

Written evidence submitted by DG Cities (SDV0020)

Introduction to DG Cities

DG Cities is an urban innovation consultancy, specialising in helping clients harness the power of technology and data to transform our towns and cities. Over a number of years DG Cities has delivered several self-driving vehicle projects exploring public attitudes and perceptions, safety, trust, and the role of local authorities in deploying services.

DG Cities research and insights focuses on ensuring that public opinions are heard and shape the development of self-driving technology. To do this DG Cities deploys engagement methods to invite the public to share their views on autonomous vehicles, engage in live and virtual trials, and participate in online workshops and discussions as to the future of the technology.

Additionally DG Cities has used the knowledge gained through these projects to participate in the steering groups tasked with developing the suite of BSI's CAV standards programme, utilising the evidence from these studies to support the standardisation of CAV technologies.

Introduction to self-driving technologies

Self-driving technologies have the potential to transform mobility. As well as improving road-safety, self-driving technologies offer a unique opportunity to improve service quality and accessibility for citizens, including those with disabilities, and those unable to drive, as well as potentially changing the patterns of private vehicle ownership and kerbside usage.

For self-driving vehicles to operate safely on our roads, it is critical that developers today take account of the complexity of modern road systems and their users and build technologies that are able to navigate even the most unique and challenging of onroad scenarios. Building future self-driving service users needs and ideas into the development of this new technology is therefore vital.

Public engagement is therefore vital to support technology developers, policy makers, academics and civil society to take account of public ideas and

opinions for the development of self-driving technologies and services. There are a large number of potential use-cases of services, for example supporting elderly groups with increased personal mobility, or enabling usership models of private vehicle access for urban citizens to reduce inner-city private car ownership. For any use case there is a real opportunity to utilise self-driving technology to support increased mobility and safety for vulnerable communities, and ensure that new technologies are accessible for all. This can only be achieved if these groups are engaged from the beginning of the project.

Recent ongoing and completed trials

DG Cities has completed several projects relevant to this call for evidence, including:

- MERGE Greenwich
- Project Endeavour
- D-Risk

MERGE Greenwich

The MERGE Greenwich vision was to develop a blueprint for a self-driving ride-sharing service, which integrated with public transport combining both existing and new transport modes. MERGE Greenwich aimed to explore how a new service could be designed and implemented in a way to maintain or increase active travel in the borough and to complement, rather than compete with the existing public transport offer.

A complex transport model and fleet simulation were developed based on forecast transport use in 2025, which positioned the self-driving ride-sharing service in the Royal

Borough of Greenwich. The project explored service viability and routes to deployment. The research methodology, tools and lessons learnt by MERGE Greenwich were designed to be replicable and can be applied to other boroughs and cities in the UK as well as overseas. The research mapped demand-drivers for self-driving ride-sharing services, considerations for

mobility service providers looking to develop new offerings and the impact this service could have on the city and its citizens.

MERGE Greenwich was a 12-month project, co-funded by government and industry. The consortium consisted of the Addison Lee Group, TRL, The Transport Systems Catapult, DG Cities and Immense Simulations. DG Cities role in the project was to contribute to the city and citizen perspective; this knowledge of city challenges and the public views gained through surveys and focus groups helped the project partners understand how an self-driving ride-sharing service should be deployed, considering the complex urban environment and the needs of cities, as well as the preferences of those who would ultimately use the service to feel confident that their needs would be fully understood and incorporated in the service design.

Findings

The MERGE Greenwich project simulated the integration of a self-driving ride-sharing service with the current transport framework. As a critical factor in the implementation of such a service, DG Cities researched attitudes and insights of potential customers as well as their current travel decision criteria. Our findings showed that:

- **Respondents were more averse to the ride-sharing aspect of the service offering than the self-driving technology.** Over 85% of survey respondents indicated willingness to use a self-driving ride-sharing service in the future but were more unsure of ride-sharing when commenting throughout the survey. Comments from participants highlighted that regulators would require self-driving technology to be proven through rigorous testing before being deployed for commercial use.
- **Views were polarised on the potential of self-driving technologies, but the majority believed they would eventually use self-driving vehicles.** Survey comments and focus group participants were extremely hesitant about sharing a journey in a small space (similar to current 4-door private cars) with strangers. Therefore any self-driving ride-sharing

vehicle must be designed to make ride-sharing socially acceptable and comfortable.

- **Design aspects were important to respondents, emphasising shared/communal use and the importance of safety:** without the need for a driving seat, respondents imagined seating would be configured similar to train or tube. Design of the customer interface (booking App) also needs to overcome consumer concerns, by providing transparency and reassurance of safety as well as a preference platform for decision making.
- **Interest in using self-driving services differed across demographics:** we found that the likely users of a self-driving ride-sharing service are currently below the age of 35 (62% of the respondents who were somewhat or very likely to use a self-driving ride-sharing service). However, many over 35s said they were unlikely to use a self-driving ride-sharing service (25% of over 55s, and 22% of those aged 35-44).
- **Leisure and late-night travel use cases were of interest to respondents:** 58% of respondents stated they would use the service for a late evening trip, whilst 55% stated they would use the service late at night. Further, it was found that the majority of respondents (73%) who said they were very or somewhat likely to use a self-driving ride-sharing service in the future thought they might do so because they would not have to find parking.

Overall, respondent's responses were emotional and powerful; introducing the concept of a self-driving ride-sharing service elicits strong polarised opinions. Some respondents are very excited; intrigued by the self-driving concept and modern technological advances, whilst other respondents are more fearful and rejecting. For cautious respondents the notion that a car has no driver feels fundamentally dangerous and the added concept of sharing a ride with strangers only increases their sense of risk. While there are barriers in attitudes to overcome before the service is widely accepted, these barriers are not insurmountable and can be addressed. DG Cities concluded the success of an self-driving ride-sharing service will depend on increasing awareness about the benefits of an self-driving ride-sharing service and ensuring potential

customers are well informed about the limited risks, and have access to materials and information to help to reduce fears.

Project Endeavour

Project Endeavour aimed to accelerate and scale the adoption of self-driving services across the UK by understanding the value of autonomous vehicle services through demonstrations and live trials, and to support the rapid development of public-road ready services. Ultimately Project Endeavour set out to test the building blocks of future self-driving services in the real world. The project ran between March 2019 and October 2021 and built on the research of MERGE Greenwich by developing and testing self-driving based services.

The project was led by Oxbotica, working alongside DG Cities and Immense. In Autumn 2020, three further partners joined the project: TRL, BSI, and Oxfordshire County Council. Each partner brought its own cutting-edge expertise to the project.

Project Endeavour delivered four autonomous vehicle trials on public roads across the UK. The objectives of these trials were fourfold:

- to validate the technology in real-world contexts.
- prove the concept of pop-up autonomy, which is the rapid deployment of an autonomous vehicle trial.
- engage the public in live trials and test the value of trials on perceptions and attitudes towards autonomous vehicles.
- Develop a replicable methodology for engaging with local authorities and other actors for the deployment of autonomous vehicle trials.

Trials took place in locations across the UK:

- Oxford - two trials on public roads, closed to public participation due to COVID-19 restrictions.
- Birmingham - one trial on public roads, closed to public participation due to COVID-19 restrictions
- Greenwich, London - 1 on public roads open to public participation.

Public research included a mixed-methods approach to engage communities from across the UK:

- Nationwide attitudes and perceptions survey: An open-access community survey was distributed via social media between May and August 2021 which explored: perceptions of self-driving vehicles, including safety, trust and accessibility, intentions of using self-driving vehicles in the future, interest in self-driving ride-sharing services and general demographic and travel attitudes. In total, 2491 good quality responses were analysed.
- Trial evaluation surveys: surveys were distributed to trial participants before and after the face-to-face Greenwich trial in August 2021. The survey explored: pre- and post- measures of perceptions of self-driving vehicles, including safety, trust and accessibility, post-trial experience of riding in a self-driving vehicle, post-trial feedback. In total, 109 good quality pre-surveys were analysed and 55 good quality post-surveys were analysed.
- Post-trial semi-structured interviews and online focus groups: trial participants were invited to feedback their experience of the trial. Fifty trial participants were interviewed after the trial experience in August 2020, and over 25 took part in online focus groups between May and July 2020. These interviews explored attitudes and perceptions towards self-driving vehicles.

Findings

Our research highlights the importance of safety perceptions to understanding the potential adoption rate of autonomous vehicles in the future. Trust in self-driving technology is limited, but a large minority is yet to be persuaded about the potential of the technology. Findings from our national survey show:

- **The Public is divided on the trustworthiness of self-driving vehicles:** almost a third (32.5%) think self-driving vehicles will be trustworthy, whilst two in five (43.8%) do not. Just under a quarter (23.6%) are undecided

- **Only a quarter would use a self-driving vehicle tomorrow if they could:** 26.8% would feel confident using a self-driving car tomorrow if it were possible to do so. Over half would not (55.1%). The remainder are undecided (18.1%).

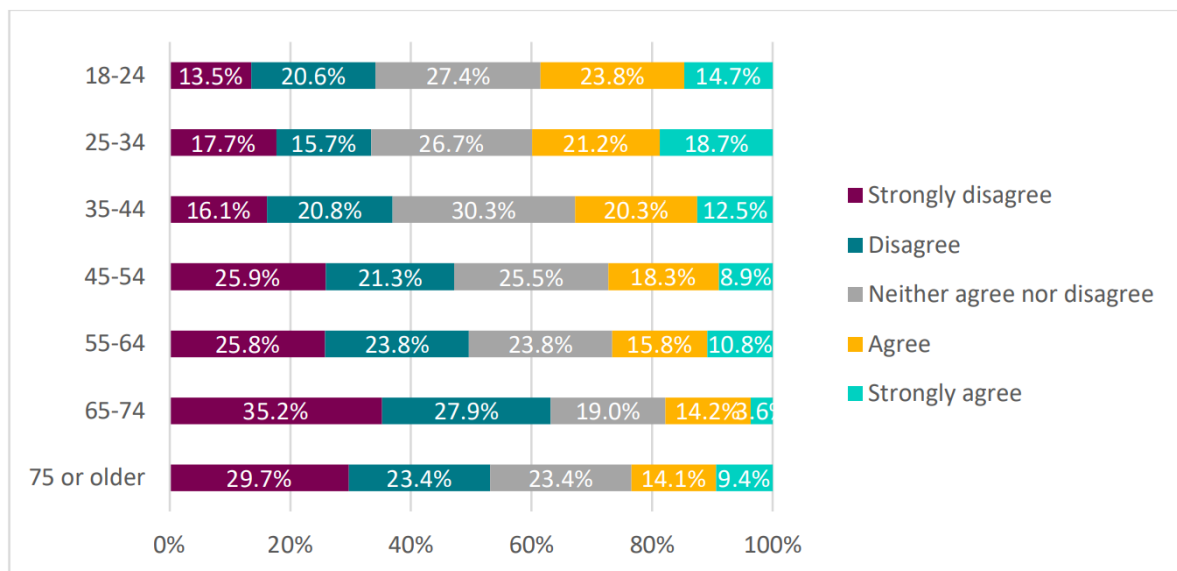
Feedback from participants through the trial interview process highlighted that improvements in safety could lead to improvements in trust:

“There’s less chance of human error, being on an autonomous vehicle, so I definitely think I would trust it.” Project Endeavour trial participant

Safety perceptions

Less than a third of the public think that self-driving vehicles will be safer than traditional vehicles, highlighting a significant attitudinal barrier to their adoption. Findings from our national survey show that three in 10 (29.9%) believe that self-driving vehicles will be safer than traditional vehicles, whilst 44.2% disagree. A quarter (25.9%) are undecided.

Figure 1: Agreement with “I think autonomous vehicles will be safer than human driven vehicles” by age



Base: n(weighted) = 2491 (Project Endeavour National Survey)

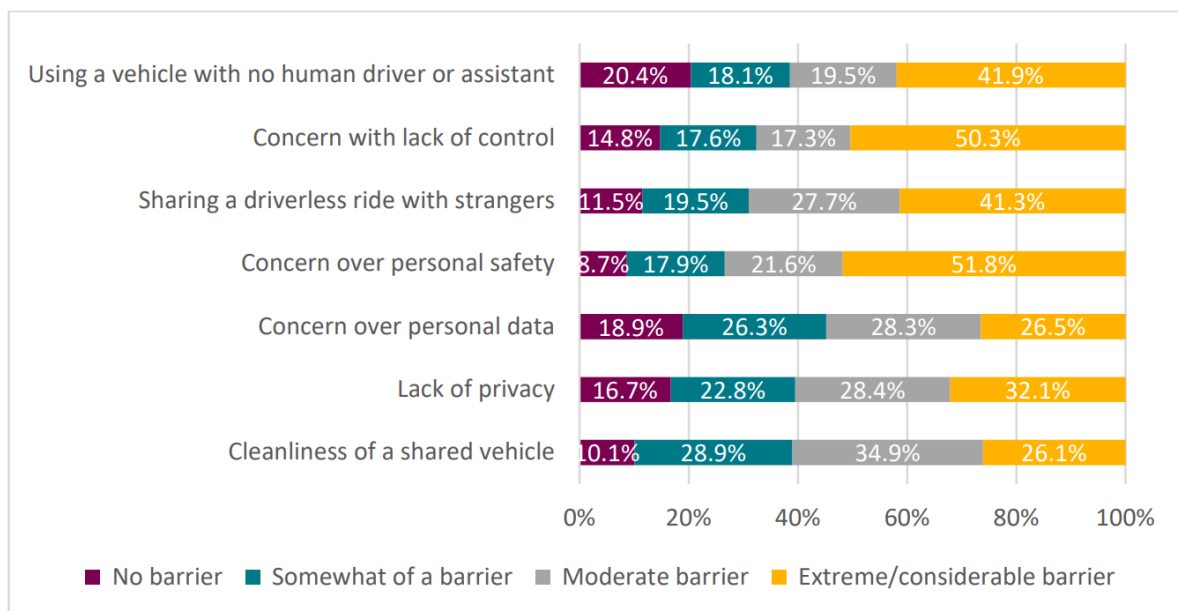
There are ways by which perceptions and attitudes towards self-driving technologies can be improved. For example, the Project Endeavour live trials

improved the safety perceptions of trial participants by 15 percentage points: before the trial, 68.3% agreed that self-driving vehicles would be safer than human driven vehicles, whilst after the trial 83.6% agreed, an improvement of 15 points.

Attitudes towards ride-sharing services

An additional element of Project Endeavour public research was to explore perceptions and attitudes towards a ride-sharing service model of deployment for self-driving vehicles. Through the national survey we tested attitudes and perceptions towards ride-sharing, and gathered feedback on if and how services could be adapted to the needs of different members of the community

Figure 2: Attitudes towards using a self-driving ride-sharing service



Base n(weighted) = 2467 (Project Endeavour National Survey)

Our research highlighted the value of engaging communities in designing for future ride-sharing services, given the types of barriers that were highlighted. For example, personal safety and lack of control were the major barriers to participants, and as such be explored through future research and in-depth service design with participants.

Engaging participants through virtual reality

In addition to online and face to face engagement, Project Endeavour produced two virtual reality films to engage communities safely throughout the COVID-19 pandemic. People across the UK were able to experience autonomous vehicles from home through two videos that were designed to bring self-driving services to life. A simple virtual reality (VR) headset was developed, which could be used with a smartphone. This was distributed to over 2500 members of the public who applied via Facebook from across the UK.

The two videos that were made accessible to the public were:

- **Self-driving cars today:** To showcase current AV technology, we developed a 3D film of the Oxford route. The video included the vehicle overtaking cyclists, operating around a roundabout and emerging from a T-junction. The video utilised visual aids to point out key technologies and was developed to be immersive and replicate what it would be like to travel in an AV in real life.
- **Self-driving cars tomorrow:** A second VR video was developed, which explored the future potential of AV technology. The animation showcased designs of future autonomous vehicle-based mobility services, and included an AV, as well as a Connected and Autonomous Mobility stop.

Our engagement research with participants in the VR study highlighted the value of engaging the public through virtual means, whilst not as effective as face-to-face, offered a unique opportunity to test self-driving concepts with a wider community. For example:

- 73.9% of VR participants believed that self-driving technology in the future will be reliable, compared to 94.6% of those who participated in the physical trial.
- 61.7% of VR participants believed that self-driving technology will be safer than human driven vehicles, compared to 83.6% of those who participated in the physical trial.

D-Risk

D-RISK is a £3m Innovate-UK funded project focusing on the development of software for safe automated vehicles. It is a collaboration between dRisk.ai, Claytex, Imperial College London and DG Cities.

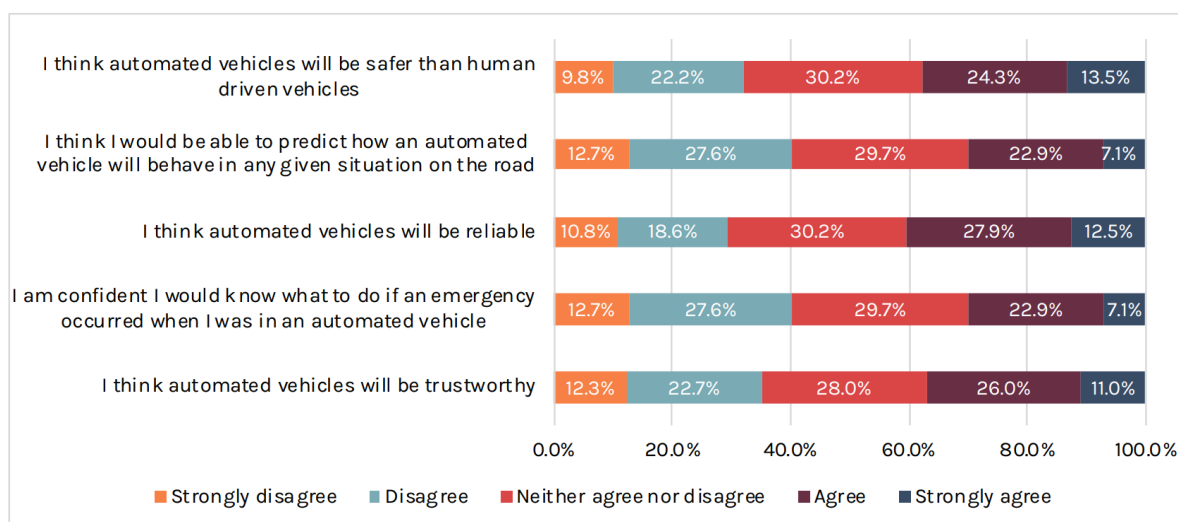
D-RISK aims to support the development of safe self-driving services by building the world's largest library of driving "edge cases": situations that aren't commonplace, and are unpredictable and high risk - scenarios which self-driving vehicles will need to be able to handle safely if they're to be used on UK roads. Edge case data is being sourced to test and validate self-driving vehicle behaviour and train self-driving vehicle AI. Sources include traffic cameras, road accident reports and public disclosure through a crowdsourcing initiative with the UK public.

Public engagement and community research is a vital aspect of the D-RISK programme. As such DG Cities has delivered research exploring public perceptions of self-driving vehicles and undertook an online campaign to crowdsource real-world edge-cases to build the D-RISK edge-case library. In addition to this DG Cities undertook a series of online experiments with the public to test attitudes and perceptions towards simulated self-driving scenarios.

Findings

Perceptions of safety and trust differed significantly between younger and older people. In general, young people viewed self-driving vehicles more favourably than their older counterparts.

Figure 3: Public perceptions of safety



Base: n = 1038 (weighted)

The safety issue was also raised by participants in the focus groups:

“There might be potential for them to be safer than many drivers but it’s going to require a lot more work. But surely the safety standard they’re aiming for is zero collisions, and zero deaths, and until they get there there’s more work to do.” D-RISK Focus Group Participant

“I’m just frightened to death of driverless cars. I drive a 125 scooter, I have a car, and I used to drive a massive one-toner work van, but the thought of driverless cars just fills me with horror. I wouldn’t even like to be a passenger on a trial run. I just don’t trust them. I don’t know how they’re supposed to work.” D-RISK Focus Group Participant

Online safety perceptions experiment

Safety perceptions have been shown to differ significantly according to context and scenario. We therefore developed an online safety-perceptions experiment to test perceptions of safety in different scenarios. We tested three pairs of simulation videos, each pair representing a common road scenario. Each pair included one video in which the participant observed a simulation based on a human response to a real-world scenario (e.g. re-constructed from UK traffic camera data). In the second video of each pair the participant watched an AI response to the same scenario. The participant was

blind to which response they were observing. Participants then rated the vehicle's behaviour on five scales: safety, predictability, avoidance capability, decision speed and humanity between zero and ten.

Figure 4: Sudden stop scenario (mean rating scores, e.g., 0 = Unsafe, 10 = Safe)



Base: Safety n = 299**, Predictability n = 293**, Avoidance capability = 289**, Decision speed = 284**, Humanity = 273. ** = <0.001 significance.

Figure 5: vehicle overtaking scenario (mean rating scores, e.g., 0 = Unsafe, 10 = Safe)



Base: Safety n = 341**, Predictability n = 337**, Avoidance capability = 328**, Decision speed = 319**, Humanity = 315**. ** = <0.001 significance.

Figure 6: vehicle turning right (mean rating scores, e.g., 0 = Unsafe, 10 = Safe)



Base: Safety n = 359**, Predictability n = 352**, Avoidance capability = 343**, Decision speed = 303**, Humanity = 345. ** = <0.001 significance.

Our research highlighted public attitudes towards self-driving vehicles in simulation can be significantly positive, if a clear comparison to a humans-driven response is also demonstrated. This is particularly true for the safety dimension, which for all scenarios tested showed better performance by the simulated self-driving vehicle response. We believe this could be a useful tool to demonstrate safety of self-driving AI to the general public, and to highlight the importance of training vehicles through real world scenarios in simulated environments.

Role and capacity of local authorities and other responsible bodies in deploying safe self-driving vehicles

Local authorities play a crucial role in creating the enabling environment for self-driving services to operate safely and inclusively for their communities. As part of Project Endeavour DG Cities undertook an engagement exercise with a number of local authorities designed to gain an understanding of the current levels of awareness and acceptance of self-driving technologies within a range

of different authority types, and to develop materials to support local authorities to understand how to maximise the value of self-driving testing on their highways.

The outputs of the engagement helped DG Cities to produce two guides:

- **CAV Trialling on Public Highways** which supports councils to help them understand the information organisations trialling in their area could be expected to provide. and the
- **CAV Trial Guide for Trialling Organisations** which is targeted towards organisations undertaking self-driving trials to help build understanding of what would be useful to provide when approaching the local highways authority.

The findings of our engagement with local authorities and other institutions showed that knowledge and awareness varied hugely by council, with some having very little engagement and others actively involved in the self-driving/CAM agenda, and seeking to understand the impact of trends and future mobility on the lives of their residents.

The role which the local authority will play in both the transition to CAM and CAM futures is complex. The divergent understanding of CAM and the ability to prepare for - and potentially benefit from - connected as well as connected and automated mobility is constrained by both information and resources. Kerbside management, intelligent transport systems (ITS), vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technology are all things which will influence future policy and infrastructure design, yet it appears a high number of councils lack the resources to proactively engage with the agenda.

Directions for future R&D

Our consumer research highlights several important directions for future work on self-driving technologies:

- **Deeper public engagement into service design:** a recurring theme across our research is that of emerging understanding and expectation

amongst the public of how future services may be operated using self-driving technologies. There is little evidence of extensive and lasting engagement with the public on the design of a self-driving service, from ideation through to piloting and towards implementation. Service user voice on the design and development of new models will benefit not only the service delivery organisation, but can also act to surface and validate assumptions and barriers.

- **Investment in behaviour change intervention design to tackle limited acceptance and interest of self-driving technology:** both Project Endeavour and D-RISK highlight a significant number of “undecided” participants who have yet to be convinced by self-driving technology. We also highlight through our work the low level of basic knowledge as to how self-driving technologies work, and their potential benefits to individuals and wider society. It is our view that there are significant embedded attitudes and behaviours related to traditional vehicle use which require transformation through extensive behaviour change intervention. Our evidence shows the important role public trials play in building public knowledge and informing attitudes, but it is not economically feasible to fund extensive trials for the large number of people who are yet to be convinced. Instead, funding should go towards exploring how to create large change through simple and effective behaviour change interventions, e.g. knowledge sharing, information distribution, access to VR solutions, and access to simulated experiments and videos. A combination of methods and channels will be needed to meet the learning needs of different user groups.
- **Increased engagement with excluded and vulnerable groups:** interest and engagement in public trials and survey methods is often amongst those with access to resources, and with interest in the topic. Future service models must be developed with accessibility for excluded and vulnerable groups in mind, and as such its critical that future research initiatives, including funded research programmes, as well as private sector R&D focuses on including vulnerable groups, including elderly,

those with disabilities, and those on low incomes into the design of future technologies and services.

- **Support for additional research on capability and capacity building in local authorities around self-driving technologies and their potential impacts.**

Local authorities need support to better understand the opportunities self drive can offer, and the influence deeper consideration of self-driving can have on wider highways matters. Local authorities should invest in the capabilities and skills to support the transition. This will include understanding how to accommodate superficially simple changes such as managing kerbside space and design for accessible self-driving rideshare pickups/drop offs, understanding the the needs for V2I and V2X and what this could mean for their street furniture, and better mapping the changes required to the street environment, including 'lining and signing'. More evidence is needed to understand the steps by which local authorities should go through to accommodate new self-driving technologies.

Conclusions

Self-driving technology is likely to significantly improve the safety and accessibility of mobility services, and even challenge the status quo private ownership model for vehicles. For many people self-driving technology remains a novel or futuristic concept. Our work on real-world trials shows the public's perceptions and views of self-driving technologies can be positively shifted through deep engagement and access to the technology. The public needs to see, touch and experience self-driving for themselves. Our work highlights just how important this is to building acceptance of the new technology.

Our evidence also shows that public input and buy-in is critical - without it service developers and technology developers risk building models which ultimately do not meet the needs of all. New self-driving services must have accessibility and usability at their core - without this it is likely that the public

will not accept or use self-driving technology, even if the society-level safety credentials for their application are clear.

Further reading

DG Cities. (2021) *Creating safe self-driving services: findings from Project Endeavour*. Accessed online: <https://www.dgcities.com/reports>

DG Cities. (2021) *D-Risk Community Insights Report*. Accessed online: <https://www.drisk-project.org/insights>

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