Connected and Autonomous Vehicles. Chapter 4, Alignment with concurrent policy agendas promoting liveability

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4. Alignment with concurrent policy agendas promoting liveability

4.1. Introduction

The previous chapter considered some of the key challenges faced in accommodating CAVs within the built environment. These challenges are issues that remain uncertain, yet present fundamental questions around how the physical environment may be impacted by the widespread uptake of more highly automated vehicles.

At the same time as policymakers are, or may be beginning, to consider what impact the arrival of CAVs might have on their cities and regions, they are also grappling with a range of other policy agendas. Several of these are intertwined with the arrival of CAVs and the challenges they may pose, and therefore must be part of this dialogue. These include issues such as ensuing residents feel safe, protecting the environment, providing access to good jobs and services, and promoting a healthy population.

The consensus across the interviews we conducted with industry experts was that the increased presence of CAVs, and in particular the arrival of highly automated vehicles, *could* be highly complementary to these concurrent policy agendas, rather than competing. However, this was often caveated with the point that this is dependent on our ability to detach ourselves from car dependencies and promote more shared use of vehicles. This was summarised by one interviewee:

> *I don't think they necessarily do compete, but they do compete if you think about an autonomous vehicle being a car. Most of the evolution of them is towards you know, pods that you stand in for a while and…you can actually get in and out of them and then go off and do something else.*

In this chapter, we examine the next three of the overarching Policy Expo questions. These are:

- What problems might arise, and will there be 'winners and losers' – if so, who and in what ways?
- How will different policy agendas – across geographic scales or policy domains – align or conflict as the urban environment begins to accommodate CAVs?
- Will policies promoting or accommodating CAVs help or hinder other urban agendas including but not limited to active travel, zero carbon, health and wellbeing, social and economic inclusion, and liveability?

4.2. Towards liveable cities

The agendas outlined above can be grouped around efforts to enhance the liveability of cities. A liveable city understood as one that has high quality public/green spaces and built form, has a transport system that allows travel by variety of means (including walkable neighbourhoods), is safe, respects nature, provides good opportunities for employment, affordable housing, and protects the health of the environment[1].

Our interviews explored how CAVs might interact with the idea of liveability of cities and regions. One academic painted a detailed picture of two possible scenarios in this regard and how these are shaped by policy interventions:

> *…it really depends on the policies that are put in place for these vehicles because in the interviews we did what came out very starkly was there were some people who said this is a great opportunity for increasing liveability in cities, we can re-shape the use of roadways space, vehicles don't need to be parked, vehicles can be spaced more closely, we could create the downtown or areas where only shared automated vehicles are allowed and so we can re-shape the environment with local regulations and therefore it's going to be a net benefit for everyone because we're leading with liveability, we think about pedestrians, bicyclists, outdoor eating, public spaces, et cetera and there's going to be a new urban age around these vehicles. This is the one extreme.*

The risk is that CAVs perpetuate urban policies that revolve around automobility and produce the negative impacts that are well understood[2]. The same interviewee highlights this by presenting this alternative scenario:

> *…the other extreme are the people who say, yes, we have to get the pedestrians and cyclists out of the way, they're going to interfere with automated vehicles, I remember an engineer saying well you cannot program one of these vehicles that they yield to pedestrians because pedestrians will cross anywhere and they will hinder traffic flow so what we'll have to do is we have to put up fences, we have to put – go back to the Nineteen Fifties or Nineteen Sixties, we have to put in tunnels or bridges, we have to separate the modes to ensure the traffic flow.*

As the interviewee summarises, "who gains from it will depend on the local regulations and how these vehicles are regulated". This clearly has significant implications on liveability in cities but also interacts with a range of different policy areas being grappled with.

The remainder of this chapter is structured around several important policy agendas, and we discuss how CAVs interact with these. We draw on the existing academic and policy evidence along with insights gained through our expert interviews. The policy areas considered include:

- Promoting safe urban environments
- Accessibility and equity
- Employment and the economy
- Energy and the environment
- Healthy populations

4.3. Promoting safe urban environments

The World Health Organisation (WHO) estimates that approximately 1.3 million people die each year because of road traffic collisions, and over half of these deaths are vulnerable road users such as pedestrians, cyclists, and motorcyclists[3]. Many of these deaths occur in low- or middle-income countries where road infrastructure is less developed. In higher-income countries, deaths are lower but still represent a priority area for policymakers. In the UK, for example, there are on average five road deaths each day[4]. The annual UK figures include car users making up 42 per cent and a combined 34 per cent being pedestrians and cyclists. Per passenger mile travelled, pedestrians and cyclists are by far the most vulnerable users (alongside motorcyclists).

Efforts to increase safety on roads is being pursued in part through technological innovation. As was outlined in Chapter 1, the European Union has recently introduced legal requirements for minimum car safety features as standard in new vehicles. Other efforts include seeking behavioural changes that can create safer environments for road users. For example, the recent changes to the UK Highway Code[5], which has created a 'Hierarchy of Road Users', placing the most vulnerable users at the top of this hierarchy. The changes have also introduced a range of further measures designed to protect the most vulnerable on the road.

CAVs: A road safety paradox?

One of the key benefits that CAVs, and particularly AVs, might bring relate to potential dramatic improvements in road safety. This is argued because, rather than relying on humans to control the vehicle – and humans make errors – CAVs benefit from computerised systems and AI to control the vehicle. This is an argument frequently used by proponents of CAVs and there is evidence to support this. Optimistic estimates argue that 90 per cent of crashes are linked to human error and could therefore be prevented by more highly autonomous vehicles[6,7]. Less optimistic estimates still suggest that potentially 34 per cent of crashes might be avoided[8]. On the surface, therefore, there seem to be promising signs that CAVs may indeed align very well with the need to promote safe urban environments.

However, the other side to this recognises that an increase in vehicle miles due to CAVs might offset any benefits seen in road safety. It is argued that the increased presence of CAVs might lead to increases in vehicle miles travelled. This may result from increased urban sprawl or that it becomes more appealing to travel longer distances with less strain on the driver as the vehicle takes on more driving tasks. In this case, the safety benefits gained through automation may be lost by more exposure to risk through the increased levels of traffic. Modelling has also demonstrated that key benefits of CAVs such as reduced collisions and increased throughput can vary according to highway geometry, the ratio of autonomous to human-controlled vehicles, and to the manner in which vehicle algorithms form 'platoons' and the headway between them.[9] In real world, rather than laboratory, conditions, such factors will vary so widely that the precise safety outcomes of CAVs may be very difficult to predict.

Ironies of automation

At present, vehicles, even new ones, are still dependent on human drivers to be in control of the vehicle and this is likely to be the case for several more years. Even then, some argue that full, 'Level 5' automation may never be reached. This means that it is likely that for a long time to come, drivers will have a role to play. Ian Noy and colleagues[10] explored 'safety blind spots' in AVs and identified what they have termed the 'Ironies of automation'. These 'ironies' relate to a view that increasing automation may actually place more demands on drivers and lead to more dangerous outcomes for road users. This is partly based on the following arguments:

- AVs will initially take the easier driving tasks leaving humans with only the most challenging to deal with.
- It will lead to a 'deskilling', for example through lack of driving practice, and subsequent reductions in driving skills and reaction times.
- Less demand for cognitive engagement in driving will lead to lower levels of situational awareness and longer reaction times.
- Less time spent driving and less familiarity with driving the vehicle can lead to poor responses when the human does ultimately have to engage in those more challenging situations.

These 'ironies' are particularly important given the long transitional period over which CAVs will be introduced into the road network. Over many years, drivers, passengers, and other road users may be faced with ever more complex interactions with uncertain outcomes.

Overestimating the abilities of CAVs

In addition to these 'ironies of automation' there are further complexities that will continue to challenge the ability of policymakers to ensure a safe environment for their residents. One of these is an overestimation of the abilities of CAVs. This over-confidence in CAV abilities can be seen – it is argued – in both drivers, passengers and other road users, specifically pedestrians. It remains early to draw concrete conclusions as to the extent to which the abilities of CAVs might be (over)estimated, indeed it depends on the true extent of the abilities (or SAE Levels) that CAVs ultimately achieve.

Some research has explored this. Work by Lynn Hulse and colleagues[11] in the UK, US, and Australia showed differences in estimation of risk by gender. Specifically, that males were more likely to regard AVs as less risky, although with males more likely to engage in riskier behaviours in the first place this was unsurprising. It has also been suggested [12] that pedestrians may "behave with impunity" with regards their interactions with more highly automated vehicles (for example, in crossing roads). This is because of a belief that AVs will be "risk averse" and pedestrians will feel more able to simply step out in front of the vehicles and trust it to stop.

Overestimating the abilities of CAVs is embedded in the extent to which you trust them. Using a CAV at higher levels of automation (i.e., Levels 3-5) involves a handing over of control. Whilst ever the technology is nascent, this is likely to be perceived by many as placing themselves in a vulnerable position. In contrast, there are some that may overestimate the abilities of more highly automated vehicles, and this can equally damage trust amongst users when things go wrong.

Research conducted on CAVs has shown that trust is one of the major determinants of intention to use the vehicles[13]. This research has also shown that the following three elements are strongly linked to trust in the use of AVs:

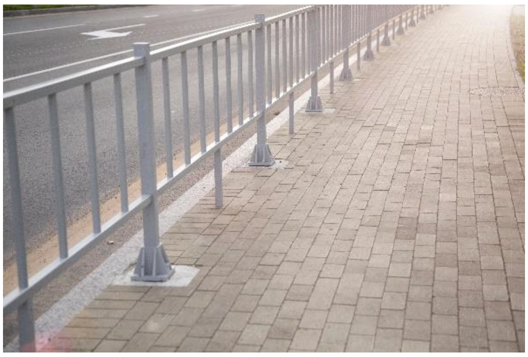
- **System transparency**: The AV acts consistently, and its future behaviour can be predicted.
- **Technical competence**: That AVs are free of making errors, are reliable, and perform consistently under different circumstances.
- **Situation management**: That AVs can provide alternative solutions and effectively respond in situations.

Segregation of road-space and users

Much of the uncertainty around the safety of CAVs and whether they, and other road users, can safely coexist alongside one another has raised questions around the future allocation of road-space. Specifically, the question of whether dedicated CAV lanes should be created in cities[14] or whether physical barriers might be erected to separate pedestrians and other vulnerable users from the road[12].

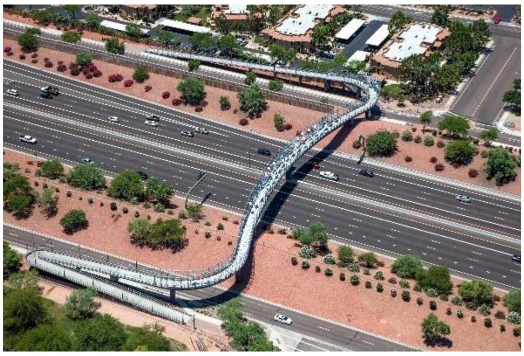
Segregation of road users is not new and is characteristic of street design of the mid-20th century, as the private car became the dominant mode of travel, with vehicles travelling at higher speeds and demanding more space. Some segregation can be prohibitive, for example, forcing pedestrians to take circuitous routes to destinations. However, there are calls for additional segregation in certain circumstances. For example, the segregation of cyclists from vehicles (and pedestrians), particularly on busy roads where vehicles travel at high speeds. These debates are central in the discourse around efforts to increase levels of cycling and evidence suggests that appropriate infrastructure can increase levels of active travel such as cycling[15].

Figure 4.1: Segregation of road users



Physical barriers to separate users seeks to reduce conflict between cars and pedestrians/cyclists but can diminish the built environment and make it more challenging to navigate.

Image source: LariBat/Shutterstock.com



Space can often be squeezed from pedestrians in favour of motor vehicles.

Image source: Tim Roberts Photography/Shutterstock.com

There is some emerging evidence to suggest that people might also prefer segregated facilities in the presence of more highly automated vehicles due to a lack of trust in the vehicles[16], although the study authors also suggest that more awareness of the abilities of CAVs will likely ultimately reduce this desire somewhat.

The desire for more segregation is potentially problematic as – implemented poorly – such segregation can be divisive and create barriers to more active ways of travelling, specifically walking. Indeed, attention has been paid to how barriers might be removed whilst still creating safer environments, for example removing physical barriers, signs, road markings, and even kerbs. The logic of these efforts is that it forces greater awareness of, and between, other road users, particularly those in motorised vehicles and helps to reduce traffic speeds[17] and make the environment safer.

The question mark over the infallibility of CAVs, particularly at the higher levels of automation might ultimately lead to barriers being put in place rather than removed, and potentially making roads more hostile to the most vulnerable road users. This will be one of the more challenging problems for policymakers to tackle.

4.4. Accessibility and equity

A critical challenge of policymakers is to address issues of accessibility and inequities amongst their populations. This is an existing problem within transport policy and the arrival of CAVs adds complex dynamics to the debate.

Increasing access for those with mobility constraints

On one hand, increasingly autonomous vehicles offer those with limited mobility, such as people with physical disabilities or elderly populations, with increased access to services and opportunities. This is something that has been examined by researchers, with the potential for benefits clearly highlighted. For instance, Faber and van Lierop[18] explored intentions of older adults in the Netherlands to use more highly automated vehicles. The Netherlands is currently second in the KPMG readiness index. This study showed there was a strong preference for on-demand, shared AVs, which emphasises the role that such vehicles might have in providing responsive - and sociable – travel options for such individuals.

It is important to recognise that needs – and engagement with CAVs – will vary across different age groups and circumstances. A good example of this is from research by Li and colleagues[19], which showed that older people (aged 60+) should not be considered as one homogenous group. Their work showed that those aged 70+ were less stable and slower in their takeover of Level 3 CAVs compared to the 60-69 aged group. Further, whilst benefits to those with mobility issues are recognised, it has been argued that these users need to have a voice in the debate around CAVs, particularly to help shape issue around design, testing and development so that such users do indeed benefit rather than risk being left behind[20].

Exacerbating inequalities

Whilst CAVs offer potentially important solutions to issues of accessibility and barriers for some residents, there is another side to this that should be considered. This relates to equity and issues of transport poverty.

In terms of access to private transport, it is recognised that this can be uneven, with those on low-incomes less likely to be able to afford it. Transport planning and the systems they produce - across different countries – can, to varying degrees create environments that mean significant portions of the populations struggle to access service due to transport poverty. High costs of car ownership and public transport, coupled with hostile environments for active travel can lead to many households becoming isolated. In addition, in the face of lower skill and lower paid jobs increasingly being located on the edge of cities (as highlighted in work by Richard Crisp and colleagues[21]), more deprived households can be forced into unaffordable car ownership due to the poor alternative transport options. Amongst these trends, Bissell and colleagues[22] argue that for CAVs, this might be no different: "just like previous mobility systems, access to [CAVs] is likely to be unevenly distributed across classed and racial lines".

Bissel and colleagues argue that some automated transport systems may emerge as multi-tiered with regards to the services offered. This could be realised through more exclusive and costly AV services that can travel further, faster, more flexibly, and more comfortably. Even at basic levels of service, the costs may be out of reach for a significant proportion of the population for many years, further exacerbating inequalities in transport.

An argument in favour of CAVs is that they will help to resolve the problem of vehicles using premium space within a city to sit unused whilst their passengers do not need them. It is suggested that they will be able to park outside of these areas where space is a premium (such as the city centre) and return when required to collect their passenger. This is potentially problematic depending on where they end up parking during these gaps. Fábio Duerte and Carlo Ratti discussed this, stating “AVs could move back home or to cheaper parking areas designated by the city as less impactful to the overall traffic”. This raises the question as to what is deemed ‘less impactful’ and who decides this. The concern being that in more deprived areas (which are often located just outside the city centre) are subjected to high numbers of CAVs navigating their neighbourhoods seeking space to park with residents having little or no say in this.

The burden of responsibility

A further factor relating to issues of equity relates to where the burden of responsibility over safety falls. Whilst all road users have a responsibility towards others, it is increasingly the case that hierarchies of road users are explicitly stated with those using modes of transport that have the potential to be most harmful (e.g., Heavy Goods Vehicles or cars) having more responsibility for those more vulnerable (such as pedestrians and cyclists). For CAVs, the identification of pedestrians, and particularly cyclists remain a challenge technologically. One solution, which has been highlighted through recent legislative developments in the US have laid the ground for the potential introduction of ‘beacons’ to protect the most vulnerable road users.

This solution involves utilising technology already inbuilt into smartphones, or sensors that could be incorporated into bicycles or worn on the clothing of pedestrians that communicate with CAVs to alert them to the presence of these other road users[23]. This places the onus onto pedestrians and cyclists to protect themselves, which is potentially problematic, particularly as awareness of such measures might make drivers more complacent and less attentive to what is in front of them on the road. As is highlighted by Carlton Reid in the reporting of these developments[23], there are important questions around equity, for instance, what if a person doesn’t have access to a mobile phone or ‘beacon’; does this place them at additional risk?

Siri Hegna Berge led some work in this area[24], specifically focused on cyclists. This found some hesitancy amongst cyclists for the potential use of ‘on-bike human-machine interfaces’ or beacons. Partly, this was driven by a view that the AV technology should be sufficiently advanced to reliably identify such users without the need for beacons before it is deployed on a large scale in traffic. The consensus from participants in this study was that the “primary responsibility of safety lies with the AV”. Additionally, this research reiterated the concerns raised by Carlon Reid. Specifically, that such requirements might create barriers to cycling, and make it less accessible.

4.5. Employment and the economy

CAVs could potentially have a significant impact on employment and the wider economy. One key area of impact would be on the occupations that are likely to be replaced, or significantly impacted by an increasing presence of CAVs. These are roles that are directly associated with the operation of vehicles, for example, freight, buses, and private hire vehicles (taxis). Such roles could be significantly threatened by the increasing role of automation and the significant financial savings to businesses achieved by removing labour costs[25]. This is in addition to the jobs across the economy that might be impact by increasing levels of automation in processes. Whilst new jobs would be created supporting the expanding CAV industry, these would not necessarily be a direct replacement for existing workers, many of whom may not have the requisite skills[26].

Alongside the impacts on those in 'at risk' occupations, CAVs are also likely to have implications for the spatial distribution of labour and jobs. This could include employment opportunities moving to locations where land is cheaper outside of the city centre thereby forcing workers into longer and more costly journeys. There is also the likelihood that automation might lead to jobs being able to fulfilled in different locations to where the technology is operating, again shifting the employment landscape[27].

4.6. Energy and the environment

Tackling energy use and reducing environmental impact is a vitally important policy area for cities and regions, particularly as efforts to deliver on net zero commitments accelerate. This is interrelated with other issues considered in this chapter, such as resident safety, liveability, and health.

One of the key arguments in favour of CAVs from an environmental perspective are the benefits they can deliver compared to human-driven vehicles. CAVs – it is argued – will drive more efficiently than a human driver could, thereby reducing fuel use. In the shorter term whilst vehicles are still reliant on internal combustion engines this is likely to hold true, particularly whilst there are opportunities for some lower-level vehicle automation that can deliver these fuel efficiencies. For example, Bidoura Khondakar and Lina Kattan[28] showed that variable speed limit controls on vehicles could deliver fuel savings of up to 16 per cent, with other studies proposing systems that might deliver even greater savings through optimisations[29].

The longer-term looks less certain from this perspective. Whilst automation may continue to deliver driver efficiencies, these benefits could be negated by the transition to battery electric vehicles, which is continuing at pace. Many existing, and low-level CAVs are still reliant on petrol/diesel or hybrid engines. As newer models of CAV are developed, particularly within the private consumer market, it is inevitable that these will be dominated by EVs. Such efforts to replace petrol and diesel vehicles with electric (or hydrogen) vehicles will remove tail-pipe emissions and - if the electricity or hydrogen is generated renewably – reduce consumption of fossil fuels.

An area where benefits could be significant would be where shared mobility is adopted, particularly where this is coupled with vehicle electrification[30]. Shared mobility reduces the number of vehicles required and subsequently reduces resource demands for the production and maintenance of such vehicles. Research by Fagnant and Kockelman[31] concluded that – in a context where shared AVs made up just 3.5 per cent of trips - one shared AV could replace approximately 12 privately owned vehicles. This emphasises the significant potential value of a shared ownership model.

4.7. Healthy populations

The need to reduce sedentary behaviours and improve the health of the population is a key challenge being grappled with at both national and local government levels. Active travel modes, which includes walking, cycling and other forms of active mobility, often are cited as ways to effectively deliver improvements in health whilst also alleviating other social (e.g., exclusion), environmental (e.g., pollution), and economic (e.g., congestion) challenges facing cities. The evidence is clear that the positive health benefits of increasing active travel far outweigh any negatives (e.g., risk from other road users or exposure to pollution)[32].

The impact of CAVs on population health is dependent on the extent of the uptake of them and in the specific types of vehicles where it happens. If private passenger services are the growth area, then CAVs will only serve to reinforce the sedentary behaviours that are so problematic at present. Evidence has highlighted how increasing vehicle miles travelled through CAVs would likely lead to a decrease in active and public transport use[33]. If the growth of CAVs leans more towards shared or public transport, then the picture might look quite different.

The extent to which investments to enable a smoother integration of CAVs might be sought at the expense of investments in other modes is also potentially problematic. If investments that seek to support healthy populations, such as active travel infrastructure, decline in order to facilitate CAVs, then this could be damaging for efforts to increase for population health. One interviewee, an advocate for more liveable urban environments summarised it as:

> *Increased deployment of CAVs would have implications on infrastructure and you'd have to make infrastructure changes as a result. Does that then come at the expense of the welcome increase in cycle infrastructure, the improvements to walking infrastructure that we've seen. So I think there is a risk that government accelerates the development of autonomous vehicles without full consideration of the potential for…unintended side effects. And even the potential for increased congestion…if you have that kind of world where…loads and loads of people making point to point journeys [by CAVs] that they would in the past have walked or cycled.*

4.8. Summary

In this chapter we have shed light on how CAVs could impact on other important agendas being pursued by local policymakers to help enhance the liveability of cities. Whilst CAVs are argued to present opportunities to improve safety, increase accessibility, reduce emissions, and create new opportunities for work, they also pose risks to these agendas, and this has been demonstrated in the literature and through our interviews. Much of this relates to the extended transitional period over which CAVs might be deployed. There is a risk for conflict between road users during this period, and decisions made in the short-term might lead to path dependencies that problematise pursuit of these concurrent agendas in the future.

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