UKRI Trustworthy Autonomous Systems Hub

THE POLICY INSTITUTE

KING'S College LONDON

Social inclusion & autonomous vehicles

Report of a Policy Lab, June 2022

The development of autonomous vehicles (AVs) – road-based vehicles capable of sensing their environment and operating without human involvement – presents a range of challenges and opportunities. They have the potential to reduce road accidents, operate more sustainably, and give drivers the freedom to undertake other tasks whilst on the road. AVs can also bring benefits to groups that are, or could become, socially excluded. For instance, they could enable people with disabilities to access a form of transport or help geographically isolated people get to critical medical services.

Although AVs can potentially bring some benefits to vulnerable social groups, this is by no means guaranteed. Moreover, issues of social inclusion and exclusion in the design and development of AVs are often overlooked, and so the Policy Institute at King's College London made this its focus for a Policy Lab in June 2022.

This report is our summary based on key insights raised by participants in the Policy Lab. We intend this summary to be useful to researchers, policymakers, manufacturers and other stakeholders engaged with the design, development and deployment of Autonomous Vehicles.[1]

What is a Policy Lab?

Changes in policy and practice often fall down when built on an inadequate understanding of the communities and challenges they seek to address. However, marshalling the research evidence, and appreciating wider social and financial implications of policy options can be a complex challenge in itself. To bridge the gap that often exists between research evidence, policy and practice changes, the Policy Institute at King's runs a series of "Policy Labs"; these are collaborative sessions that bring together research, policy and practitioner expertise to assess the evidence, understand barriers and constraints to change and use this understanding to inform policy options that can help improve outcomes.

1 Thank you to all participants for attending and contributing towards the Policy Lab.

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Social inclusion and exclusion in autonomous vehicles

Issues of social exclusion are widespread within the UK. The number of people aged 65+ is set to grow by around 50 per cent in both urban and rural areas between 2016 and 2039. In 2019/2020, more than one in five of the UK population (22 per cent) were in poverty – 14.5 million people. 11.9 million people (22 per cent of the population) do not have the digital skills needed for everyday life in the UK. And in 2020/21, 22 per cent of people in the UK reported having a disability, equivalent to 14.6 million people.[2] Many of these people experience, or may experience, issues of social exclusion, and AVs have the potential to make transport more socially inclusive for people in some of these cases. However, the design, development and deployment of AVs could be such that their increased use might actually exacerbate problems of social exclusion.

It is, therefore, essential to understand issues of social inclusion and exclusion in the context of AVs if they are to be designed and developed in a way that makes them socially inclusive. By exploring and understanding these issues, AVs can be designed and developed with social inclusion in mind from the outset. Having a clearer understanding of issues of social inclusion in AVs is also critical for delivering the UK Government's Inclusive Transport Strategy, which aims "to move from infrastructure design and service provision which focuses on achieving 'accessible transport' (eg by changing existing infrastructure to meet the needs of disabled people) to delivering 'inclusive travel' (with services designed through dialogue with disabled people and other groups so that the needs of transport users are identified upfront)".[3]

To explore issues of social inclusion and exclusion in AVs, The Policy Institute at King's College London hosted a Policy Lab for the Trustworthy Autonomous Systems Hub that brought together a range of stakeholders to consider the following question:

> *How do we ensure that autonomous vehicles are designed, developed and deployed in order to benefit everyone?*

Trustworthy Autonomous Systems Hub (TAS-Hub)

The UKRI TAS Hub assembles a team from the Universities of Southampton, Nottingham and King's College London. The Hub sits at the centre of the £33M Trustworthy Autonomous Systems Programme, funded by the UKRI Strategic Priorities Fund.The role of the TAS Hub is to coordinate and work with six research nodes (Functionality, Governance and Regulation, Resilience, Security and Trust and Verifiability) to establish a collaborative platform for the UK to enable the development of socially beneficial autonomous systems that are both trustworthy in principle and trusted in practice by individuals, society and government.

Stakeholders in attendance included civil servants, manufacturers, academics and charity representatives. To address this question, the Policy Lab focussed discussion on several specific case studies that have either recently been subject to new government

2 References for each of these statistics can be found in the briefing pack associated with this report. https://www.kcl.ac.uk/policy-institute/assets/social-inclusion-policy-lab-briefing-pack.pdf

3 Department for Transport (2021), The inclusive transport strategy: achieving equal access for disabled people.

legislation or are more general issues of concern that could be considered for future legislation or policy.

This report summarises the key ideas produced during the discussions at the Policy Lab, while the accompanying briefing pack outlines, in more detail, the policy context for the issues discussed, which was circulated to participants in advance.

Case studies

Automated Lane Keeping Systems (ALKS)

Automated Lane Keeping Systems (ALKS) are automated systems that can take control of a vehicle. They control the position and speed of a car in a single lane. In April 2021, the UK government announced that vehicles fitted with ALKS will be permitted to use the ALKS capability on motorways in Britain, but only at speeds of up to 37mph (60km/h). They also announced that vehicles with ALKS technology could be legally defined as self-driving, "as long as they receive GB type approval [approval to be used on British roads] and that there is no evidence to challenge the vehicle's ability to self-drive."

Drivers will not be required to monitor the road or keep their hands on the wheel when the vehicle is driving itself. However, the driver will need to stay alert and be able take over when requested by the system within 10 seconds. If a driver fails to respond to the transition demand, the vehicle will stop itself, alerting other vehicles.

Under proposed updates to the Highway Code, people using ALKS will be allowed to watch television on built-in screens, but they will not be allowed to use mobile phones. Vehicles with engaged ALKS are considered by the government as self-driving cars, where a driver is not responsible if the vehicle crashes. In terms of the classification by the Society of Automotive Engineers (SAE), these vehicles would be considered as Level 3, or semi-autonomous.[4]

Automated Lane Keeping Systems present a range of both technical and wider challenges, some of which concern matters of social inclusion. For example:

- *Driver's in-cabin face monitoring software* – if this is biased to be better at detecting the face of people who are of a particular ethnicity (eg white) or age (eg young) then it might discriminate against certain groups who are often socially excluded. Or if it is designed to sense peoples' fatigue, drowsiness, intoxication, stress and expressions of emotions it will build in psychological assumptions behind linking, eg facial expression to emotion.

- *Take-over request* – if a request to take over the driving task in certain situations (eg exiting the motorway) is not universally designed for everyone, this might lead to cognitive overload and more accidents. For instance, people might have hearing impairments, or a driver with small children might be distracted when a request to take over is issued. At the same time, vehicles with ALKS which require a driver to

4 https://www.sae.org/blog/sae-j3016-update.

remain alert and be ready to take over the driving task bring limited benefits (if any) to people who are not permitted to drive (eg people with certain disabilities). They will not allow these less-able bodied people to gain or maintain independence.

The Policy Lab focussed discussion on the recent government announcement that cars fitted with ALKS will be permitted to use the ALKS capability on motorways in Britain, but only at speeds of up to 37mph (60km/h). The discussion explored issues around responding to a transition demand about control of the vehicle, and developing in-cabin monitoring to ensure the safe operation of vehicles with ALKS. It also considered other potential uses of autonomous vehicles that are currently being tested, researched or developed, with a particular emphasis on pedestrian detection systems.

Other case studies

The Policy Lab also explored other use cases with potential social inclusion issues, particularly in relation to using AVs outside of motorway situations:

- *Communication with other road users* – if AVs rely on other road users to see flashing lights or hear sounds from the car this will be problematic for people with sight or hearing impediments. Likewise, pedestrians might attempt to communicate with the AV, but it might not recognise them or their signals because they are, for example, in a wheelchair, slower to move, or in non-Western clothing.

- *Pedestrian detection systems* – if this is better at detecting people dressed in certain clothing (eg Western clothes rather than Asian or Middle Eastern dress), or people of a particular ethnicity (eg white).

Each of these examples presents potential issues of social exclusion, relating to a broad range of characteristics, including age, disability, mental health, digital literacy, ethnicity and race.

The Project Lifecycle

This Policy Lab aimed to find solutions for how to address social exclusion issues in AVs at the different stages of their design, development and deployment. To do this, the Policy Lab adapted the framework of the Project Lifecycle, initially created by researchers at the Turing Institute when considering issues of ethical data usage.[5]

At each of the three stages – design, development and deployment – it is possible to ask a range of questions relating to the role of social inclusion in AVs.

1. Design

- *User needs* – who is the technology aimed at and what needs is it being designed to meet? How were these needs identified, and who participated in the process of defining them? Does the technology need to be built in the first place? Are there existing solutions available that would be better?

5 Turing Commons (2022) Introducing the Project Lifecycle (A Sociotechnical Approach):

https://turing-commons.netlify.app/rri/chapter2/project_lifecycle/

- *User capabilities* – what skills or capabilities will be needed to use the technology, and how can it be designed so that all target users can benefit from it?

- *Ethical and legal considerations* – what existing legal and policy frameworks apply to the use case? Are there any regulatory gaps that arise because of the novelty of the technology? Are there ethics committees or internal review boards that can help evaluate the ethical credentials of the project?

- *Stakeholder impact assessments* – which affected people and communities should be consulted to identify and evaluate possible harms and benefits associated with the project (eg socioeconomic inequalities that may be exacerbated or reduced as a result of carrying out the project)?

2. Development

- *Data collection and data bias* – what data need to be collected? How can projects ensure that data (and data preparation and engineering) do not reflect existing biases, resulting in biased or discriminatory outcomes, with a negative impact on marginalised communities?

- *Explainable AI* – developers/computer scientists would need to decide which model they want to use and how complex it should be in terms of interpretability. For example, certain learning algorithm models are less interpretable than others. Lower interpretability can offer greater accuracy or prediction. However, there is a risk of using a ''black-box model" where the relationship between the input features and the output is often too difficult to interpret or explain.

- *User testing/usability* – how can projects ensure that design/product/technology works for everyone? On which groups will tests be conducted?

3. Deployment

- *Over-trusting and under-trusting technology* – what human factors can affect the technology's performance? What are the risks associated with over-trusting and under-trusting technology? How do these risks relate to the problem of social exclusion?

- *Technology updating* – how often should the data for the technology be updated? Would it affect users more positively or negatively if it was updated either continuously or periodically?

- *Product/technology assessment* – how do we ensure that the product is useable, equitable, enjoyable and useful?

Key points

Based on discussions of the case studies, and using the Project Lifecycle approach, the Lab identified a number of important takeaways to ensure matters of social inclusion are built into the design, development and deployment of AVs. These are related to ALKS – which will soon be seen on British roads – and to more general issues currently researched and tested, such as pedestrian detection systems and communication with other road users.

We have taken the key insights made by the groups on the day, but we have also included some critical comments and additional remarks to give them a broader context and to make these insights informative to policymakers and other stakeholders working in the domain of AVs.

Automated Lane Keeping Systems

1. Clarifying the purpose of ALKS

The crucial takeaway for policymakers is to clarify the purpose of ALKS and who should benefit from it. It could be argued that fully autonomous vehicles (SEA Level 5) could be the most beneficial for the public, and so it might not be worth introducing partially automated cars where a user in the vehicle still needs to take over the request. A vehicle that can operate only on motorways, and returns control to the driver when required, excludes, for example, less able-bodied people from its use. At the same time, we recognise fully autonomous vehicles – which can operate without human intervention in all cases – are expensive to build and test.[6]

2. Transition demand

Under the current proposals, a vehicle with ALKS will issue a transition demand in certain situations. If a driver does not respond, a vehicle will slow down and eventually stop.

If we think about developing a transition request to make it more inclusive for people with different needs, certain groups might need a longer time to respond to a transition demand. This might affect people who are neurodiverse, those with hidden/temporary disabilities and people with situational impairments. This poses a challenging question of how to ensure that transition demand is designed in a way that includes people with different personal characteristics and needs, and at the same time, ensuring a longer time to take over the driving task does not cause an accident.

Furthermore, greater transparency is needed around when and why a system requests a driver to take over control of a vehicle, in order to avoid potential abuses of the system. For example, if people treat this more as a navigational system where they ignore directions, there is potential for more accidents and disruptions depending on the situation (eg an unrecognised road).

One of the proposed solutions is to ensure that the human-machine interface (HMI) is designed to be easy to understand and use for everyone, including people with different needs.

6 Patrick McGee (2021) 'Rolling out driverless cars is 'extraordinary grind', says Waymo boss,' https://www.ft.com/content/6b1b11ea-b50b-4dd5-802d-475c9731e89a.

3. Training for ALKS

People would need to re-learn how to drive in vehicles with transition demands. Driving in these vehicles could require a new set of skills, especially when the system communicates for the human driver to take over the driving task. It may be necessary, therefore, to require people to take and pass additional training to be able to drive in vehicles with the ALKS feature.

4. Consent for updates

People are less forgiving when technology makes mistakes. Necessary updates might be required to ensure the safe operation of ALKS vehicles. There is a question of whether people should consent for updates to be made to the system or whether these should be imposed through regulations. When necessary updates are compulsory through regulation, there is also an issue of explainability from the end-user perspective; what these updates can mean and what they do.

5. In-cabin monitoring (facial recognition and eye-tracking) in vehicles with ALKS

Companies work on different in-cabin monitoring features that can detect fatigue, drowsiness, intoxication and stress, and expressions of emotions – such as fear, anger, joy, sadness, contempt, disgust and surprise. This technological solution raises significant issues, such as how invasive eye-tracking technology is, and concerns about manufacturers passing responsibility on to drivers/users.

ALKS, facial recognition, eye-tracking, etc may all exclude certain groups. It is important to take steps to increase access, ie by designing for specific social inclusion interventions, and to include the costs, as well as the benefits, of the technology. For example, the costs of setting up, monitoring and maintaining the system, including processing huge volumes of data.

Pedestrian detection systems and wider issues

1. Communication with other road users (vehicle to human communication)

A self-driving vehicle would need to have an inclusive design that considers people's different capabilities for consuming information. It would also need to be clearly marked to other road users that this vehicle is self-driving.

It is also important that other road users, such as pedestrians and cyclists, who will share the road with AVs, are engaged from the beginning with manufacturers and others in the discussion before the design stage is initiated.

2. Institutional biases

There are concerns about institutional biases of data/algorithm-driven systems, eg if an algorithm is trained only on evidence from male subjects. When in the process of design and development are these issues considered? This implies there should be some "anticipatory reflection" early in the design process, or even before design commences, without it being over-burdensome.

3. Definition of a self-driving car

A more general point, relating to the deployment of AVs overall, emerged from our discussion at the Policy Lab: does the SAE classification help or hinder? The SAE classification is very useful, but it perhaps implies that each stage is "additive", gradually building to a top-level (Level 5), whereas this is not the case in practice. Rather than beginning with the SAE hierarchy, it could be better to start from the question: *how is control and supervision allocated between the technology and the individual?*

From a legal perspective, a vehicle is self-driving, or it is not. In its ALKS proposals, the government does not refer to different levels of automation based on the SAE classification. Vehicles with ALKS will be considered self-driving when the system is engaged. This distinction is important from a legal perspective – to not shift the blame on a driver when ALKS is in use, and they are not responsible for the driving task. However, it can add more confusion to the end-users, as they would need to remain alert and be ready to resume driving when they are prompted.

There appears to be an important regulatory issue regarding the links between the definition of self-driving, public understanding, marketing and safety. In the UK, the government on 19 August (after our Policy Lab) published a policy paper on realising the benefits of self-driving vehicles, including consulting on a new safety ambition for self-driving vehicles. This followed recommendations from the Law Commissions including "writing the test for self-driving into law, with a 'bright line' distinguishing it from driver support features, a transparent process for setting a safety standard, and new offences to prevent misleading marketing."

4. Transnational data sharing

AVs are being designed in different countries, such as China, India, Germany and the Middle East, with a "standard" user in mind. This might be someone of a certain skin tone or facial complexion, or who wears distinctive clothing, and as such, each approach can introduce data and person-recognition bias. However, if data were pooled across different countries into a single programme, the software would be more broadly based and hence capable of detecting drivers and pedestrians from a diverse range of backgrounds, nationalities and ethnicities.

The pooling of such data would require strong economic and regulatory incentives at a governmental level. The UK government could look to introduce a regulation that makes transnational data sharing mandatory for cars made overseas to be sold in the UK. They could also offer to lift certain tariff barriers if car manufacturers were compliant in this data sharing.

However, considering the current geopolitical environment, we recognise that this proposition would need to be carefully considered. For example, this could lead to the UK government creating a strategic dependency on certain states with which the UK's overall aims may be in conflict. There are also ethical concerns with creating products for export to countries with different legal and civil liberties frameworks.

5. Regulations to cover all pedestrians

Pedestrians vary significantly in appearance, behaviour and capability. For example, older people may walk slower than younger people; people in wheelchairs are at a lower position of height to most adults who walk upright; and people wear varying clothing styles that are sometimes dark or light, or tight or loose.

Understanding what counts as a pedestrian is critical for detecting pedestrians. Government regulation should require that AV developers take a broad and inclusive view into who a pedestrian is, involve those pedestrians in the design process, and cater for them in the production of AVs.

6.Updating with changes to the built environment
As the built environment changes, AVs need to be updated so that they can accurately detect what is around them. This includes changes such as pedestrianised roads with dropped curbs and changing legislation around the permissible behaviour of cyclists when on the road.

Conclusions

Every technological innovation should be good for the public. This itself is a difficult task, as technology is not neutral; it is built *by* people – who impose their own biases – and *for* people – who end up using technology in different, sometimes unintended ways. To help partially to meet this aim, participants in this Policy Lab looked at possible social exclusion issues when building features of AVs with autonomous systems, and questioned decisions at every stage of the innovative process.

The overarching aim of this Policy Lab was to critically evaluate the proposed technological solutions that are currently under development or being tested and researched using the Project Lifecycle framework. This framework encouraged participants to critically reflect and deliberate across every stage of the product development.

This approach itself is a change in thinking as it questions decisions made at each stage when building new products and helps to challenge assumptions that might impact society. It also prompts us to think if some technological solutions should be implemented in the first place. So, rather than asking a question such as: what are the possible issues associated with having AVs on British roads? We can ask: why should we have AVs on British roads? Who will benefit from them and who will not? What are the potential social exclusion risks when implementing technological features of AVs (eg pedestrian detection systems or in-cabin monitoring)?

Groups that worked particularly on case studies concerning vehicles with ALKS – transition demand and in-cabin monitoring – both concluded that different levels of automation might not bring benefits to all members of society, and perhaps vehicles which drive themselves in all circumstances will bring most possible positive outcomes for all members of society (assuming they are implemented correctly). The government needs to carefully consider who is driving current developments, what are the motivations behind them, and what the end environment should look like.

In light of current regulation, vehicles with ALKS are considered as self-driving (when the ALKS system is enabled), but a person behind the wheel still needs to take over the driving task in certain situations, and currently vehicles will only be able to operate in ALKS-mode at relatively low speed and on motorways. ALKS-enabled vehicles do not meet the SAE definition of being fully autonomous and are not “self-driving” in that sense. These requirements limit the benefits to the public – eg people living in rural areas or disabled people.

Focusing specifically on developing technological features within AVs, participants identified social exclusion risks such as data bias when developing cameras, sensors to detect pedestrians, or even challenged some approaches such as in-cabin monitoring, which was more considered as an invasive approach.

The UK government takes a proactive approach toward the regulation of autonomous vehicles to foster innovation. This can be seen, among other things, through approving vehicles with ALKS. Nonetheless, it is not very apparent where the government’s Inclusive Transport Strategy sits within the context of future transport and current developments. This suggests the importance of more Policy Lab events focused on social inclusion and exclusion issues with regard to AVs. These could take up a single issue – perhaps one identified through our key points – that is closer to the point of legislation and policy.

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