dg:cities

PUBLIC ATTITUDES AND PERCEPTIONS OF AUTONOMOUS VEHICLES AND RIDE-SHARING

PROJECT ENDEAVOUR
2019 COMMUNITY SURVEY

Contents

Acknowledgements

This report was written by Ed Houghton, Head of Research and Service Design, and Hiba Alaraj, Project Manager at DG Cities.

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Introduction

URBAN TRANSPORT SYSTEMS IN FLUX

Our world is changing. Cities must adapt to not only meet but prioritise national, regional and local aims and objectives in the areas of sustainability, resilience and economic prosperity. The climate emergency means there is a greater push to net zero, and even more recently the impact of COVID-19 has highlighted the importance of resilient and adaptive urban systems.

Accessible, safe and clean mobility is vital in supporting healthy economies and societies. Integrating new technology into the lives of citizens and maintaining an adaptive flexible approach to accommodate emerging technologies and trends is central to responding to the changes that cities are already experiencing.

The increasingly severe climate emergency and global pandemic are influencing many of the trends cities and urban systems were already experiencing, including the shift from ownership to usership, the rising importance of urban accessibility combined with urban mobility, and the revived role of local neighbourhoods. As cities globally navigate the COVID-19 response and recovery period, urban mobility and the role of technology will stay close to the top of the agenda.

Autonomous vehicles are a rapidly maturing technology which offer an exciting opportunity to rethink urban mobility with sustainability in mind. Whilst technology is quickly improving, there exists a need for further evidence and insights as to how future mobility systems which utilise autonomous vehicles can incorporate the needs of users and the wider communities in which they may operate. Included in this is the increasing potential offered by ride-sharing services as an additional, and complementary, form of on-demand public transport.

This work builds on previous studies, including that of the Innovate UK (IUK) funded MERGE Greenwich project[1], and attempts to further illuminate the barriers to adoption and opportunities offered by autonomous-vehicle ride-sharing (AVRS) in our evolving urban environments.

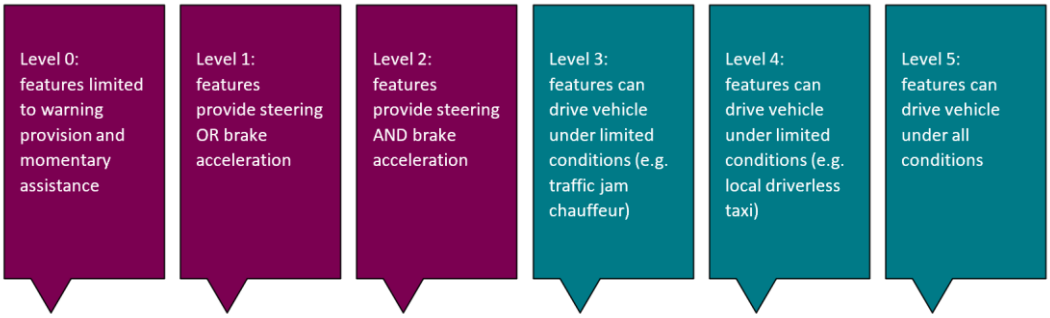
Autonomous vehicle ride-sharing: what is it, and how will it factor into the urban mobility mix

There are many definitions of autonomous (or driverless) vehicles and ride-sharing. Below we include an overview of the key definitions we draw on for this study:

[1] https://mergegreenwich.com/category/news/

- **Autonomous Vehicles (AV) (or driverless vehicles)** have a high level of computerised decision making which enables them to operate without a driver although a steward could be on onboard in place of a driver[2]. Levels of automation in vehicles can vary but according to the Society of Automotive Engineers (SAE) International, there are 6 levels of automation[3]:

Figure 1: Levels of automation



Source: SAE (2018)

AVs offer several potential benefits to the communities in which they operate, including[2]:

  - Reduce traffic accidents caused by human error
  - Reduce overall journey times for drivers by eliminating the need to find a parking space
  - Provide accessibility for all
  - Reduce emissions (for optimum city benefits AV technologies need to be electric)

- **Ride-sharing** is a service which enables two or more passengers to share the same vehicle, where they have similar trip origins and destinations. Ride-share services are booked via a single app that displays driver wait time and cost & and journey duration time. There are several benefits of ride-sharing services to users and the communities in which the services operate, including[2]:
  - Reducing congestion and emissions by decreasing the number of vehicles on the road
  - Lowers travel costs for users
  - Provides cost savings from removal of car ownership fees

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[2] MERGE (2017). Report 1A: *Anticipated uptake of Autonomous vehicle ride-sharing*. Available at: https://mergegreenwich.com/wp-content/uploads/sites/13/2017/10/MERGE-Greenwich-project-Anticipated-uptake-of-AV-ride-sharing-1.pdf

[3] SAE (2018). *SAE International Releases Updated Visual Chart for Its "Levels of Driving Automation" Standard for Self-Driving Vehicles*. Available at: https://www.sae.org/news/press-room/2018/12/sae-international-releases-updated-visual-chart-for-its-%E2%80%9Clevels-of-driving-automation%E2%80%9D-standard-for-self-driving-vehicles

    - Provides opportunities to plug gaps in current public transport offerings

- AV ride sharing (AVRS) is the combination of autonomous or driverless vehicles and ride-sharing services. The combination of these services, integrated with current public transport systems, creates the future of transport whereby journeys are planned, booked and optimised via a single platform. The advantages of AV-ride sharing are improved if people shift away from personal car use and if AV-ride sharing is used to complement current transport systems.

COVID-19 AND THE CURRENT STATE OF THE SECTOR

The COVID-19 pandemic is expected to have a lasting and significant impact on urban systems and mobility. When economies endured successive lockdown in 2020 there were considerable shifts in travel behaviour, away from public transport and towards private vehicle use. Early data highlights that this shift could be long lasting: 23% of UK people surveyed expect to drive more after the pandemic, compared to just 9% who expected their private car use to drop. This trend was in line with other global economies towards private car usage, which could be hugely damaging for governments and authorities looking to curb emissions and meet stretching climate targets.

Demonstrations of clean, safe and efficient forms of urban mobility are therefore vital to help reduce the impact of private vehicle usage. Autonomous vehicle ride-share services are frequently considered to be a solution to both reduce private vehicle ownership rates and increase mobility use as they offer a clean and convenient complimentary form of transport alongside more traditional forms of public transport.

There have been many trials of AVs globally, and developments towards a driverless or self-driving vehicle, capable of operating in a real-world environment are ongoing. Level 4 AVs were planned for deployment in US cities in 2018[4], but research has stalled.[5] A number of AV trials have taken place in the UK since 2015 and by 2021, there will be trials of autonomous buses and taxis in the UK.[9]

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[4] Merge (2018). Will AV ride-sharing make cities greener, more efficient and more accessible at: https://mergegreenwich.com/wp-content/uploads/sites/13/2018/07/MERGE-Greenwich-Will-AV-ride-sharing-make-cities-greener-more-efficient-and-more-accessible.pdf

[5]Bloomberg (2020). The State of the Self-Driving Car Race (2020). Available at: https://www.bloomberg.com/features/2020-self-driving-car-race/

The growth of AV-ride sharing, will be directly influenced by public perception attitudes of the service. Research conducted by MERGE, a Greenwich AV research project developed to explore AV development and adoption, found that over 85% of survey respondents indicated that they would be willing to use an AV in the future, whereas less than half of respondents (46%) were willing to use a ride-sharing service.[6] This research also found that users of AV-ride sharing will likely be car owners and taxi users. The main incentive for both users to switch to AVs is a reduction in price/cost savings, & the experience of being in an AV (applicable for taxi users). Elderly respondents noted that accessibility & comfort were very important aspects of transport and expect AVs to offer this.

[6] Merge (2018). Will AV ride-sharing make cities greener, more efficient and more accessible at: https://mergegreenwich.com/wp-content/uploads/sites/13/2018/07/MERGE-Greenwich-Will-AV-ride-sharing-make-cities-greener-more-efficient-and-more-accessible.pdf

Project Endeavour

Project Endeavour is a mobility project that is designed to accelerate and scale the adoption of autonomous vehicle services across the UK.

The project has been running since March 2019, and will continue until the Autumn of 2021.

The project is led by Oxbotica, working alongside DG Cities, Immense, Oxfordshire County Council, the Transport Research Laboratory (TRL) and the British Standards Institution (BSI). Each partner brings its own cutting-edge expertise to the project.

Project Endeavour involves autonomous vehicle (AV) trials on public roads, which are currently operating in Oxford, and will extend in Spring 2021 to include new sites in Greenwich, London and another UK city.

We are also producing advanced simulations to replicate real-world transit scenarios, and engaging with local authorities and members of the public to shape new autonomous mobility service solutions.

The project is designed to develop a flexible, safe, inclusive, and scalable framework that can be used to establish future AV trials more efficiently and in a broader range of locations.

ABOUT THIS STUDY

This study is designed to support the development of AVRS services by investigating the general public's perceptions and attitudes of AVs, ride-sharing services, and the extent to which the general public uses different forms of public transport.

A survey of the UK public was conducted in 2019, the data of which was used in this analysis before the onset of the COVID-19 pandemic. This research acts as a pre-pandemic baseline, allowing a unique comparison when further data is collected in 2020 and 2021. An overview of the demographics of survey participants, and further exploration of the methodology can be found in Appendix 1.

Data from this study is being used to help shape Project Endeavour's public trial programme, and is intended to inform innovation and the development of AV technologies, as well as the development of evidence-based transport policies and interventions.

The outcomes of Project Endeavour will be reported when the trial completes in Autumn 2021.

Key findings

In this section we explore the findings from the Project Endeavour survey of the UK public which took place between July and December in 2019, before the current COVID-19 pandemic. This chapter is split into the following sections:

- Current public transport travel practices: how does the UK public currently use public transport?
- Ride-sharing: perspectives and usage information of ride-sharing services.
- Autonomous-vehicle ride-sharing: perspectives and opinions on potential AVRS services.

The full survey and analysis methodology can be found in the appendix.

CURRENT TRAVEL PRACTICES: PUBLIC TRANSPORT AND VEHICLE OWNERSHIP

Key findings

- An overwhelming majority consider current public transport modes to be cramped (98%) and large majority believe public transport is unclean (76%).
- Commuting (73%) and travelling to and from recreational activities (60%) are the major reasons why the UK general public use public transport.

Introduction

Public transport systems play a vital role in connecting communities and driving economic prosperity. According to 2019 transport statistics for the UK, private cars have the highest shares of passenger journeys in the UK, compared to all other modes of transport. Across Great Britain 68% of workers typically travel to work by car, but in London this proportion is significantly lower at 27%. Of the public modes of transport, buses (58%) and national rail (28%) have the highest shares of passenger journeys[7]. Statistics for London differ from the national average. According to Transport for London, in 2018, 37% of trips were made using private

[7] Department for Transport (2019). *Transport Statistics Great Britain 2019*. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/870647/tsgb-2019.pdf

modes of transport, only 1% higher than trips made using public modes of transport[8].

UK public transport usage is projected to be outstripped by growth in private car use. Predictions for future car traffic in the UK vary, but the highest forecasts point to continued growth in vehicle kilometres: increasing between 13% and 37% by 2040. The car fleet is also expected to increase from 30 to 44 million vehicles from 2010 to 2020[9].[10] Growth at this rate is likely to overwhelm already pressured urban transport infrastructure. Despite the forecasted increase in private car use and the decrease in bus use, rail will continue to have an upward trend.

These trends are key given transport's significant contribution to UK greenhouse gas emissions. Since 2016 transport has been the highest contributing sector of greenhouse gas emissions, with transport accounting for 27% of net domestic GHG emissions in 2017. Transport also accounts for half of all UK domestic NO_x emissions.[7] The advent of cleaner forms of transport, such as ride-sharing services which compliment public transport systems, could help to reduce transport net transport GHG emissions. This is key if the UK is to achieve its target of net zero carbon emissions by 2050.[11]

Issues with public transport:

Current transport challenges within the UK have been identified for three types of settlements: urban areas, smaller cities & towns and rural areas.

- **Urban areas:** Despite good public transport connections in urban areas (e.g. Manchester, Birmingham & London), cars are the main mode of commuting (other than in London). Transport can be very expensive and cause economic stress for households, especially where transport accounts for a significant proportion of their income. This cost burden is higher for people living in less accessible areas of cities (i.e. outskirts). Light commercial vehicles are another problem in urban areas, as they increase congestion and contribute to air pollution.
- **Smaller cities and towns:** Similar to urban areas, smaller cities & towns also experience congestion & poor air quality. This is exacerbated by lack of hard infrastructure in public transport (e.g. rails), and the increase in public buses. However, due to lower

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[8] Transport for London (2019). *Travel in London Report 12*. Available at: http://content.tfl.gov.uk/travel-in-london-report-12.pdf

[9] Government Office for Science (2019). A time of unprecedented change in the transport system. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/780868/future_of_mobility_final.pdf

[10] Department for Transport (2015). *Road traffic forecasts 2015.* Available at: www.gov.uk/government/publications/road-traffic-forecasts-2015

[11] The Climate Change Act 2008 (2050 Target Amendment) Order 2019 is available at www.legislation.gov.uk/uksi/2019/1056/contents/made

population densities in these areas, hard infrastructure becomes uneconomically viable, whereas buses are not limited by this as they can operate on existing infrastructure.

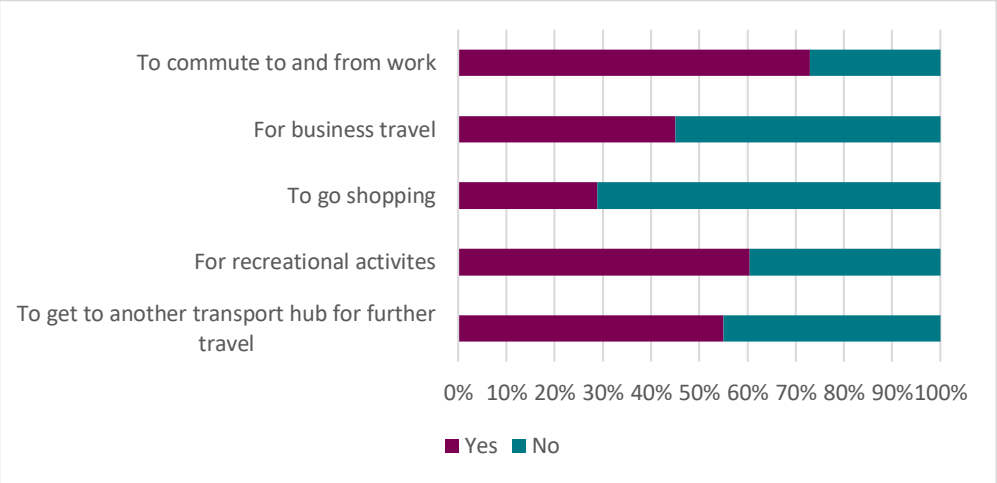
- **Rural areas:** Rural areas have very limited, infrequent and often expensive public transport as it is challenging to provide an integrated profitable public transport service in rural areas where density is low and people are dispersed.

Innovation and alternative transport modes are required to improve the modality mix, and increase the use of public transport. Project Endeavour proposes that autonomous vehicle services, such as ride-sharing, can help to overcome many of the stresses placed on public transport in its current form. Project Endeavour is testing a viable addition to the existing public transport offer, blending personal safety and security, with the ease of access of private vehicle use.

Reasons for using public transport

The Project Endeavour public survey illustrates that almost three quarters of respondents are using public transport to commute to and from work, and six in 10 use public transport to travel to and from recreational activities.

Figure 2: Purpose for using public transport



Base: All respondents n = 222. Non-response coded as “No”

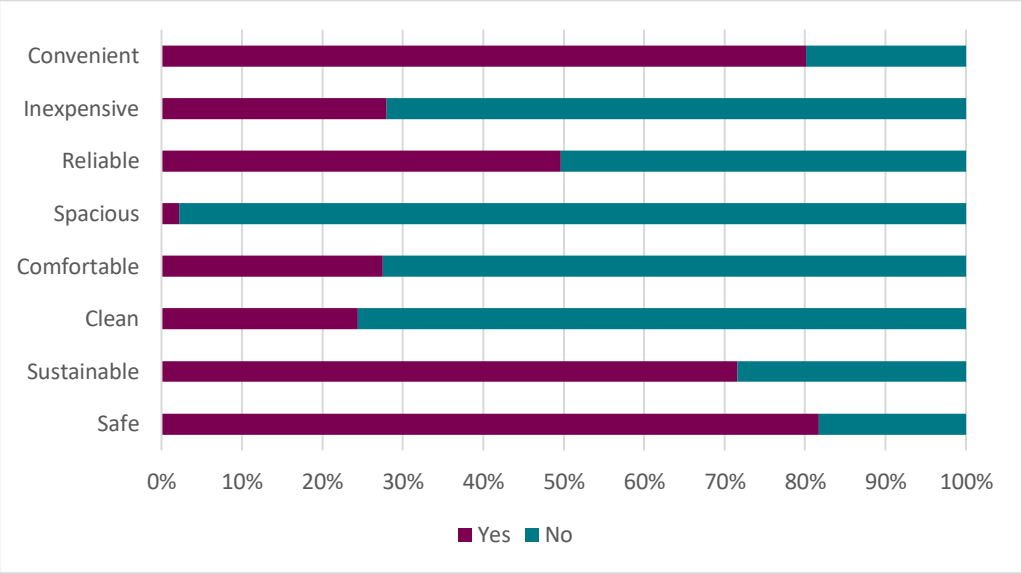
Public transport quality

Perceptions of public transport were mixed: whilst the majority (80%) view public transport as convenient and safe (82%), respondents recognised that public transport is cramped (98%) and unclean (76%).

Interestingly the data revealed a moderate positive relationship between car ownership and perceptions of public transport reliability: people who owned at least one car were likely to view public transport as reliable –

whilst those who owned no private vehicles were less favourable of public transport reliability.[12]

Figure 3: Rider perceptions of public transport



Base: Convenient n= 166; Inexpensive n= 146; Reliable n= 119; Spacious n = 137; Comfortable n = 69 ; Clean n = 69 ; Sustainable = 74 ; Safe n = 71

RIDE-SHARING

Key findings

- Almost two-fifths (38%) are already happy using ride-sharing services, and a third (33%) intend to use services when they become more common.
- The top reasons why ride-sharing services are chosen are convenience (62%) and to save money (61%).
- Almost three-quarters (72%) of those who use ride-sharing services are using the service for recreational purposes.
- Cited barriers for those who haven't used ride-sharing services before were perceptions of service unpredictability (72%) and concerns with sharing with strangers (62%).

[12] A Chi-Squared test of independence was conducted to test association between car ownership and perceptions of public transport reliability. There was a statistically significant association between car ownership and perceptions of public transport reliability $X^2(1)=16.617$, $p=<0.001$. The association between car ownership and perceptions of reliability is moderately strong, $\varphi=0.374$. n=222, all respondents.

Project Endeavour is trialling autonomous vehicles and exploring with users the potential for autonomous vehicle ride-sharing (AVRS) services.

Ride-sharing refers to journeys where two or more people share a car and travel together towards a common destination.[13] Very little publicly available data exists about the extent to which ride-sharing services make up the transport modality mix, nor are there many projections for growth – however ride-sharing is widely considered to be a viable modality for future service development.

Ride-sharing services can be considered as similar to private-hire taxis, and a potential proxy for analysis purposes. Data for taxi use in the UK highlights that usage rates are consistent across genders and highest among those aged 21-29 years; before dropping off for older users. Rates of taxi use also differ by car ownership: people without a car take four times as many taxi trips a year as those who live in a household with access to a car. Total annual trip distances by taxis have increased by 22% between 1997 and 2018.[14]

The data in this report highlights pre-pandemic data from 2019, which acts as a baseline for future research as part of Project Endeavour.

Ride-sharing service usage

In this study we explored the extent to which the general public is using ride-sharing services, their perceptions of service quality, and views on cost differences between transport modes.

Project Endeavour data shows that almost two-fifths (38%) are currently happy using ride-sharing services, and a third (33%) do not use ride-sharing services at present, but intend to when they become more common. Only 15% are not happy using ride-sharing services, highlighting huge potential for future service innovators and developers.

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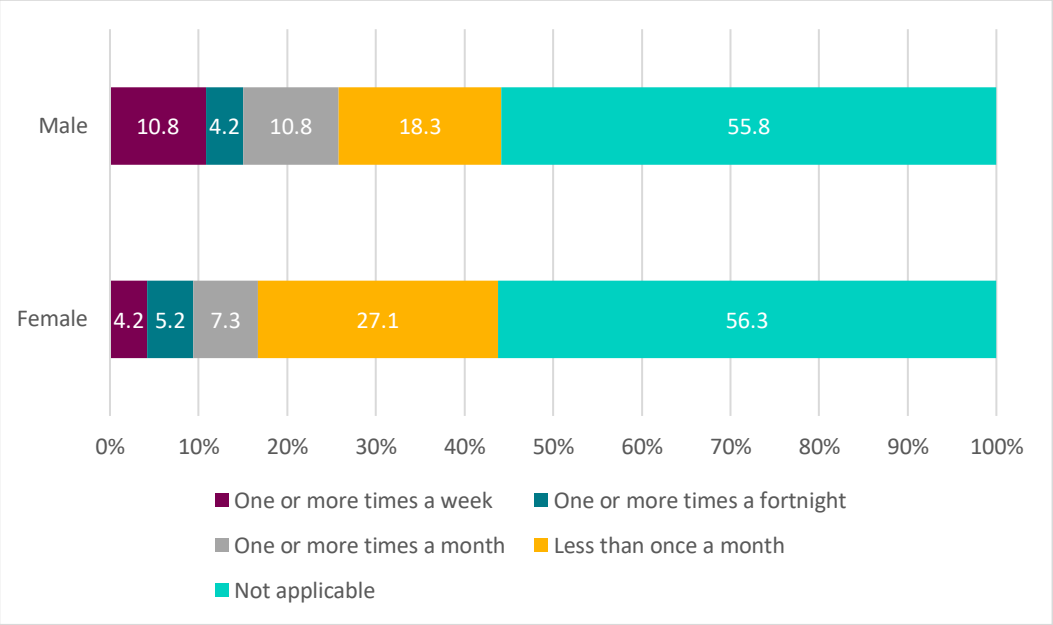
[13] Government Office for Science. (2019) *Review of the UK passenger road network*. Government Office for Science. Accessed on: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773676/passengerroadtransport.pdf Accessed on: 14.09.20

[14] Government Office for Science. (2019) *Review of the UK passenger road network*. Government Office for Science. Accessed on: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773676/passengerroadtransport.pdf Accessed on: 14.09.20

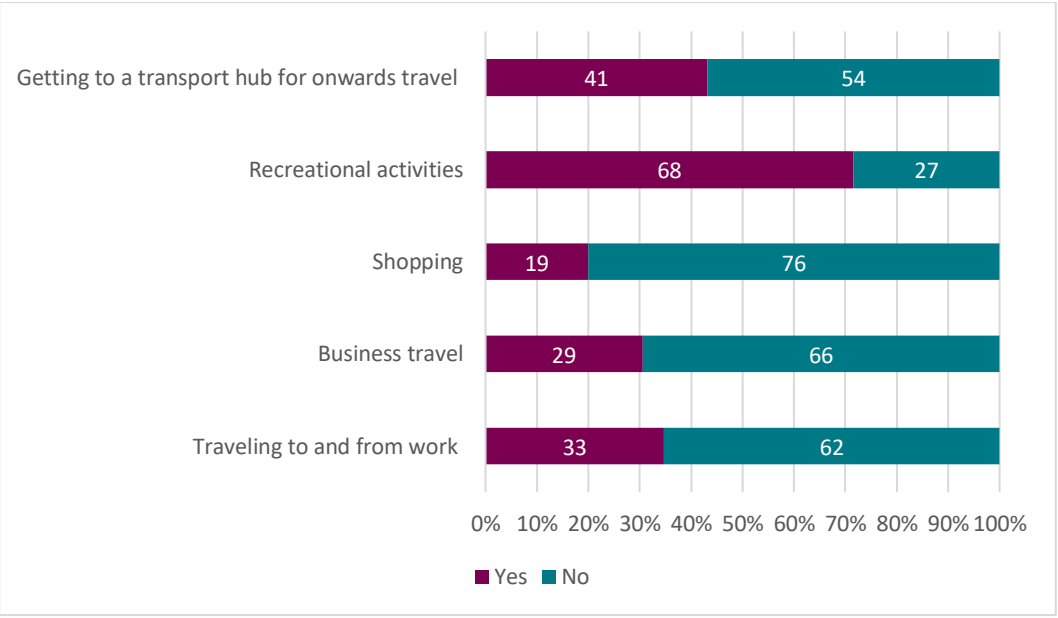
Figure 4: ride-sharing service usage by gender



Base: n = 216 (Disclosed Male and Female respondents only)

In total 95 respondents stated that they had used ride-sharing services previously. This group cited recreational purposes (72%) as being the most popular purpose of using a ride-sharing service (figure 5):

Figure 5: Purpose of using ride-sharing services (%)



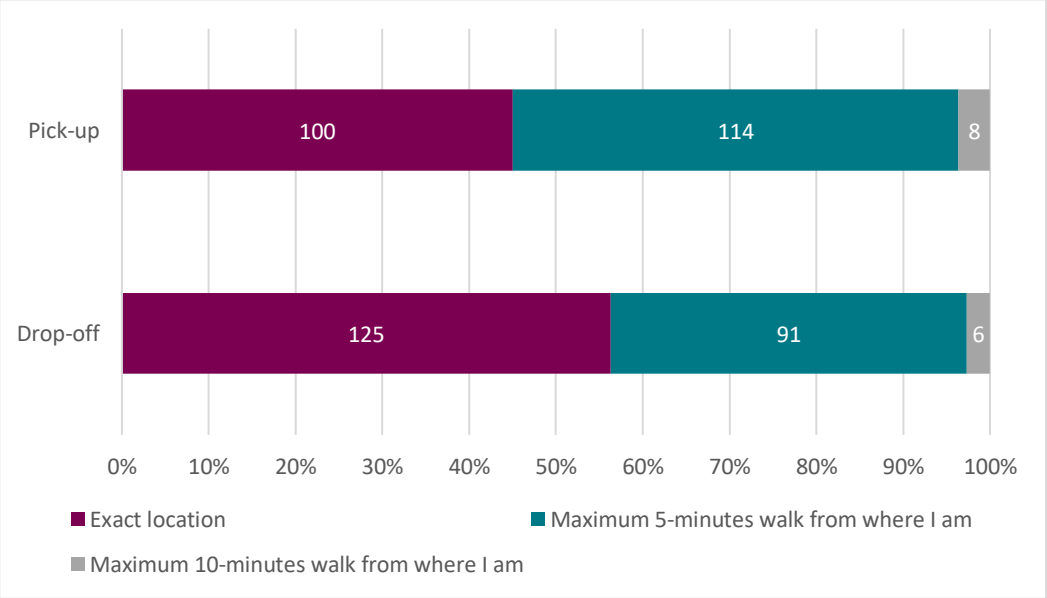
Base: n=95 (Males and Females only; previous ride-sharers only)

Around six in ten (62%) of those who have used ride-sharing services chose ride-sharing because it is convenient, 61% to save money, 45% to save time and 37% because ride-sharing is perceived to be more sustainable than other forms of transport.

Ride-share pick-up and drop-off preferences

Ride sharing services are able to tailor pick up and drop off location for users, making them potentially more accessible and convenient than other forms of public transport. In this study we explored the pick-up and drop-off preferences for respondents, which appeared to show that the public are more likely to request an exact location for drop off than pick up, and are more flexible when requesting pick-up from the service. A maximum walk of 5 minutes was important for pick-up (52%), whilst the exact location for drop-off was preferred by 57% of respondents. Less than 5% were willing to walk a maximum of ten minutes for either pick-up (4%) or drop off (3%) (figure 6).

Figure 6: Ride-sharing pick-up and drop-off preferences



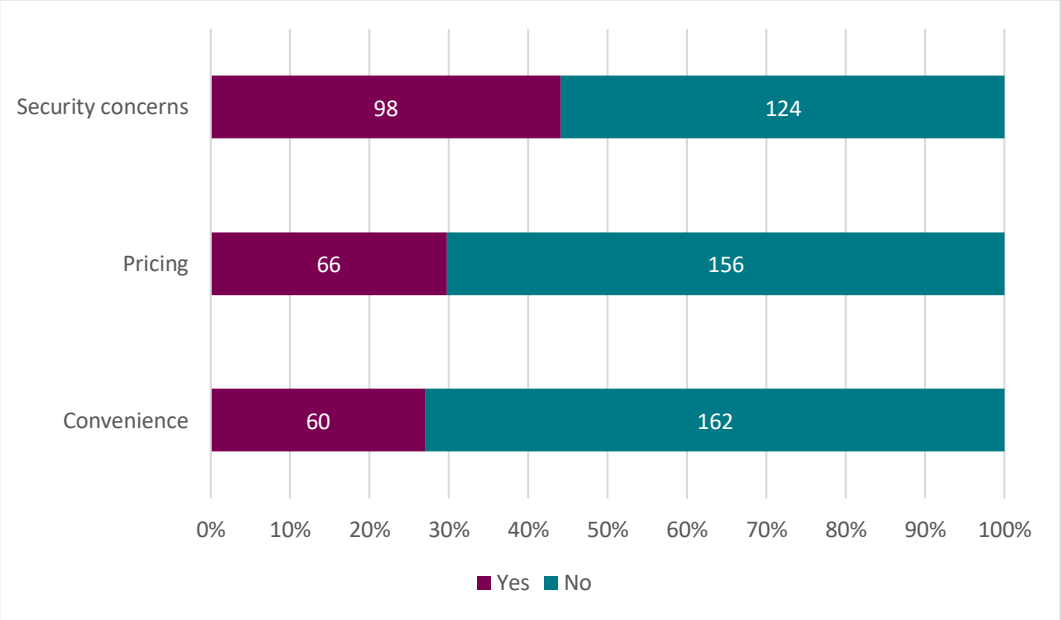
Base: n = 222 respondents (All respondents)

We tested whether respondent pick-up and drop-off preferences differed by gender and age, for example whether men or women were more likely to cite pricing, convenience or security concerns as the reason for their selection. Whilst there were no differences in preferences by gender and age, we found that those who identified as disabled were

more likely to request exact location for both pick-up and drop-off.[15] [16] This is an important reflection for the development of accessible and inclusive AVRS services in the future.

The data showed that women were statistically significantly more likely than men to cite security concerns as the main reason for their selected preference[17]. Other preferences did not differ by gender. Age was not found to influence the selection of preference drivers. This highlights an important consideration for the design of future services. Full results for all drivers can be seen below in figure 7.

Figure 7: drivers of pick-up and drop-off preferences



Base: n = 222 (all respondents)

[15] A Chi-Squared test of independence was conducted to test association between disability status and pick up location preferences. There was a statistically significant association $X^2(2)=7.528$, p=0.023. The association was moderate, ϕc =0.187. n=216; disability "yes" or "no" responses only.

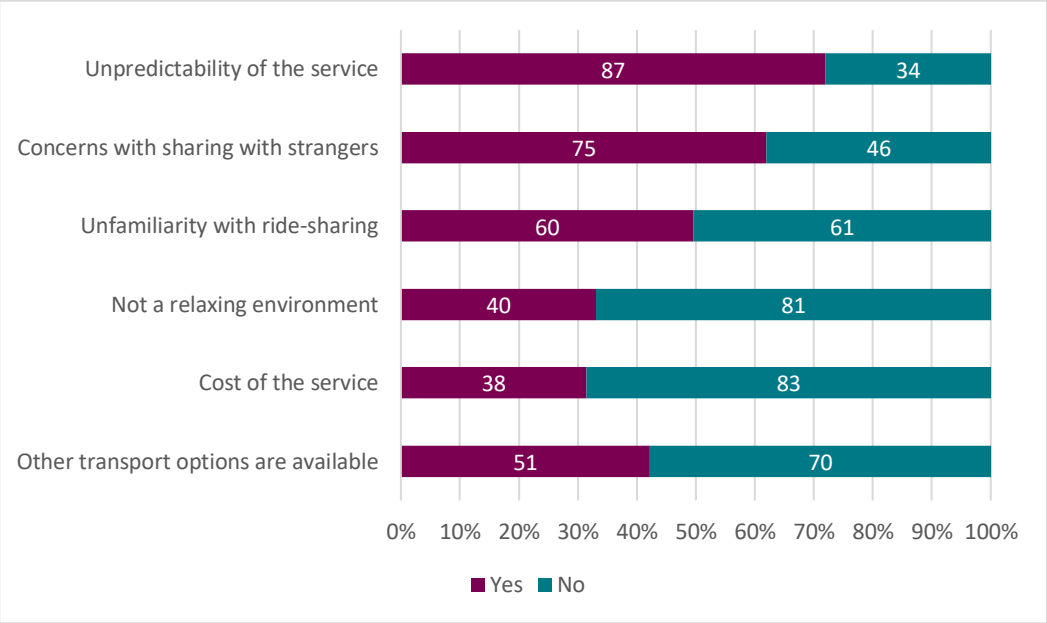
[16] A Chi-Squared test of independence was conducted to test association between disability status and drop location preferences. There was a statistically significant association $X^2(2)=7.513$, p=0.023. The association was moderate, ϕc =0.187. n=216; disability "yes" or "no" responses only.

[17] A Chi-Squared test of independence was conducted to test association between gender and the security concerns as a driver of pick-up or drop-off preferences. There was a statistically significant association $X^2(1)=4.717$, p=0.030. The association was weak, φ=0.148. n=216 (male and female only)

What barriers prevent the use of ride-sharing services?

In total 121 respondents stated that they had not used ride-sharing services. These respondents were from mixed gender and age demographic backgrounds. They highlighted several barriers to ride-sharing, the major barrier being the unpredictability of the service (72%) and concerns over ride-sharing with strangers (62%). All findings did not vary significantly by age, gender or disability.

Figure 8: Barriers to ride-sharing (%)



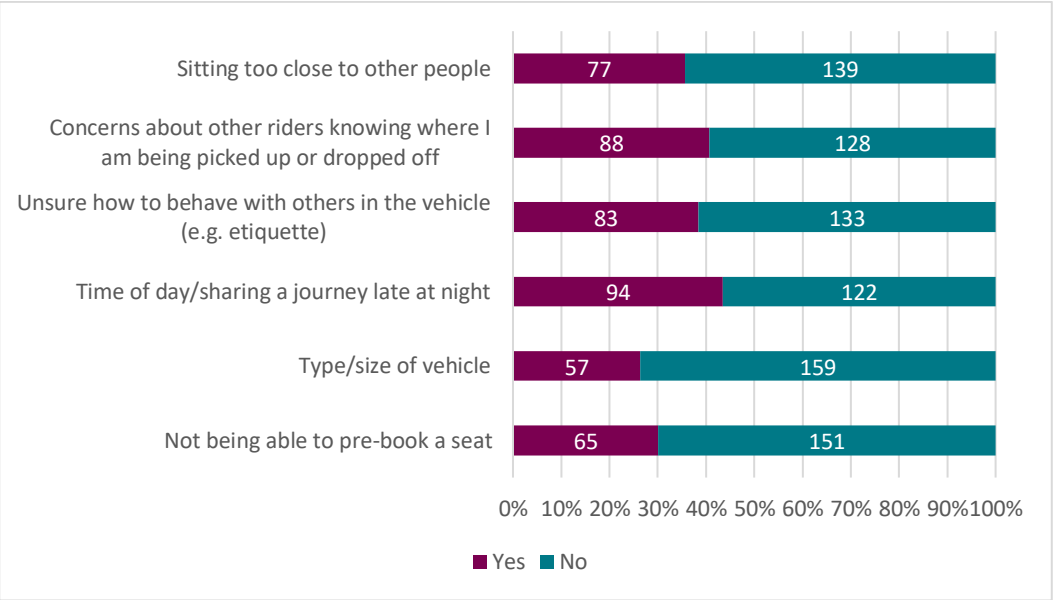
Base: n=121 (Males and Females only; Those who haven't used ride-sharing services)

What are the public's concerns with ride-sharing with strangers?

The most common concerns for the public included privacy concerns and lack of knowledge of etiquette. The most prevalent concern was concern over sharing journeys late at night (44%). We found that this was a particularly pressing concern for women, who were statistically significantly more likely than men to cite "Time of day / sharing a journey late at night" as a concern with ride-sharing. [18]

[18] A Chi-Squared test of independence was conducted to test association between gender and Time of Day There was a statistically significant association $X^2(1)=15.430$, $p<0.001$. The association was moderate, $\varphi=0.267$. n=121 (non ride-sharers only)

Figure 9: Concerns with ride-sharing with strangers



Base: n=216 (Males and Females only)

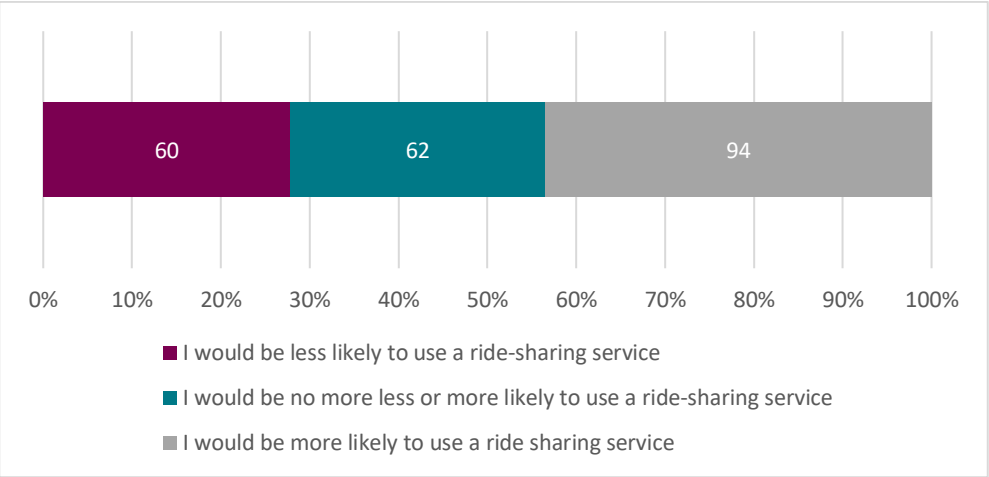
Travelling with luggage

Respondents were asked whether they would use ride-sharing services if they were travelling with luggage. Just over 4 in 10 (44%) were more likely to use ride-sharing services if they were travelling with luggage, compared to over a quarter (28%) who were less likely (figure 10). There was no difference in response by gender or age.[19] [20]

[19] A Chi-Squared test of independence was conducted to test association between gender and views of using ride-sharing services when carrying luggage. There was no statistically significant difference $X^2(2)=3.072$, $p=0.215$. n = 216; Males and Females only

[20] A Chi-Squared test of independence was conducted to test association between age and views of using ride-sharing services when carrying luggage. There was no statistically significant difference $X^2(10)=11.833$, $p=0.296$. n = 214. Ages 18-69 only; Male and Females only.

Figure 10: Carrying luggage and using ride-sharing services



Base: n=216 (Males and Females only)

AUTONOMOUS RIDE-SHARING SERVICES

Key findings

- Men are more likely than women to be early adopters of autonomous ride-sharing services (58% vs 35%) and women are more likely than men to wait until services become more common (29% vs 18%)
- Men were more likely than women to be happy using a driverless AVRS service in the future (58% vs 37%).

Who will be the early adopters of autonomous-vehicle ride-sharing services?

Adoption trends for autonomous vehicle ride-sharing highlight differences between those who will be quick to use new services, and those who may be more cautious. Our data illustrates some gender differences: that men are more likely than women to be an early adopter (58% vs 35%), and that women are more likely than men to wait until services become more common before they adopt a new service (29% vs 18%).[21]

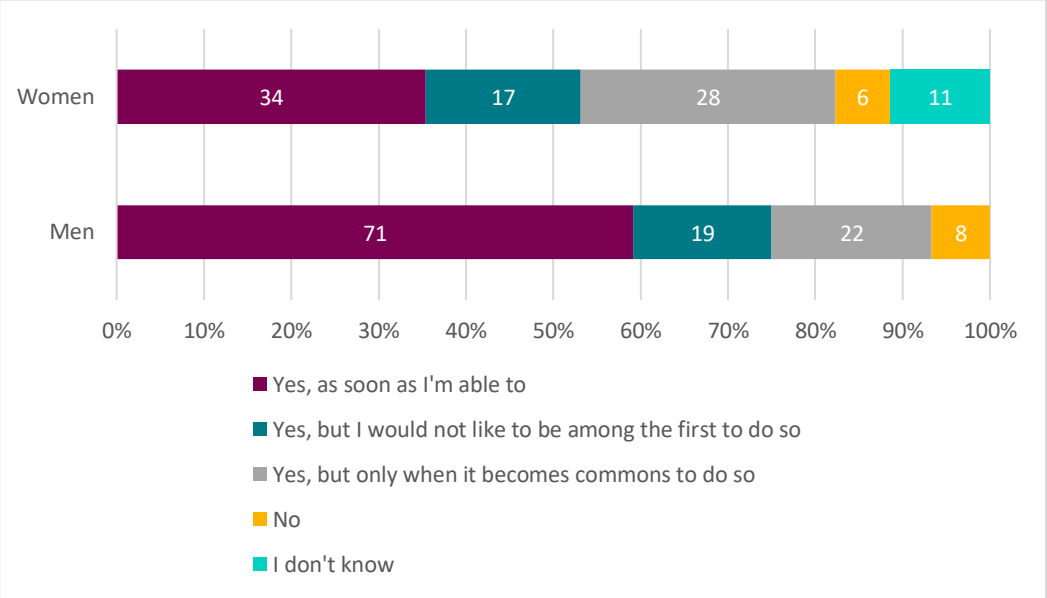
These findings are very much in line with data highlighted in the 2018 AVRS customer research survey (MERGE), which illustrated a similar gender difference in service adoption.[22] The majority of the survey

[21] A Chi-Squared test of independence was conducted to test association between gender and interest in using AVRS. There was a statistically significant association $X^2(3)=8.425$, $p=0.038$. The association was weak $\phi c = 0.203$. n= 216 (Male and female only)

[22] MERGE Greenwich (2018) Customer attitudes to autonomous-vehicles and ride-sharing. Accessed online: https://mergegreenwich.com/wp-content/uploads/sites/13/2018/04/MERGE-Greenwich-Consumer-attitudes-to-AV-ride-sharing-3.pdf Accessed on: 15.09.20

respondents who were happy to use AVRS and had very few concerns about it were males (n=88).

Figure 11: adoption preferences for AVRS services



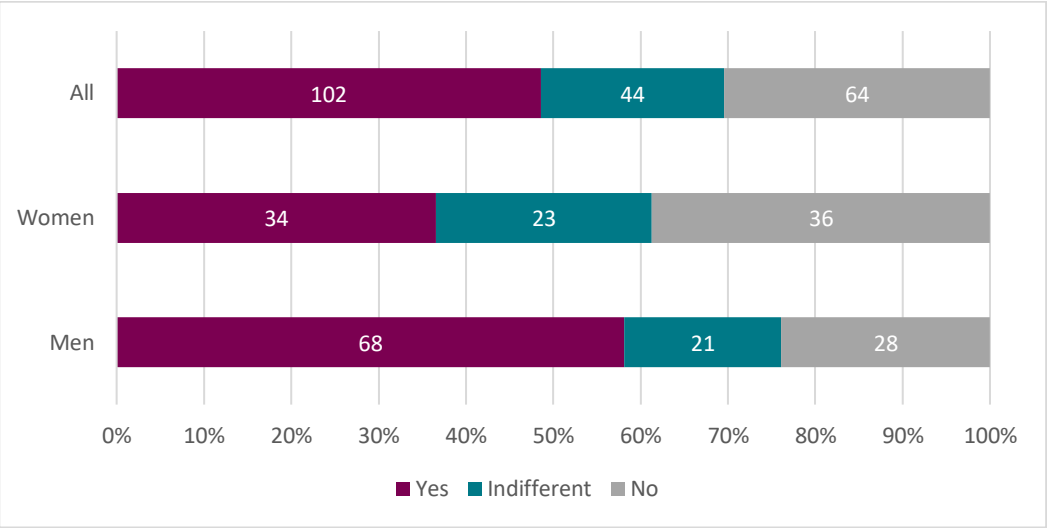
Base: n=216 (male and female only)

What are respondent perceptions of AV ride-sharing services?

A major innovation of AVRS is the driver-less aspect of the transport mode. We tested whether responders were happy using a driverless ride-sharing service (figure 12) and found that men were statistically significantly more likely than women to state that they are happy using such an AVRS service.[23] Women in the survey instead appeared to prefer ride-sharing services which were manned by a human driver. This presents an important barrier that will need to be overcome to make services gender inclusive.

[23] A Chi-Squared test of independence was conducted to test association between gender and happiness using an AVRS service. There was a statistically significant association $X^2(2)=9.819$, $p=0.007$. The association was weak $\phi c = 0.216$. n=210 (male and female only; non-respondents removed).

Figure 12: happiness using a driverless ride-sharing service



Base: n=210 (male and female only; respondents only)

Our data also showed that level of AV knowledge was positively correlated with happiness with driverless AVRS services: as self-reported knowledge of AVs increased, so did the likelihood of stating happiness with using driverless AVRS services.[24] This appears to illustrate that by improving the level of AV knowledge of the general public it may be possible to increase the general public's willingness to use driverless AVRS services in the future. However, this alone is unlikely to allay security and safety fears which women highlight as a concern regarding AVRS: specific design interventions will likely be required to overcome these specific barriers.

How will the public use AVRS when they become available in the future?

Survey respondents were asked how they will use AVRS services when they are more widespread. Our data shows that almost two-thirds of respondents would use AVRS services for recreational purposes (63%) whilst just under half (48%) would use AVRS for travelling to and from work (figure 13).

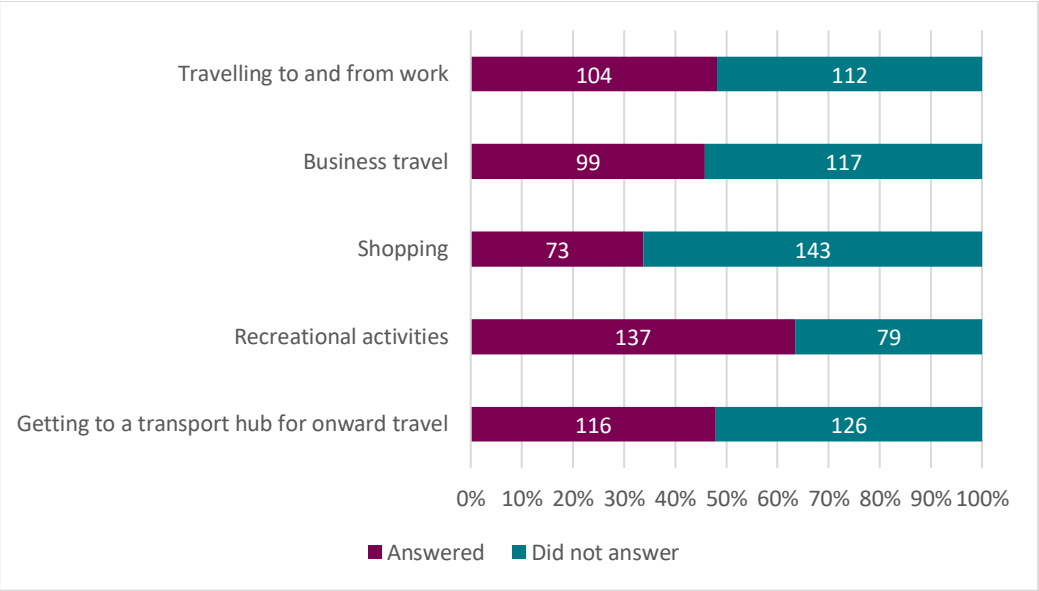
We also found that males are statistically significantly more likely than females to use an AV ride-sharing service to travel to and from work[25], and people aged 16-24 are statistically significantly more likely than

[24] A Chi-Squared test of independence was conducted to test association between level of AV knowledge (re-coded as dichotomous) and happiness using driverless AVRS. There was a statistically significant association $X^2(1)=8.373$, $p=0.004$. The association was strong $\varphi=0.240$. n=216 (male and female only; non-respondents removed)

[25] A Chi-Squared test of independence was conducted to test association between gender and purpose of using AV ride sharing services for travelling to and from work. There was a statistically significant association $X^2(1)=5.077$, $p=0.024$. The association was weak $\varphi=0.153$. n=216 (male and female only; non-respondents removed)

older age groups to use AV ride-sharing service to travel to and from work.[26] This suggests a potential demographic for future AVRS services to target.

Figure 13: Purpose of using AV ride-sharing services



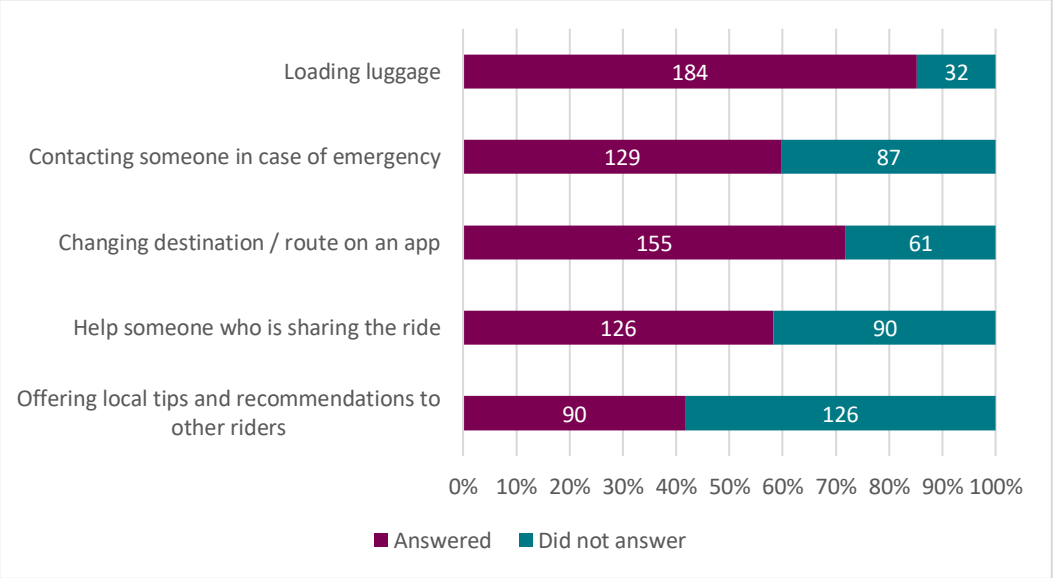
Base: n=216 respondents (Male and Female only)

Which tasks are passengers happy to undertake in a driverless AVRS service?

Traditional ride-sharing or taxi services are operated by a driver who can provide passengers with additional services, for example loading luggage, managing an emergency and offering local tips and advice to travellers. In this survey we asked whether ride-sharers would be happy to do these tasks themselves in a ride-sharing AV in which there is no driver. The results presented here are similar to those from the AVRS MERGE customer survey, whereby 56% of respondents indicated that they would prefer to have a steward on board to monitor social interactions, and to potentially carry out various services (e.g. loading luggage).

[26] A Chi-Squared test of independence was conducted to test association between age and purpose of using AV ride sharing services for travelling to and from work. There was a statistically significant association $X^2(5)=11.767$, $p=0.038$. The association was moderate $\phi c = 0.234$. n=216 (male and female only; non-respondents removed)

Figure 14: Tasks users are happy to undertake in a driverless AVRS service



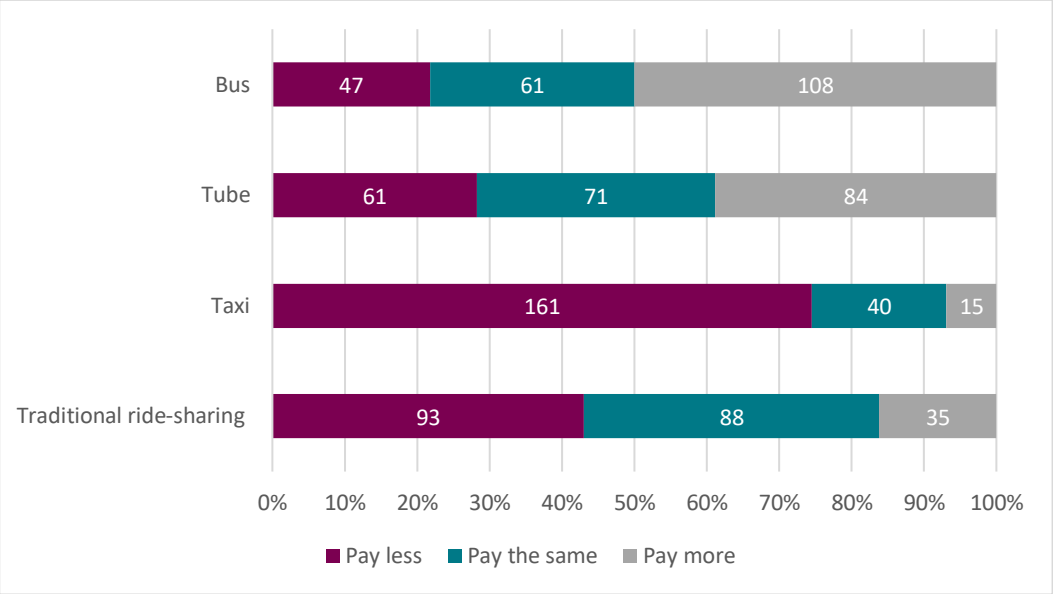
Base: n=216 (Male and female only)

Cost expectations of AVRS services

Our data highlights that respondents appear to put a premium on traditional/human-driver services such as taxi services and traditional ride-sharing services. Respondents to the study expect AVRS services to cost around the same or less than traditional ride-sharing services, and expect a price point lower than a traditional taxi service. Our data also shows that women are statistically significantly more likely than men to want to pay less for AV ride-sharing services compared to traditional ride-sharing services, possibly indicating the value that women put on having a human-driver in the vehicle.[27]

[27] A Chi-Squared test of independence was conducted to test association between gender and cost expectations for AV ride-sharing compared to traditional ride-sharing services. There was a statistically significant association $X^2(2)=6.335$, $p=0.042$. The association was weak $\phi c = 0.171$. n=216 (male and female only).

Figure 15: AV ride-sharing cost expectations compared to other services



Base: n=216 respondents (Male and Female only)

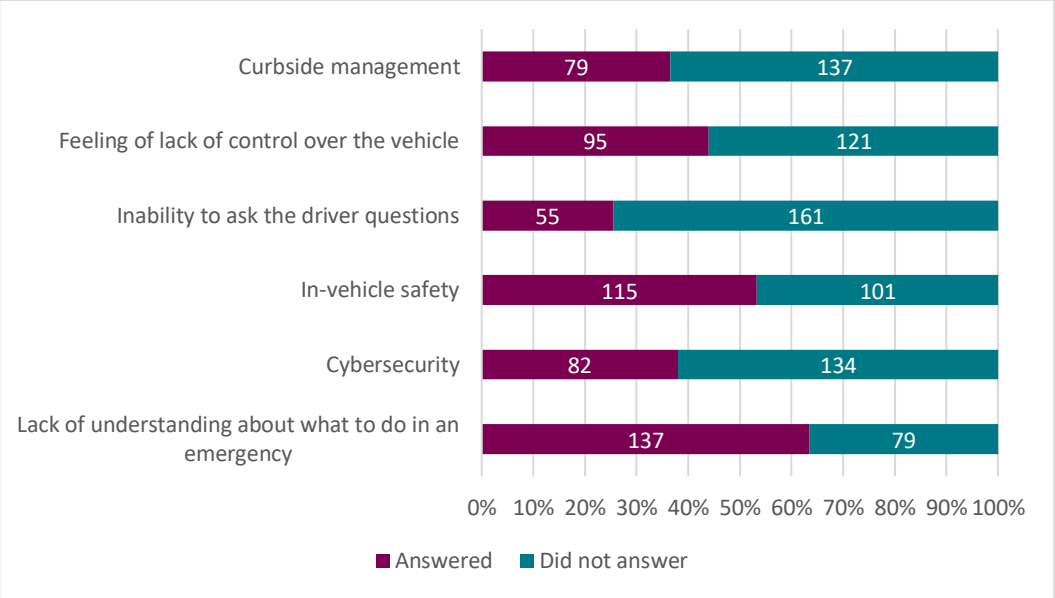
What are the barriers to using AVRS services in the future?

We asked respondents to consider which barriers may exist which may prevent them from accessing and using AVRS services in the future (fig 16). Lack of knowledge about what to do in an emergency (63%) and in-vehicle safety (53%), were cited as the main barriers to using AVRS in the future.

We also found that females are statistically significantly more likely than males to cite "inability to ask the driver questions" as a barrier to using AV ride-sharing services, potentially highlighting a service-design requirement for future services to ensure services are gender inclusive.[28]

[28] A Chi-Squared test of independence was conducted to test association between gender and "inability to ask the driver questions". There was a statistically significant association $X^2(3)=7.231$, $p=0.007$. The association was weak $\varphi=0.183$. n=216 (male and female only).

Figure 16: Barriers to using AV ride-sharing services



Base: n=216 (Male and female only)

Discussion and conclusion

AV ride-sharing services offer an exciting opportunity to complement existing transport modes with innovations which optimise existing infrastructure and reduce the number of privately owned vehicles on the road.

Our data builds on the outcomes of the MERGE project, and further solidifies the view that users of future services will access AVRS for recreational or commuting purposes. The Project Endeavour survey also illustrates that there are many opportunities to create a flexible service that meets the needs of different users in the community.

Whilst the data in this report is pre-pandemic, it offers a useful baseline against which changing trends in perceptions and attitudes can be assessed. Whist it is not yet known how urban mobility will be effected by COVID-19, this data combined with future data collected by Project Endeavour, will enable us to understand the long-term challenges and opportunities resulting from the pandemic.

The next stage of Project Endeavour will therefore explore these different user-perspectives in greater detail, and enable a longitudinal comparison for policy and research purposes.

THE PUBLIC PERCEPTION: A FRESH ALTERNATIVE TO MASS PUBLIC TRANSPORT

Whilst we find that the UK public is generally content with public transport there are clear deficiencies in cleanliness and space which score low with the surveyed public. AV ride-sharing services that will be developed on the results of the Endeavour project offer a viable and high-quality alternative that overcomes these major issues of cleanliness and safety.

There is overall support for AV ride-sharing services, with the majority of respondents stating they are interested in using an AV ride-sharing service either immediately or when it becomes more common to do so.

This study also shows that the general public have clear cost and quality expectations of AV ride-sharing services that should be considered in the design and development of future services. These services will also need to take account of the traditional ride-sharing tasks that can no longer be included in the service due to the potential absence of a driver. Alternative payment models, such as those outlined in previous studies such as MERGE, including concessions schemes, will be further explored in the next phase of Project Endeavour.

DESIGNING AV RIDE-SHARING SERVICES WITH END-USERS IN MIND

Data from this survey highlights that future services must put user needs front and centre. We recognise real diversity in the needs of future service users: e.g. user preferences for travelling later at night illustrate that women have much greater concerns of personal safety and as such services will need to take this into account from conceptualisation, through to design and implementation. Women are also less happy than men to use an AVRS, as women prefer ride sharing services operated by a driver. To encourage women to use AVRS, it is important to design the service to address barriers (e.g. safety) that make them feel less comfortable about being in an AVRS. Further discussions should be conducted to design AVRS that meet gender preferences.

The barriers to ride-sharing highlighted the importance of privacy, safety concerns about sharing with strangers, and perceptions of service quality to potential future service-users. Transparent data sharing, demonstrations of live-services, and access to customer-service help are all potential ways to reduce or remove these barriers entirely. Further exploration of these barriers will feature in the next phase of user-research. It is important that measures are undertaken to ensure that passengers feel safe when using AV ride-sharing services. This can include the provision of a steward, to accompany riders, a measure that was also highlighted in the MERGE survey.

Improving the public's general awareness and knowledge of AV's will support service usage. We found mixed levels of knowledge of AVs which could impact service acceptance – a programme of education and information sharing may improve uptake/interest in AV ride-sharing services, and further create public good-will towards innovations that could improve the liveability of urban communities and the wider environment.

Next steps for Project Endeavour

Project Endeavour will trial a fully operational autonomous vehicle (AV) on public roads across 3 UK city locations and includes a unique opportunity for members of the public to engage and participate, supporting the co-creation of future ride-sharing service models. User research through surveys, focus groups, and public workshops will look

to address some gaps in this study – this includes seeking perspectives on inclusive technology, as well as capturing user requirements from diverse communities which are required to develop future services. New data from the next phase will offer a useful comparison to this 2019 dataset.

The consortium is also developing advanced simulations to replicate real-world transit scenarios, and throughout the project is working closely with local authorities to map out future service requirements and demands.

The project is designed to develop a flexible, safe, inclusive, and scalable framework that can be used to establish future AV trials more efficiently and in a broader range of locations.

The next phase of Project Endeavour's community-facing research will be crucial – as communities emerge from COVID-19 restrictions and navigate ongoing uncertainty, this new context offers a unique opportunity to test environmentally-friendly, safe, and convenient alternatives to public transport.

Throughout 2021 the trial will move from Oxford to two other locations in the UK: Greenwich in London is the second of these, and a 3rd UK city situated in the Midlands or North of the UK will be the final trial site for Endeavour. Across these cities the public will be able to learn more about autonomous vehicles, and experience the technology through live trials and engagement with developers and other experts.

User research in the next phase of Project Endeavour will explore several key areas:

- User preferences for AVRS services: who will be the keen adopters, who will play it by ear, and who will need convincing. We will explore their characteristics, interests, drivers, and barriers to engaging with AVRS services.
- User evaluation of AVRS trials: project partners will work closely with local communities to explore use perceptions of service quality including mapping needs vs wants, accessibility testing and mapping community personas. This includes surveying and conducting focus groups with trial participants and local communities.

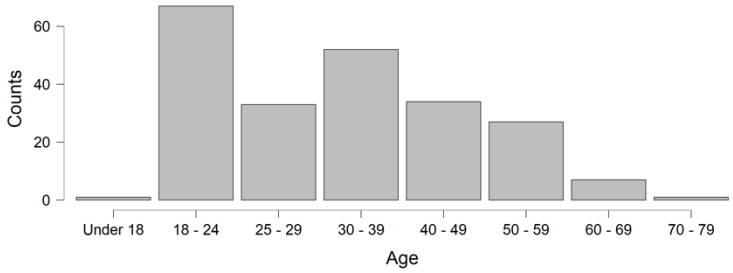
To find out more about Project Endeavour visit the website: www.projectendeavour.uk

Appendix

APPENDIX A1: DEMOGRAPHICS

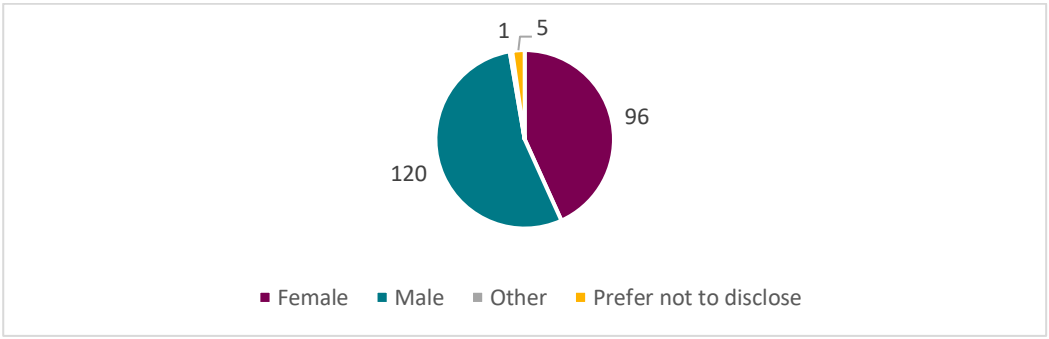
In total 222 respondents completed an online survey conducted in 2019, before the COVID-19 pandemic. Further demographic information about respondents can be found below:

Figure A1: Age



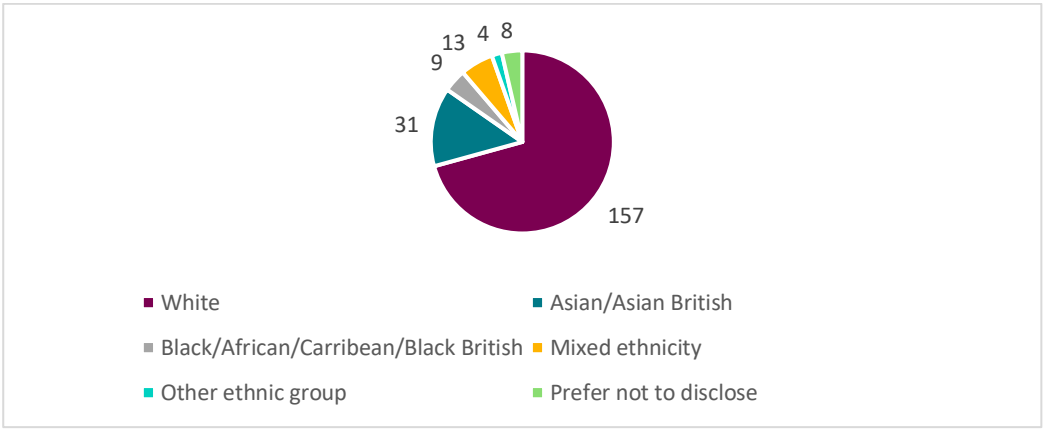
Base: n=222

Figure A2: Gender



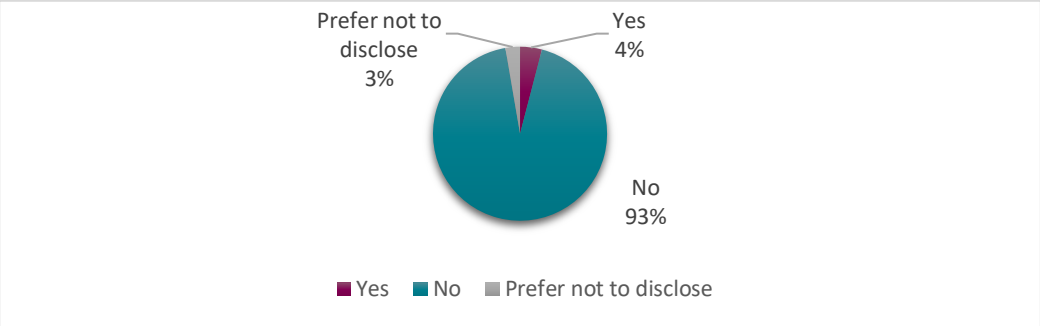
Base: n=222

Figure A3: Ethnicity:



Base: n=222

Figure A4: Disability status



Base: n=222

Figure A5: Individual income

Base: n=222

APPENDIX A2: STUDY LIMITATIONS

There are several limitations worth noting when considering the analysis in this study:

In total 222 respondents completed an online survey. A convenience sample via known networks was employed, as well as general online marketing, which may result in self-selection bias of respondents. Several demographics were skewed, including age, towards younger people and disability status, towards non-disabled individuals. The study sample is therefore not representative of the UK population.

The limitations highlighted above will be minimised in the next stage of user-research for Project Endeavour in the following ways:

- Multiple online channels will be used to recruit to online surveys via platforms including Facebook and LinkedIn.
- Focus group participants will be recruited from across the communities Endeavour is operating in, to ensure a diverse representation of perspectives and voices is included in the final report and in on-going user-design activity.

APPENDIX A3: NOTES ON THE ANALYSIS METHODOLOGY

The survey received 222 respondents. Not all respondents were used for each separate analysis. The base number highlights the number of respondents used and the specific filter applied for each separate analysis.

As data is categorical, contingency tables are applied and Chi-square tests of significance are performed to understand the relationship between variables. Where chi-square tests are not appropriate, Fisher's exact tests are conducted and reported.

The associated effect sizes for Chi-square tests are also included; Phi (φ) and Cramer's V (ϕc), and the Odd's Ratios for Fisher's exact tests.

dg:cities