Opportunities for Sustainable Urbanism from the Rise of Autonomous Vehicles

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Abstract

The rise of autonomous vehicles at a time of rapid technological and societal changes, population growth, and pressured natural resources presents exciting opportunities for sustainable urbanism.

Autonomous vehicle technology is advancing quickly, with trials already underway in various Australian cities and international locations. Experts agree that the positive transport safety and environmental benefits of autonomous vehicles will drive their implementation and transform our current notion of transportation. The way people choose to travel and live in our cities will likely change, as will accessibility to employment and other daily essential services. The unprecedented availability of data to transport-users and authorities, as well as advanced transport analytics is likely to result in the growth of personalised transport offerings such as “Mobility as a Service” and “Demand Responsive Transport”. The rise of autonomous vehicles and digitisation in our transport systems could ultimately lead to reduced car ownership, changed land use patterns and greater connectivity which presents valuable opportunities for sustainable urbanism in Australian cities.

Sustainable urbanism refers to urban landscapes that are designed and managed for positive health outcomes, preservation of biodiversity, materials efficiency, and reduction of harmful emissions. This paper seeks to identify opportunities for sustainable urbanism through the implementation of automated vehicles via a literature review. Based on the literature and the authors' industry-based experiences, this paper argues for a model of operation, planning and design for the rise of autonomous vehicles, which would facilitate sustainable urban environments for Australian communities.

Introduction

Transport, mobility and a thriving natural environment within cities are intrinsically linked to economic prosperity and quality of life. A good quality transport system is one that is efficient, reliable, equitable, minimises traffic congestion, safe and capable of sustaining a city and its future generations. The transport system provides communities with access to the essential services we need daily to survive: food, shelter, healthcare, employment, education and security. Our mobility enables face-to-face interactions that are not only important for social cohesion and economic productivity, but also vital to create the connections that lead to new ideas, new businesses, more advanced knowledge and ultimately economic growth. The natural environment in urban areas is made up of ecological systems which underpin our local economy, health and well-being through provisioning, cultural, regulating and supporting services (Natural Resource Management Ministerial Council, 2010). For example, the natural environment in cities cleans the air, purifies local waterways, disperses seeds and pollen and provides stress relief and recreation.

Global urbanisation is expanding rapidly, causing severe environmental degradation undermining the productivity, accessibility and liveability of our cities (Sushinsky et al., 2013; Goddard et al., 2010). Sustainable urbanism seeks to address this, stemming from the concept of sustainable development most famously defined in the Brundtland Report of 1987 as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. Since the Brundtland Report, Australian society has changed. Our social and economic activities occur faster and more frequently than ever before and are becoming increasingly decentralised as technology offers us increased flexibility and mobility. To address current sustainability challenges, we require a broader definition of sustainable urbanism.

Stossel et al. (2015) use an ecological economics perspective to define a sustainable city as one that has good environmental quality within its boundaries; does not harm the environmental quality and climate elsewhere outside the city boundaries and operates within the limits of ecosystems (Stossel et al., 2015). For the purpose of this paper, we define sustainable urbanism as urban landscapes that are designed and managed for positive health outcomes, preservation of biodiversity, materials efficiency and reduction of harmful emissions. Under this broad definition, issues such as walkability, biophilia (the essential relationship between people and nature), environmental conservation, urban sprawl and climate change mitigation can be addressed.

There is a general consensus among experts that connected autonomous vehicles (CAVs) will be implemented across urban landscapes in the future, altering the way we use our transport infrastructure and transforming our current notion of transportation. The way in which this will occur is still up for debate as there are many different models of implementation including how roads will be modified to accommodate CAVs, how CAVs will be owned and shared, how CAVs will communicate with each other and infrastructure, how CAVs will interface with public transport (PT), and what kind of policy framework would enable the implementation of CAVs. Careful consideration of these issues is critically important as there is the potential for the rise of the automated vehicles to exacerbate current urban sustainability problems and undermine public infrastructure. This paper explores current urban sustainability challenges and proposes a model of CAV implementation which would facilitate sustainable urban environments for Australian communities.

Sustainability Challenges in Urban Landscapes

Urban landscapes in Australia are facing significant sustainability challenges. There is a drastic loss of biodiversity, increasing consumption of materials, increasing emissions and waste production, and a lost connection to nature. These problems are largely caused by the rapidly increasing urban population resulting in both increased densification and urban sprawl, associated infrastructure development to support the population, and the heavy use of petrol and diesel fuelled vehicles. Urban landscapes are also facing the effects of climate change which is creating unprecedented weather patterns (Roggema, 2017).

Over 50% of the world's population currently reside in urban areas (Ambrey & Fleming, 2014). In Australia, 67% of people live in a capital city and populations in our cities and surrounding urban areas are rapidly increasing (Australian Bureau of Statistics, 2017; Roggema, 2017). Up to 89% of the Australian population reside in towns and cities overall (Ambrey & Fleming, 2014). The increasing population requires either an increase in the urban footprint of a city resulting in urban sprawl or an increase densification to accommodate a larger number of people in the existing footprint. The Australia State of the Environment 2016 report reflects this with data showing that population growth tends to be most concentrated in outer suburbs, inner cities, some urban infill areas and along the coast, therefore, both densification and urban sprawl are occurring in Australia (Commonwealth of Australia, 2016).

Increased densification of urban landscapes can create road congestion due to the use of single occupant privately owned vehicles travelling to business centres which can erode mobility within cities (Viegas et al., 2016). In Australia, private road vehicles currently account for 87% per cent of the aggregate urban passenger task (Commonwealth of Australia, 2016). Higher density dwellings and the traffic infrastructure to service them are often constructed at the expense of urban green space. Ambrey and Fleming (2014) found that the value of green space increases with population density and is critical for wellbeing and life satisfaction in cities. Green space in urban landscapes is also critical for many native Australian species. Densification can also result in increased noise and social problems such as concentrated social disadvantage and undermined social cohesion (Ambrey & Fleming, 2014).

Similarly to densification, urban sprawl can lead to congestion on roads. In developing their report *Delivering Sustainable Urban Mobility (2015),* the Australian Council of Learned Academies found that the 'inner-regional' communities that surround Australian cities rely almost entirely on private cars for transport. The inner-regional community is a population of more than 4 million people, many of whom commute long distances to work in major employment hubs such as the inner city (Godfrey et al., 2015).

Growing urban footprints place pressure on existing infrastructure networks and services such as water distribution, waste removal, treatment and disposal and transport. Fringe developments on Greenfield sites are often distant from employment, with resulting long journey times, high transport costs, high infrastructure connection costs for taxpayers, and negative social and environmental consequences (Infrastructure Australia, 2016).

Furthermore, the continued expansion of Australia's cities through Greenfield development means that the outer suburbs of our cities are increasingly taking land away from farming and habitat for Australia's biodiversity (Commonwealth of Australia, 2016).

Many studies have shown that environmental challenges such as climate changes and species extinction negatively impact on mental health and wellbeing of people (Dean et al., 2011). As cities expand or become more dense in population and infrastructure urban biodiversity is reduced, green space is generally lost and any fragments of natural habitat are destroyed (Sadler et al., 2005; Sushinsky et al., 2013). This results in the community losing its exposure to biodiversity and connection to nature. The preservation and enhancement of green spaces is vital to reversing this trend but in urban landscapes where space is at a premium, this can be difficult.

Ideally, urban green spaces are diverse and include public parks, botanical gardens, private gardens, green walls, green roofs and importantly, natural habitat fragments such as bushland or wetlands (Sadler et al., 2005). Incorporating a variety of different types of green spaces enables a higher level of biodiversity to exist in urban landscapes. This in turn provides health, provisioning, cultural, regulating and supporting services. As climate change increases the frequency of extreme weather events, preserving natural wetlands can help to manage flooding and mangroves can maintain the integrity of river banks. Vegetation reduces the heat island effect which reduces the energy consumption of air conditioned buildings and reduces the risks associated with hot weather to human health (Revell & Anda, 2014; Roggema, 2016). Vegetation also regulates carbon dioxide in the atmosphere and airborne pollutants and mitigates local impacts of climate change. The presence of a variety of animal species in urban landscapes enriches our lives, inspires us and educates our children.

The Rise of Connected Autonomous Vehicles

The development of autonomous vehicles or driverless vehicles is starting to converge with connected vehicle technology. Connected vehicles communicate with each other and with the infrastructure surrounding them. There is a growing awareness that the two, connected and autonomous systems, will need to complement one another to create a viable self-driving car: the connected autonomous vehicle (Blogg et al., 2016).

Connected autonomous vehicles benefit the transport system as follows:

- Increase road safety by eliminating traffic crashes caused by human error (Fagnant & Kockelman, 2015). Most traffic crashes (80% to 95%) are caused by human error (Singh, 2015) so the potential road safety, social impact and economic improvements as a result of removing human error from traffic crashes is likely to be significant.
- Increase accessibility for people who are unable to drive themselves such as the young, elderly and mobility impaired (Fagnant & Kockelman, 2015).
- Reduce the cost of mobility, of both people and goods by reducing the cost of taxis and delivery services(Fagnant & Kockelman, 2015)

- Increase the utilisation of automobiles, and reduce the demand for off-street car parking (Litman, 2017)
- Increase the demand for short-stay “pick-up / drop-off” street parking
- Reduced freight costs (Fagnant & Kockelman, 2015)
- Connected autonomous vehicles will increase traffic capacities, since digital connectivity between vehicle-to-vehicle and also vehicle-to-infrastructure will allow vehicles to travel more closely together (Litman, 2017).
- Connected vehicles have the benefit of reduced emission and energy consumption (Li et al., 2015). For example, they may be powered with electricity instead of fossil fuels and when implemented under a shared CAV model can optimise trips, reducing overall kilometres travelled.

Around the world, connected vehicle technology and automated driving trials are ongoing. In Australia, there are a number of connected and / or autonomous vehicle trials underway (Intelligent Transport Systems Australia Incorporated, 2018) as outlined below.

- Eastlink Trials, Connected and autonomous vehicle technology trial, Melbourne, Victoria
- Intelligent Vehicle Trial, Connected and autonomous vehicle technology trial, Ipswich, Queensland
- Intelligent transport technology, Electric autonomous shuttle bus trial, Perth, Western Australia
- Congestion-busting trials, Intelligent transport system technology and Vehicle-to-Infrastructure messaging trial, Victoria
- Autonobus trial, Autonomous shuttle bus trial, Melbourne, Victoria
- Vehicle-to-Pedestrian (V2P) technology trial, Adelaide, South Australia
- Autonomous Passenger Vehicle Trial, autonomous shuttle bus trial, Darwin, Northern Territory

Please refer to *Appendix A – objectives and key learnings of Australian trials*.

Overall, each of the trials are isolated to a particular mode or contained link in the network. It will be some time before CAV technology has an impact across the entire transport network, research indicating that network-wide impact could be achieved as soon as 2030s with significant proportion (40%) of all vehicle travel being CAV by the 2040s (Litman, 2017). Trialling and testing of CAV technology is well underway and emerging at a rapid rate, and given the advantages of connected driverless vehicles, it is foreseeable that this emerging technology will be implemented in our urban cities. This presents us with a challenge to implement CAV in a way that benefits the greater public good and capitalises on opportunities for sustainable urban growth.

Future Urban Sustainability Challenges and Automated Vehicles

Driverless vehicle technology, if not implemented carefully, could result in negative environmental outcomes. Imagine a future scenario where automated vehicles replaced private passenger vehicles (private ownership model). Under a private ownership model longer commutes could become more acceptable to individuals resulting in urban sprawl and increased overall driving kilometres (Litman, 2017). Bansal et al. (2016) discuss the risk of urban sprawl being exacerbated by the rise of the automated vehicle due to the efficiency of the technology allowing people to work whilst travelling in cars encouraging individuals to shift their home locations to more remote locations, to enjoy lower land prices and bigger homes. This would exacerbate urban sprawl and increase a region’s vehicle-miles travelled (Bansal et al., 2016). The International Association of Public Transport address this issue stating that CAV must be shared, without a successful shared model, urban sprawl would be exacerbated and traffic congestion would increase as CAV would replace current privately owned cars but would be used even more extensively (UITP, 2017).

Under a private ownership structure there would be more overall system inefficiencies. For example there is likely to be empty running of vehicles or “dead-running” as CAV vehicles would not park at their destination but return home. This results in excess resource consumption, more travel and potentially increased congestion.

The implementation of CAV technology under private ownership models may result in lower levels of walkability relative to shared ownership model. Private ownership model exacerbates the sustainability challenges we face today, which is our “Car is King” culture of high dependency on private vehicle travel, public transport remains unattractive relative to private vehicle modes, high cost of funding new roads and road upgrades with the end users not paying the true cost of the entire road based trip; and congestion. The flow-on effects of high private vehicle dependency are air pollution, health and climate change. It is obvious that implementing a private ownership model of CAV would result in less than ideal urban outcomes.

There are also challenges for a shared CAV model. There is a risk that motorised transport could become so attractive that very short trips become increasingly common. The smaller trips are not only an inefficient use of motorised vehicles but could discourage walking. Another factor influence the uptake of shared mobility models that passengers must be prepared to spend some time with an unknown stranger in a relatively confined space (Krueger et al., 2016).

Implementation

CAV present us with opportunities to ameliorate many of the urban sustainability challenges we are currently facing in our cities, however, they need to be carefully integrated into urban landscapes if we are to capitalise on their benefits and avoid unintended negative consequences.

A review of published research and literature indicates that the key will be how CAV will change where people choose to live and work. There is debate on whether autonomous vehicles will ultimately complement or substitute existing modes (private versus public transport). The literature review of private ownership models for CAV implementation found many disadvantages as outlined above and few benefits (i.e. road safety benefits were applicable to both shared and private ownership models).

CAV technology instead could provide a cheaper vehicle technology to enable shared mobility (shared ownership model). The benefits of shared ownership model are reduced risk of urban sprawl, increased road safety and increase traffic carrying capacities however without transport policies to guide private sector investment, it may be difficult to implement CAV technology in a sustainable way that promotes public transport and positive outcomes for the greater good.

A key challenge for shared mobility implementation is governance. It is likely that CAV technology in the future will continue to be market led with private investment. To achieve urban sustainability outcomes, CAV technology will continue to require market led investment but it will have to be strategically led by government policy under a shared mobility ownership model. It must be realised that the greatest transport system benefit and greatest urban sustainability outcome will result from a shared mobility ownership model. Policy makers, city custodians and planners will need to consider how our transport strategy needs to change to ensure that this occurs.

Not only would private ownership models exacerbate the urban sustainability issues of today, but there are actually significant opportunities for improved urban sustainability under shared ownership. How shared ownership models may be implemented are still up for debate. The International Association of Public Transport (UITP, 2017) suggests that AV could replace public transport modes (mainly buses) or result in a new private/public hybrid option that could emerge to be a Mobility as a Service multi-modal trip service (incorporating shared autonomous vehicle (AV) technology and public transport modes in the same journey), refer Figure 1. The capacity and efficiency benefits are further enhanced if implementing a *connected* AV (CAV) model under the diversified system of AV and public transport suggested by UITP (2017). There are significant opportunities for walkability, increased urban biodiversity, increased active transport, increased multi-modal trips, decreased congestion, better car parking outcomes and more productive urban space, increased green spaces, reduced air pollution, improved mobility, improved social outcomes and even reduced road kill.

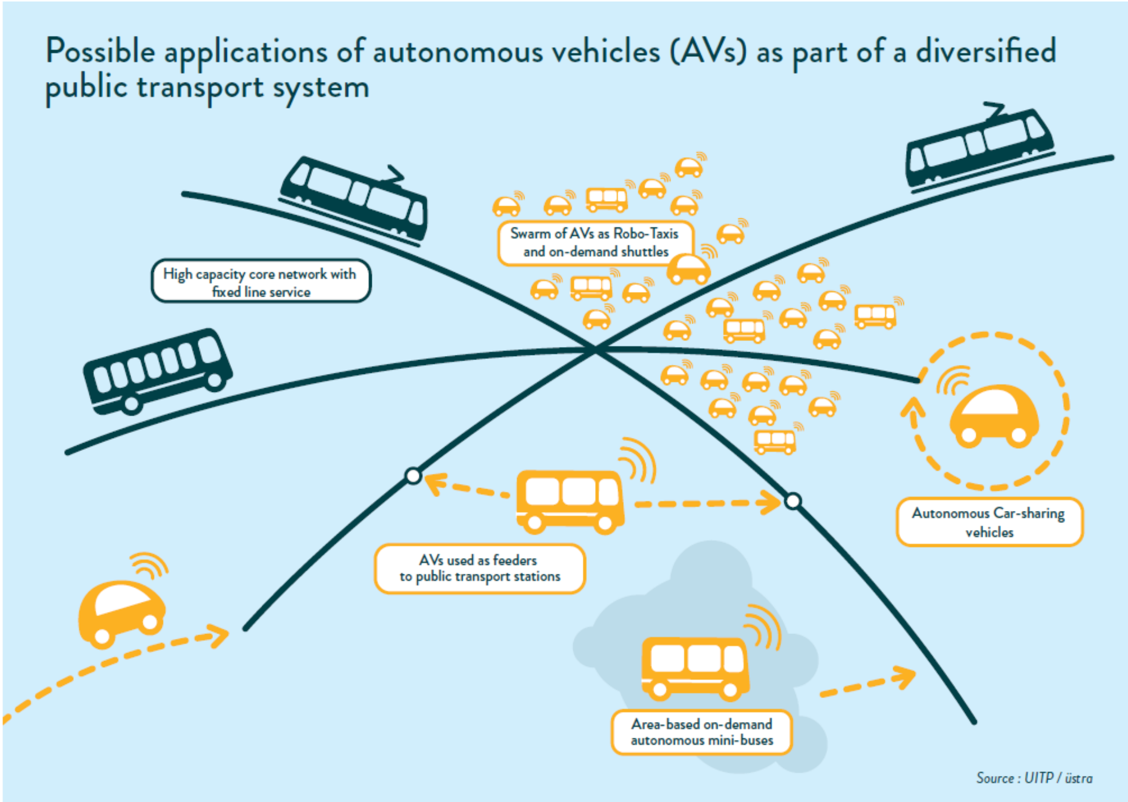

Figure 1 Connected and driverless vehicles have the potential to be integrated with public transport (UITP, 2017) and will be essential if we are to reduce private vehicle travel

Possibly the most significant impact to land use in a city as a result of CAV implementation could be car parking space. The spaces devoted to car parking today which are currently some of the least biodiverse urban spaces could be repurposed to allow for improved sustainable areas and more productive uses. This may include on-street and off-street car parking spaces that are either below ground, at surface level or above ground. Car parking spaces could be repurposed to include extended pedestrian zones, better quality active transport (pedestrian/cycle pathways) or more green space for recreation, to clean the air and to provide shade. Depending on the surrounding environment, car parking spaces could even be retrofitted with light infill active or public transport modes such as cycle-ways, travelators, monorail or light rail which could be applied to infill corridors to 'connect the dots' between destinations and move people quickly over a short to medium distance. There may even be opportunity to repurpose car parking spaces to provide low-priced office/small business spaces, shared co-working office space, artisan business spaces, community food trucks, community art or even the installation of shared community gardens which has the potential for improved social cohesion.

Improvements in transport data analytics also has the potential to provide optimised personalised transport connections to mass public transport nodes, providing very intelligent demand responsive transit solutions. Transport data analytics that works across modes, both public and private vehicles, has the potential to better harmonise supply and demand on the network to mitigate peak transit times and reduce the severity of congestion.

Setting the Foundations for Sustainable Urbanism & Implementation of CAV Technology

In the future urban challenges such as increased population, increased densification of our cities, as well as fiscal and resource constraints, will mean that it will be important to ensure that the transport strategy maximises sustainable modes that move the most number of people efficiently. Under the rise of autonomous vehicles there is an opportunity to rethink mobility, both in relation to the efficiency and sustainability outcomes.

The transport system in established world-class cities such as London, Paris and Beijing move people and goods most efficiently using either the public mass transit corridors or the matured motorway network. A mature motorway network is one that is orbital or radial in structure, connected to the road network using the ‘hub and spoke’ principle. This is one necessary foundation for efficient movement for people and goods and longer distance trips in a city. Another necessary foundation is public mass transit, such as urban rail, fast rail or subway systems. Mass transit efficiently moves people over large distances within a city and complements a mature motorway network.

Under the rise of autonomous vehicles there is potential to rethink the public transport network hierarchy – replace meandering low patronage bus routes with CAV. CAV be a bottom tier in a strategic public transport network, providing a feeder to more strategic high frequency highly patronised public transport services, mass transit being the highest level. Faster and more attractive public mass transit could then be at the highest level. There may also be potential to think more creatively about lower order streets and rethink the traditional road hierarchy – either repurposing or closing local roads which could enable walkability within the city and increase accessibility.

CAV has the potential to maximise the capacity of both a mature motorway network and increase throughput (patronage) public transit. The increase in capacity of the motorway network is due to the connectivity between vehicles that allows them to travel much closer together – the capacity benefits can be five to seven times existing highway capacities (Hussain et al., 2016). Whereas the capacity increase on urban arterials or streets is lower around 2-fold or 3-fold since vehicles in congested conditions already travel close together at stop-start conditions through intersections or in “interrupted traffic flow” conditions (Lioris et al., 2017). The International Association of Public Transport (UITP, 2017) explains that CAV under a shared mobility implementation scheme has the potential to increase public transport patronage and improve access to mass transit corridors, as outlined earlier. If cities cannot mature these two strategic transport networks, it will be difficult to implement CAV in a manner that capitalises on the capacity increases created by CAV. Cities that do not have mature motorway network or mature public mass transit will not benefit from the significant capacity increases that CAV will afford those cities with strategic transport networks already in place. It is the view of the authors that these two foundations, a strategic motorway network and a strategic public mass transit, are the two foundations for sustainable mobility with CAV.

Under a high proportion of CAV in the vehicle fleet, transport economics could be rethought. CAV will extend the infrastructure life of motorways and roads since their capacities will increase. Current road infrastructure will therefore have higher value. Australia spends on average $20Billion per year on new roads and road upgrades. Road users today do not pay this true travel cost, with governments subsidising the cost of new roads and road upgrades. A shared model could also provide an opportunity for a more financially sustainable funding model, with trips costed so that users pay the true travel cost. In the future, a proportion of transport infrastructure spending could redirected from roads towards faster and more attractive public transit, especially since there could be a shift from our “car is not king” attitude towards a culture where the public transport network (or multi-modal trips offered by mobility-as-a-service) would be the primary means of moving passengers.

The above relies on a robust policy framework that ensures that CAV operate in the best interests of the community. If private corporations are left to lead the implementation of CAV then there is a risk that this technology may be used to primary benefit profitability of shareholders through maximising distances travelled using CAV, and therefore, undermining the public transit network.

Summary of the Opportunities for Sustainable Urbanism

Opportunity 1: Repurpose some of the urban streets to biodiversity corridors. Re-plan highway/motorway planning to preserve green space.

Opportunity 2: To think creatively and not miss out on the opportunity to implement CAV in a way that increases walkability in our urban centres. There is an opportunity to redesign lower order streets or even repurpose lower order streets to allow pedestrian access only instead of vehicular access.

Opportunity 3: Rethink traffic rules and traffic priorities in cities. Consider swapping vehicle priority for pedestrian priority to encourage walking and cycling trips, and to also encourage multi-modal trips by prioritising walking at public transport stations for ferry, bus, light rail, train, subway etc.

Opportunity 4: Repurpose ‘park-and-ride’ nodes to be DRT / MaaS drop-off / pick-up areas that provide access to mass transit. There is an opportunity to redesign this access node to provide more green space, trees and shade and serve as major “biodiversity” nodes in the city.

Opportunity 5: Repurpose car park buildings that may be made redundant through the implementation of CAVs to support sustainable urbanism outcomes. For example, car park building or the land they are situated on could be replaced with residential buildings to increase densification of cities.

Opportunity 6: Fewer cars results in dematerialisation which in turn results in global emissions reductions. This is a significant efficiency improvement, McKinsey & Company (2018) found that currently most vehicles sit idle for around 90% of the time (McKinsey & Company, 2018). Fewer cars and more efficiency of trips resulting in reduced air pollution.

Opportunity 7: Use mobility-as-a-service models as a tool to empower transport users to make more sustainable travel choices. Provide users with the true carbon emission cost or environmental impact of each of their travel options to give users a more informed choice. Capitalise on the opportunity to cost travel where users pay a true actual cost of travel, with provision for appropriate and equitable travel for all users. Perhaps the transport economics of our current transport system could be rethought too, where users pay the true cost of their travel.

Opportunity 8: Improved mobility for people who previously were isolated – the old and the young. Results in better health outcomes through social cohesion, access to employment and access to services including health services. Education facilities

Opportunity 9: Improved health outcomes due to access transport - increased walkability in terms encouraging people to walk – prepared to walk up to 400 m considered walking distance

Opportunity 10: Reduced fauna road kill. A large proportion of road kill is a result of human factors including fatigue, speeding and distraction.

The above paper considers implementation of CAV and strategic transport in an Australian context which has high growth in urban centres with relatively low urban density. Regions where connectivity to regional coastal areas is common, and where population/employment growth projections show intensification of our urban centres into the future.

Further Research

This paper has identified several opportunities for sustainable urbanism from emerging connected autonomous vehicle technology. Quantifying the sustainability benefits and impact to Australian cities is the next step of our future research. There is also potential to examine how this emerging connected vehicle technology in our cities may be interfaced with regional centres.

Conclusion

The rise of autonomous vehicles is both a threat and a great opportunity. The threat is that implementation of this technology is not undertaken for the greater good, resulting in in poor outcomes.

Emerging autonomous vehicle technology presents an opportunity to reconsider urban challenges like high population, rapid urbanisation, economic growth, quality of life and liveability of our cities, biodiversity, the essential relationship between nature and people, urban sprawl, traffic congestion and social isolation. City engineers, planners and policy makers today have a unique opportunity in history to adopt transformative transport technologies in way that can maximise the efficiency of the transport system and best serve the public for generations to come.

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Appendix A – CAV technology trials and key outcomes

Trial	Description	Key Learnings / Outcomes
Eastlink Trials Connected and autonomous vehicle technology trial Melbourne, Victoria	Test of autonomous vehicle technologies (highway autopilot, partial automation of steering, acceleration and braking) along a privately-owned highway, Eastlink. The trial allows the operator of the freeway, Eastlink, to assess the envelope within which autonomous vehicles can safely operate on the highway network: which lanes, what times, which parts of the network. The testing is of a vehicle that steers itself in the lane (lane keeping assist) and adjusts speed via acceleration and braking to maintain a safe distance to other vehicles (adaptive cruise control) with onboard sensors to dynamically monitor other vehicles and road users. The trial also includes testing of autonomous overtaking, which when initiated by the driver, then sees the vehicle taking over to find a safe overtaking opportunity, autonomously implementing an overtaking manoeuvre with the indicator signals. The trial involved a range of manufacturers including BMW, Honda, Mazda, Mercedes, Mitsubishi, Tesla and Volvo.	Key learnings are related to the motorway infrastructure and traffic management: ▪ Line-markings need to be good quality (including reflectivity and luminosity) and contiguous on both sides of the freeway lane. ▪ In construction zones, yellow line markings are indistinguishable from the while lines and are incompatible with the lane keeping assist technology. ▪ Speed signs require consistency in style and consistency in placement away from the major carriageway road signage to enable more reliable interpretation by vehicles. ▪ Overhead speed signage and lane control signs (lane open or closed) are generally not read reliably by vehicles. **https://infrastructuremagazine.com.au/2017/08/24/eastlink-trials-automated-vehicle-technologies/**
Intelligent Vehicle Trial Connected and autonomous vehicle technology trial Ipswich, Queensland	A large-scale test to trial vehicles and infrastructure that can talk to one another as well as to test cooperative and highly-automated vehicles on public roads. Around 500 motorists will have their vehicles retrofitted with cooperative intelligent transport technology that can warn drivers on unforeseen operating conditions such as pedestrians, red light running or queues ahead that aren't visible to the driver. The testing is being conducted on a road network in the presence of major employers, an active CBD and a location close to an existing managed motorway, giving key learnings for a range of urban operating environments.	The trial will help to understand the implications for drivers and infrastructure and will also help to understand the improvement to driverless vehicles when vehicles can talk to other vehicles and infrastructure. **http://statements.qld.gov.au/Statement/2016/11/24/australias-largest-intelligent-vehicle-trial-to-be-held-in-qld**
Intelligent transport technology Electric autonomous shuttle bus trial Perth, Western Australia	Test of an electric driverless shuttle bus on-road within Perth's metropolitan area. The trial route is 25 mins in length. The trial builds on a previous pilot in Perth which tested a driverless bus off-road.	The learnings from the trial will create an enhanced framework for other trials of automated driving technologies in the future. The trial will ensure compliance with road and vehicle safety standards.

		http://www.roads.org.au/insider/ArticleId/119/roads-australia-insider-september-9-2016
Congestion-busting trials Intelligent transport system technology and Vehicle-to-Infrastructure messaging trial Various locations, Victoria	A series of three trials aiming to reduce congestion, improve the integration between different modes of transport, and provide information to people so they can make optimal or alternative transport choices. The first trial is an advanced signalling system that gives trams priority at intersections with traffic lights. The second trial is technology to allow vehicles to pass through consecutive waves of green lights and enable road users to make smarter decisions through messages about the state of the traffic ahead via GPS and a smart phone app. The third trial is testing of roadside infrastructure such as traffic lights and electronic speed signs to communicate with vehicles, or vehicle-to-infrastructure communications. This is to enable assisted steering and acceleration (connected vehicle technology).	The testing will give key learnings on how to make the transport system "smarter". The trials will also advance connected vehicle technologies. https://www.premier.vic.gov.au/tech-trials-to-bust-congestion-on-our-road-network/
Autonobus trial Autonomous shuttle bus trial Melbourne, Victoria	The driverless bus will travel on an existing transport route transporting passengers from public transport interchanges and carparks to popular destinations around a university campus. The Autonobus is fitted with advanced sensor systems to detect and track objects with speed and precision. The trial operators are aiming to improve congestion and road safety outcomes.	The trial will improve understanding of the way driverless vehicles interact with passenger demand and existing transport options. https://theurbandeveloper.com/articles/la-trobe-university-trials-driverless-bus
Vehicle-to-Pedestrian (V2P) technology trial Adelaide, South Australia	The trial demonstrated vehicles interacting directly with pedestrians' and cyclists' mobile phones over the 4G network. The technology was tested using common scenarios, such as a car and a cyclist approaching a blind corner, a car reversing out of a driveway, and a car approaching a pedestrian.	The tests have shown that safety between vehicles and vulnerable road users can be improved simply by broadcasting safety signals from smartphone technology leveraging the current 4G cellular network. This technology can be applied to Vehicle –to- Infrastructure (V2I) messaging. Application of this trial will allow for testing optimal green light timing where the vehicle is informed of the optimal speed to approach a traffic light so that that they get a green light when they arrive, therefore allowing a more continuous flow of traffic and reducing congestion. http://dpti.sa.gov.au/news?a=371223