

The inexorable rise of automated food deliveries and potential anticipatory policy actions

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Abstract

Objective: Food deliveries to consumers using autonomous vehicles are forecast to become commonplace in Australia and globally. The aims of this study were to (i) explore the anticipated nature of AV food delivery services in Australia and (ii) identify available policy options to optimise positive outcomes and minimise any negative consequences for health and well-being.

Methods: In total, 36 interviews were conducted with 40 expert stakeholders across a range of relevant sectors including transport, urban planning, health and telecommunications. Interviewees discussed the ways in which automated food deliveries are likely to be implemented and the potential implications for lifestyles and health.

Results: The interviewees expected automated food deliveries to constitute an extension of current trends towards online food ordering and rapid home deliveries, with potential adverse implications for diet quality at the population level.

Conclusions: Effective regulation of automated food and beverage delivery services will be needed to anticipate and address this emerging phenomenon.

Implications for Public Health: There is the opportunity to optimise the public health outcomes associated with automated food deliveries while minimising potential negative consequences through proactive anticipatory action. Delays could result in undesirable and irreversible changes to the food environment.

Key words: food, transport, autonomous vehicles, diet, nutrition

Introduction

Food availability is a key determinant of food choice and therefore diet quality.¹ A rapid expansion in the availability of unhealthy foods over recent decades has been associated with deteriorating diets and increases in nutrition-related diseases.² Burgeoning trends in online food ordering and on-demand meal deliveries have the potential to exacerbate this situation.^{3,4} Both grocery and meal delivery services have grown quickly in popularity⁵ although most of the expansion of meal delivery services has been at the expense of the grocery sector rather than the restaurant industry.⁶ This trend is of concern given

that meals ordered online are likely to be less healthy than those prepared in the home.⁷⁻⁹

Developments in autonomous vehicle (AV) technology could amplify home delivery trends.⁶ AVs are self-driving vehicles that are emerging across a range of road, rail, sea and air applications.^{10,11} It is estimated that AVs will become the dominant form of road transport by 2050.¹² AVs have enormous life-saving potential due to their forecast ability to reduce the prevalence of road crashes¹³ and thus are an important component of future road systems.¹⁴ Beyond human transport, AVs have product delivery applications that are of great commercial interest.^{15,16} Convenience is a primary determinant of the use of online food delivery services,¹⁷ which means the profitability of the

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home delivery sector hinges on the ability of a finite pool of human drivers to maximise deliveries within specific time periods. This is proving to be logistically challenging, which is contributing to industry interest and investment in autonomous forms of delivery that also have benefits in terms of decreased labour costs and reduced risks of driver injury.^{6,16,18}

Most published research to date examining automated food delivery systems has been conducted in the United States, Europe and Asia and has focused on logistical considerations associated with implementation across various applications including AVs that operate on roads (e.g. vans and trucks) and footpaths (e.g. street bots).^{15,16,18–22} Scant attention has been paid to the potential public health implications of the increases in food and beverage availability that are likely to accompany the widescale use of AVs for this purpose.²³ To date, automated food delivery trials in Australia have been limited to drones,^{24,25} but land-based food delivery trials are currently being implemented in other parts of the world.^{26,27} In preparation for Australian developments in this area, the aims of the present study were to (i) explore the anticipated nature of AV food delivery services in Australia and (ii) identify potential policy options to optimise positive outcomes and minimise any negative consequences for health and well-being.

Methods

The present study was part of a larger body of work examining the potential social and public health-related impacts of AVs. As per the Australian Government's prioritisation of the social issues relevant to land-based automated vehicles,²⁸ the focus of this study was on food and nonalcoholic beverage deliveries being actioned via land-based AVs. An exploratory approach was adopted that involved conducting 36 interviews with 40 individuals who were expert stakeholders across the fields of transport, urban planning, health and telecommunications. Most interviews were conducted in a one-to-one format, but a small number (n=3 interviews) involved multiple individuals from the same organisations at their request. The interviewees held roles in government departments (n=21), private transport/technology companies and industry peak bodies (n=11), academia (n=5) and nongovernment organisations (n=2).

Recruitment involved identifying relevant contacts of the investigator team, undertaking web searches to identify other experts and using a snowball approach by asking interviewees to nominate others who would have relevant knowledge and interest in participating. A semi-structured interview guide was used to enable each expert to contribute according to their specialty area, while also covering consistent ground across interviews wherever possible. Discussion topics included the interviewee's role and expertise, the likely nature of AV food deliveries in the future, anticipated consumer responses and the potential outcomes for diet quality.

On average, the interviews ran for 68 min (range 51–122 min). The interview transcripts were coded using NVivo 12 qualitative data management software. The coding approach involved an inductive, iterative process of open and then selective coding.²⁹ This involved initially creating conceptual "nodes" in NVivo based on the topics covered in the interview guide and then progressively fleshing out the node hierarchy to include new topics as they emerged. Examples of initial (deductive) nodes included AV type (e.g. road vehicles, street bots), health issues (e.g. obesity, physical inactivity), and other

consequences (e.g. road and footpath congestion, job losses). Emergent (inductive) nodes included those relating to food and beverage delivery business models, estimated levels of consumer demand, vulnerable consumer groups, urban planning implications and potential regulatory options. The emergent nature of the data coding process necessitated the use of a single coder (author SP), which is appropriate for analyses requiring an adaptive approach to generate novel findings via thematic analysis rather than attempting to match data to an existing theoretical framework.³⁰ Once data coding was complete, themes were derived by interrogating individual nodes and examining node intersections (i.e. where interview content was coded to multiple nodes). The themes were refined in consultation with other team members who had conducted the interviews (VF and LB) and finalised through agreement between all members of the research team.

Results

Reflecting the diverse backgrounds of the interviewees, the discussions covered varying issues relating to the use of AVs for food deliveries. Some interviewees focused mainly on the logistical aspects of AV deliveries (especially those representing the transport and technology sectors), while others were primarily interested in the health and well-being implications of heightened food availability (e.g. those working in the health sector). While interviewees did not attempt to nominate specific dates by which food and beverage AV deliveries would become commonplace, there was a general understanding among those in the transport and technology sectors in particular that this is an inevitable outcome.

The findings from the broad-ranging discussions were categorised into three major themes: (i) anticipated business models, (ii) implications for different population groups, and (iii) policy options to optimise the potential positive outcomes of AVs while ameliorating possible negative outcomes. These themes are summarised in [Table 1](#) and outlined below with example quotes provided (in some cases minor edits were made to enhance clarity and prevent interviewee identification). Given the small number of AV experts in Australia, limited interviewee descriptors accompany the quotes.

Anticipated business models

Interviewees consistently compared the future of AV food deliveries to the current situation where online apps provide rapid access to snack/meal delivery services for urban-based consumers and supermarket retailers provide online shopping services that include home delivery options. AV deliveries were expected to amplify these trends, thus representing an extension of the current situation rather than constituting a complete disruption to food access systems. Most often, food delivery was discussed in the context of individual meal deliveries and to a lesser extent grocery deliveries.

(It's) a broader conversation about the really increased prevalence of food delivery services. This would be another step on the pathway of availability of it. It's not new, it would just be a different way of providing that same accessibility to things that maybe aren't the best choices. (State Government, transport)

The attraction of AV deliveries over and above existing options was perceived to be due to the combination of lower costs and greater availability of supply resulting from the replacement of human drivers. These benefits were generally considered to represent a

Table 1: Summary of interview findings.

Theme	Nature of change	Implications
Potential business models	- Extension of existing trends in online food ordering and deliveries	- Reduced delivery costs - Increased service capacity - Faster freight - Widened time windows for delivery operations
Potential outcomes for population subgroups	- Variable outcomes across population subgroups	- Increased online meal ordering among price-sensitive households - Increased sedentarism among those reliant on shopping steps - Children as a vulnerable group - Enhanced food access opportunities for those in regional/remote locations
Potential policy actions	- Swift action needed to pre-empt permanent changes	- Charges/levies - Bans - Location restrictions - Advertising restrictions

compelling force for the rapid uptake by both providers and consumers of autonomous food deliveries once they are available, regardless of any potential negative outcomes.

The convenience and the experimentation around what are good combinations of delivery system for the food to match the availability of the eater, I think has some pretty powerful drivers behind it and I don't think it's likely to stop. (Peak body, transport)

You take the driver out of the Uber commercial model and you have quite an attractive profit for Uber. (Private company, technology)

There's a growing expectation from consumers that they want next-day, same-day, the delivery, food delivery, those sorts of things. So, there's a lot of investment going out of those shuttles into food delivery and that sort of service, which people want, and they want it 24 hours a day, seven days a week. (Peak body, transport)

As a general rule, something that offers a much higher level of convenience for people is quite an attractive proposition. On that basis, one has to ask some searching questions around whether or not it might deliver convenience, but is the cost of that convenience actually worth it? (State Government, transport)

Concerns were expressed about increased congestion on roads and footpaths resulting from a higher volume of food delivery vehicles. There was particular apprehension about street bots due to lower market entry barriers (e.g. the technology exists and has been trialled extensively in some cities and investment costs are lower than for larger road AVs) and the potential for pedestrians to be injured or discouraged from engaging in active transport due to congested footpaths.

It's quite likely you would have hubs and from there you could have a delivery, little delivery robots that are driving on your footpaths at a slow speed and delivering it at your doorstep. It's not difficult at all, actually. (State Government, transport)

In a future where we're getting more delivery via automated vehicles, I would see that it'd be more likely that the issue would not be so much how these vehicles are functioning on the road, but more how they're functioning on the footpath. ... one of the key issues would be around how those delivery robots or delivery systems take space away from other people and other transport modes, and particularly from vulnerable transport modes such as pedestrians, or who knows maybe cyclists or e-bikes or e-scooters. I think that's probably the most important issue that we would want to consider. (Federal Government, transport)

A possible implementation model that was described as highly unfavourable involved unsolicited approaches from AVs spruiking unhealthy foods. In this scenario, AVs take on the role of old-style ice-cream vans that trawled neighbourhoods promoting their wares.

Anybody can get their Macca's anywhere, but autonomous food trucks can really extend that ... If I'm driving the car I can be like, I'm not driving to the McDonald's. If the McDonald's comes to my doorstep, that's a whole different story. (State government, planning)

Commercially that's (*trawling AVs*) a fantastic venture. From a public health perspective, not so much. (State Government, transport)

At the other end of the food delivery spectrum is the use of AVs for freight applications. This was considered to be an area where AVs have clear advantages that could result in an improved food supply. Automated trucks were described as having benefits in the form of faster trip times due to more efficient fuel use and no requirement for fatigue/sleep breaks, resulting in fresher produce on arrival at lower cost.

(*Drivers*) have to take fatigue breaks as part of the legislation, especially if you're driving a B-double for long distances. I'd say reducing the cost of travel, so the biggest cost for transport companies is fuel as well as the driver's wage. So if you're reducing those two, that should significantly reduce transport costs in Australia. ... I think it would have a positive impact on the agricultural sector as well, moving goods to the ports a lot quicker improves freshness, reduces costs to farmers. (Private company, technology)

While there would be job losses associated with the use of automated freight vehicles, this was considered to be a positive outcome in the long term because of the unhealthy nature of the occupation.

Truckies, particularly long-range truckies, typically have back ache and back problems with their feet out for long periods of time and there's quite a bit of obesity. (State Government, transport)

The use of AVs for short-haul trips was also seen to be potentially advantageous due to the enhanced ability for round-the-clock deliveries resulting from fewer staffing requirements and lower noise emissions from electric automated trucks.

In terms of efficiency for getting vehicles to market, in terms of to your local shopping centre, if you had an automated truck that was electric, that was a small container truck, potentially that could operate at night with less impact to communities. So there may be an opportunity for an automated vehicle fleet to move

24/7 ... So there might be some benefits there too in terms of getting things from port to shopping centre faster, therefore better quality of the produce if it's fresh. (State Government, transport)

Implications for population groups

Discussions about the potential impacts of AVs on population groups ranged from very broad to more specific sections of society that may experience either positive or negative outcomes from AV food deliveries. Examples of broad groups included those with greater price sensitivity who may consume larger amounts of processed foods if they become less expensive and more available via AVs.

The cheaper food delivery services become, the easier it is for people to stop cooking and having food delivered to them and potentially the health consequences for them aren't great as well. (Private company, telecommunications)

It was noted that those who are physically inactive could become even more sedentary without the exercise involved in food shopping.

Particularly if they're an older person, ... they might no longer be in situations where they're naturally moving; like going to the bus stop, going to the railway station, carrying their groceries and getting a little bit of additional exertion. (Academic, transport)

Alternatively, AVs could have an important role to play for vulnerable groups such as the elderly during pandemics due to their ability to offer contactless food provision.

(For) the elderly or the mobility impaired or in an environment where there might be a lockdown ... That kind of technology would potentially have significant benefits if there were to be another situation like we have at the moment with COVID. (State Government, transport)

Children were nominated as another group that could be negatively affected by greater availability of cheap, unhealthy foods, facilitated by AV delivery systems.

You wouldn't want a school child ordering an autonomous burger delivery during lunchtime. (Academic)

Finally, those living outside of the metropolitan area, and especially Aboriginal and Torres Strait Islander peoples in remote areas, could potentially benefit from the use of AVs to deliver products in a timely fashion on a more regular basis.

That's one of our biggest issues is food access for low-income families in regional areas, Aboriginal families. ... if you could actually just increase the frequency of deliveries to those areas, that would make an enormous difference. (State Government, Health)

Potential policy responses

There was general agreement across the interviewed stakeholders that pre-emptive policy and regulatory responses will be needed to ensure the enormous potential benefits of AVs for crash and road injury prevention are complemented by improvements in food access without intensifying current trends towards the overconsumption of unhealthy foods.

(If it's) completely unregulated it can have really awful outcomes because it's all just driven by bottom line, profit and doesn't consider the impacts onto others. (Private company, engineering)

You have to be a bit proactive and say, "There's this new thing that these people are trying to deploy so we better quickly make a decision about who can deploy it". And how do you regulate that

when some companies have shown that they're willing—and I guess Uber and Airbnb are examples of this, they're willing to just get into a market and let people, communities and governments sort it out later. (State Government, planning)

However, determining and implementing effective anticipatory actions was acknowledged to be difficult given the complexity of the problem and the need for a suite of approaches across multiple entities to achieve optimal outcomes. It was noted that current regulatory systems are unprepared and that an apparent inability to address burgeoning obesity rates and numerous associated diet-related diseases illustrates the scale of the task ahead, exacerbated by continuing debates about appropriate government intervention versus the role of personal responsibility.

What does the new policy world look like and what are the new policy levers that you have to pull? We're struggling to manage even what that looks like for food delivery today from a car or an e-bike, let alone what it looks like with the automated vehicles ... Where there's a market, it's market driven. It's really, really tough to know what to do in this space. It doesn't come back just down to individual responsibility ... I think the policy impediment of that dialogue that continues around personal responsibility is going to make this really hard to change. I don't know whether it's a policy lever or whether it's more of a community awareness, an advocacy kind of lever that we need to pull. But again, I'm not sure that all communities don't want this to happen. It's hard to sit on your high horse and say, we don't want this to happen to you. (State Government, health)

Various regulatory approaches were raised as potential strategies to ensure the introduction of AVs does not adversely impact diets at the population level. As described below, these strategies included charges/levies, bans, location restrictions and advertising restrictions.

It was noted that the spaces traversed by AVs will largely operate on government infrastructure, which raises the issue of whether this infrastructure is being used as intended and in the public interest.

For states and territories, it's about, this is the infrastructure you've provided, and is this (*food delivery AVs*) the best use of it? Or what is the best use of it and how do you ensure that this is the future that actually works and is not something that's people tripping over them or getting hit by them. (State Government, transport)

A suggested policy option to address this issue was the introduction of user charges that discourage forms of automated delivery vehicles that present particular hazards. For example, unsolicited delivery vehicles promoting unhealthy foods could have larger charges applied reflecting their more predatory nature.

You would hope that road user pricing would address that ... if these vehicles are just always circulating and always on the road network, there'd be a mechanism for looking at how we can balance that from a cost perspective so that it's either not able to happen all the time or you can incentivise those kinds of activities to the right windows. (Federal Government, transport)

In the case of food delivery street bots, it was suggested that outright bans may be needed to keep footpaths safe for other users.

I think it's going to start to be crowded. The scooters are already becoming a bit of an issue ... If you have these little autonomous food delivery options, they take up even more space ... the transport authorities could always legislate around it and not allow them on the footpath. (Federal Government, transport)

In terms of location restrictions, it was suggested that specific types of sites could be inappropriate for food delivery AVs to operate without obtaining prior permission. Schools were the most commonly mentioned sites where there should be restricted access.

Councils own a lot of the streets and the footpaths, and you have regulations around what vendors can be where in particular zones anyway. Maybe that's the way to do it. You would have to have permission to park up at a school. (State Government, infrastructure)

Finally, it was recognised that like other delivery vehicles, AVs used for food delivery purposes are likely to have their visible surface areas covered in advertising. It was understood that as home deliveries become more common, this advertising will become a more prevalent throughout suburban streets, which was considered problematic if the foods being promoted are unhealthy. An interviewee proposed the application of cigarette packaging restrictions to these vehicles to prevent substantial increases in unhealthy food branding in Australian neighbourhoods.

Maybe there's a way to extend to a plain packaging version for delivery bots, like we have for cigarettes in Australia. (State Government, planning)

Discussion

The study findings highlight the need to consider pre-emptive policy action to ensure the negative aspects of automated food deliveries are balanced with their potential public health benefits. As noted by some interviewees and raised in previous research, relevant precedents exist where gig economy actors such as Uber and Airbnb have rapidly penetrated markets before regulators could respond, permanently changing the nature of the marketplace.³¹ Delays in introducing effective strategies to ensure emerging transport technologies support rather than discourage healthy eating may result in an irrevocably lost opportunity.

The study participants identified a range of positive and negative outcomes that are likely to emerge from the advent of automated delivery vehicles. The policy challenge will therefore be to optimise potential benefits through supportive intervention while taking steps to prevent disbenefits. In terms of benefits, freight applications present a use case for which multiple positive outcomes can accrue through shorter trip durations, lower noise and greenhouse gas emissions, and fresher products on arrival,³² while also providing the opportunity to gradually migrate workers out of an unhealthy occupation.³³ The productivity benefits of autonomous freight vehicles mentioned by the interviewees are evident in trials currently occurring around the world.³⁴ Trials are also about to commence in Australia,³⁵ and this could be an area of increased focus for policy makers, especially considering the amount of long-haul food transport required for a country with such large geographical coverage. As suggested in the interview data, a priority for advancements in freight AVs could be the servicing of rural areas where food delivery schedules are currently inadequate. Similarly, greater attention could be given to AV food delivery applications designed to increase access to healthy foods among population groups with special needs, such as those with mobility restrictions or particular vulnerability to infection.³⁶

In terms of disbenefits, the changes currently occurring in the food delivery system resulting from the rapid expansion of online food ordering already present substantial challenges for policy makers.¹⁷ This is occurring in the context of the majority of the adult population suffering from overweight and obesity and other diet-related diseases,³⁷ highlighting the enormity of the task involved with attempting to anticipate and address any additional issues associated with the emerging phenomenon of automated food deliveries. The interviewees noted that widespread access to such deliveries is likely to amplify existing trends by making unhealthy foods even more convenient and affordable. Previous research has found that online food ordering is more common among those with poorer diets and those living with obesity,^{38,39} suggesting that enhanced access via AVs could compound negative health outcomes for these groups.

The interviewees nominated a range of possible policy actions that could be taken to ameliorate the potential adverse consequences of increased availability of unhealthy food via AVs. These included (i) applying charges/levies to prevent the social costs of increased delivery of unhealthy food from being externalised to communities, (ii) banning some forms of AV food delivery (e.g. street bots), (iii) placing restrictions on where deliveries can be made (e.g. permission could be required from school management prior to deliveries made on or around school premises) and (iv) limiting the advertising that can be displayed on AV food delivery vehicles. There may also be the opportunity to implement strategies recommended for improving the nutritional quality of product offerings on food ordering apps, such as giving healthy options visual prominence, using healthy default food choices, providing nutrition information about products on sale (e.g. mandatory display of the relevant Health Star Rating score), blocking ads for unhealthy options and issuing prompts to cue the selection of healthier options.^{17,40,41} Such strategies could assist in addressing current trends in unhealthy meal home deliveries and increase the likelihood of AVs being used to deliver healthier options.

The primary limitation of this study was the exploratory, qualitative approach that involved interviewing purposively recruited stakeholders, with the notable exclusion of members of the general public. A second limitation was the reliance on an Australian sample, which means the findings may not be relevant to international contexts. Future research could use alternative data collection methods with larger and more representative samples to access a broader range of views and produce more generalisable results.

In conclusion, effective regulation of automated food deliveries will be needed to anticipate and address potential negative consequences of widespread AV food deliveries. The findings of this study can assist policy makers consider appropriate actions to minimise potential adverse effects on diet quality at the population level while optimising the abilities of new transport technologies to increase the availability of healthy food to all.

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Ethical approval

Ethical approval for the study was obtained from the University of New South Wales Human Research Ethics Committee, and all interviewees provided informed consent.

Conflicts of interest

The authors declare no conflicts of interest.

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