susilo, Y. O., & Cats, O. (2014). Exploring key determinants of travel satisfaction for multi-modal trips by different traveler groups. *Transportation Research Part A: Policy and Practice, 67*, 366-380.

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & health sciences, 15(3)*, 398-405.