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Urban Sustainability in the Face of Emerging Autonomous Transport and Delivery Systems: Public Support for Potential Government Policies

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Abstract

Intersecting advances in autonomous vehicle (AV) and home delivery technologies have substantial implications for city planning, traffic congestion, and population health. Understanding public preferences for how these new technologies should be regulated is essential for developing effective policy responses that are aligned with community priorities. This study examined public support for 20 government policies that could be used to govern AV-based transport and delivery systems. In total, 3000 Australian adults completed an online survey that assessed policy support and gathered data on travel behaviours, lifestyle factors, and delivery service use. Overall, respondents expressed moderate to high support for the proposed policies, with a mean score of 3.51 on 5-point scales. The most supported policies were those requiring AV ride-hailing providers to comply with accessibility standards (76% agreement), imposing curfews on drone deliveries (75%), and providing training for workers displaced by automation (75%). Proposed policies aimed at reducing reliance on traditional private vehicles were least strongly supported (range 27–40%). Respondents who used public transport, ride-hailing services, and active transport in a typical week were more supportive of almost all the assessed transport-related policies compared with non-users. These findings provide insights to inform the development of publicly acceptable policies for AV-based transport and delivery systems that intend to promote sustainable urban environments.

Keywords: autonomous vehicles; drones; product delivery; policy support; public transport; active transport; ride-hailing

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1. Introduction

Autonomous vehicle (AV) technologies are being introduced around the world, including passenger transport and product delivery systems that operate on the ground and in the air [1]. These developments are expected to transform urban environments, travel behaviours, and product delivery systems [1–4]. As a consequence, they have critical public policy implications across multiple domains.

The varying levels of automation for on-road motor vehicles have been defined by SAE (Society of Automotive Engineers) International [5]. Beginning at 0 and ending at 5, the levels increase from no driving automation to full driving automation. Private AVs equipped with partial driving automation (Level 2) are becoming available worldwide, and AV ride-hailing taxi fleets (Level 4) are operating in some cities in the United States (US) and China, and are in the process of being introduced in the UK [6,7]. In terms of aerial AV transport, passenger drone trials and demonstration flights are underway in the US, the United Arab Emirates, and several Asian countries [8–10]. In parallel, autonomous delivery vehicles are emerging, including drones, street bots, and parcel vans [11]. AV delivery services are delivering small packages, medical goods, pharmaceuticals, food, and beverages [12,13]. At present, delivery drones and robots are commercially deployed in several countries [14,15], while autonomous parcel vans remain in an early stage of piloting [16]. As AV passenger transport and product delivery systems continue to proliferate, they are expected to have substantial impacts on urban sustainability [3,15,17,18]. Whether these impacts are primarily positive or negative is likely to depend on the policies and frameworks that shape deployment.

Urban sustainability is broadly defined as the pursuit of long-term human and environmental well-being, specifically concerning environmental, social, and economic outcomes [19]. The emergence of AV passenger transport and delivery systems has implications across each of these three dimensions. Possible benefits, which are described further in Section 2 below, include improved traffic flow and efficiency and reductions in greenhouse gas emissions, energy consumption, air pollution, and vehicle-related collisions and fatalities [18,20–26]. Furthermore, AV passenger transport systems may improve accessibility to jobs, service availability to those located in regional areas, and provide greater mobility for people with disabilities [3,27–30]. In addition, AV product delivery services may enhance the efficiency of last-mile logistics [31,32]. Adverse effects may include increased congestion, urban sprawl, reductions in physical activity, increased access to unhealthy foods, and the displacement of workers in traditional vehicle-specific industries [3,27,33–35].

The diverse and substantial potential implications of AV passenger transport and delivery systems highlight the need for proactive and carefully designed regulatory frameworks to guide deployment [36]. Such frameworks could include pricing mechanisms; operational restrictions; data governance; and safety regulations that shape travel behaviour, delivery patterns, and urban development outcomes [4,30]. As many of these measures could restrict the movement of people and their products, understanding public support is critical. Public attitudes can influence the political feasibility, implementation, compliance, and sustained effectiveness of proposed regulations [37]. Despite the importance of public acceptability, there remains limited research examining public support for AV-related policies within the context of sustainable urban development. This gap is significant due to the substantial implications of autonomous vehicles for the environmental, social, and economic sustainability domains, and therefore the need for public support in enabling the implementation of relevant regulations to enhance these outcomes.

While many of the expected concerns regarding AVs are globally shared, their policy implications are likely to vary across national settings. In Australia, the context of the present study, autonomous road vehicles are expected to begin deployment in the late 2020s, indicating the pressing need for AV regulation to guide their sustainable integration [38]. As regulation develops, understanding public attitudes towards AV-related governance is increasingly important. Previous Australian studies have examined aspects of public support for AV regulation, finding that operational restrictions are generally viewed favourably, while taxes and levies receive comparatively lower levels of support [39,40]. However, these studies have considered a relatively narrow range of policies. As a result, evidence on

public support for a comprehensive suite of AV governance measures spanning transport, urban planning, accessibility, and public health remains limited. This study addresses this gap by examining public support in Australia for what appears to be the widest range of AV policies assessed to date across both passenger transport and delivery systems. In addition, the study aimed to identify respondent characteristics associated with policy support. The findings provide insights to inform the development of publicly acceptable policies for AV-based passenger transport and delivery systems and their integration into sustainable urban environments.

2. Literature Review

2.1. Environmental Sustainability

Under a full-adoption scenario, AVs may reduce noise pollution through improved traffic flow and more efficient operation of the road network [41]. Ride-hailing and private AVs are expected to reduce energy consumption, greenhouse gas emissions, and fine particulate matter compared with their traditional manually driven counterparts [18,20–22]. Vehicles will be designed to maintain optimal speeds, brake and accelerate carefully, and plan efficient trip routes, features that ultimately reduce exhaust emissions and petrol consumption [21,42]. In terms of product delivery services, drones are predicted to consume less energy than traditional trucks and vans when delivering small packages, owing to their electric power source and high delivery efficiency per kilometre [43].

Despite these potential environmental benefits, there are potential negative effects of AV transport systems on urban sprawl. People may choose to relocate further away from central business districts (CBDs) due to being able to use their time more productively while travelling in AVs [3,35]. Continued urban expansion could trigger adverse impacts on land and water resources through the loss of native vegetation and increased runoff [21]. Similarly, modelling suggests that urban sprawl driven by reduced transport costs and changes in travel behaviour may create challenges for urban planning and the efficient provision of public services [35]. As driving in AVs becomes cheaper, more convenient, and therefore more widespread, vehicle kilometres travelled could increase by more than 50% under a full-adoption scenario [44]. Distances travelled by empty vehicles, known as 'ghost rides', may also increase as ride-hailing AVs reposition between trips and private AVs circulate while searching for parking, potentially resulting in exacerbated congestion and emissions [44,45]. Finally, for electric AVs, advancements in battery manufacturing are required as current processes are resource-intensive and raise environmental sustainability concerns [18]. Little research has been conducted on the environmental harms of autonomous delivery services, although studies suggest considerable noise pollution from delivery drones [46,47]. The noise burden is expected to increase with drone fleet size, highlighting the need for regulation in residential areas [46].

2.2. Social Sustainability

Positive outcomes for social sustainability include greater accessibility and equity. For instance, reduced travel costs may increase workforce participation and enhance social inclusion, particularly for those without a driver's licence and those requiring mobility assistance [3,27]. Likewise, AV delivery services could contribute to health equity by improving access to medical supplies in regional areas [29] and groceries in food deserts [28]. AVs present a potential supply-side component of the emerging Sustainable Mobility as a Service (MaaS) model. In this context, AVs could increase service availability, enhance accessibility, and reduce reliance on private vehicle ownership, thereby positively contributing to a sustainable urban mobility system [48–50]. The adoption of ride-hailing and personal AVs may also create opportunities to repurpose city centre parking facilities

for green and people-oriented spaces [18,51,52]. This repurposing may be driven by reduced demand for centrally located parking, as ride-hailing AVs could decrease the number of vehicles in operation and personal AVs may be able to park further from city centres. Together, these outcomes suggest considerable potential for AV transport and delivery systems to advance social sustainability.

Alongside their anticipated benefits, several social sustainability risks for AV passenger transport and delivery systems have been identified. Specifically, public health concerns include potential reductions in physical activity as people increasingly rely on private AV transport and travel longer distances due to dispersed urban development [34], as well as greater access to unhealthy foods and beverages through the expansion of autonomous delivery services [33]. Although AVs have the potential to improve mobility and service provision in regional areas, their deployment may be hindered by a lack of infrastructure, including road signage, sensors, and communication technologies. Such limitations could restrict the availability of AV transport and delivery systems, resulting in inequitable access and undermining social sustainability [53]. Lastly, personal privacy and data security are key societal concerns associated with both passenger transport and product delivery AVs [54,55]. Companies may collect personal information, including addresses and bank details, when processing orders, as well as video and audio recordings of passengers during vehicle operation [56,57].

2.3. Economic Sustainability

Positive outcomes for economic sustainability include the ability of AVs to reduce vehicle crashes compared with human-driven vehicles, with studies indicating fewer fatal crashes and AV-pedestrian collisions [23–26]. This in turn would result in lower medical service costs, thereby decreasing the associated economic burden [51]. Similarly, AVs may broaden access to employment opportunities by enabling people to travel further at lower cost [27] and increasing workforce participation among people with disabilities, for whom commuting can be a key barrier to employment [27]. AVs may also improve traffic flow and reduce congestion as road capacity may increase with the adoption of shared AVs and less time spent searching for parking, generating economic benefits through reduced fuel consumption, lower travel delays, and increased reliability of passenger transport [58]. In delivery systems, AVs may enhance the efficiency of last-mile logistics by similarly eliminating parking search time and reducing operational and labour costs [31,32].

The primary economic risk of AVs is the expected displacement of workers, particularly those in driving-related occupations and associated industries, including vehicle repair, servicing, and insurance [3,27]. This shift in the workforce composition could worsen economic and social inequality unless appropriate measures, such as retraining programs, are implemented [18,59]. Additionally, the rapid advancement of AV technology has outpaced the development of regulatory frameworks, liability guidelines, and insurance models, creating uncertainty in the market [59]. This market uncertainty could deter both private and public investment and hinder economic growth within the AV sector [59]. The possibility of increased urban sprawl, as described earlier, may also pose risks to economic sustainability as potentially costly infrastructure may need to be constructed further from city centres [27]. Such development could include roads and charging facilities for passenger transport AVs, as well as take-off and landing infrastructure and warehouses for product delivery AVs.

2.4. Public Support for AV Policies

Reflecting the importance of public acceptance for policy effectiveness, a growing body of literature has examined public attitudes towards AV-related policies intended to guide

the technology's development, deployment, and societal impacts [38–40,56,60,61]. Previous research has typically focused on examining public support for data governance and safety regulation, with comparatively limited investigation of policies addressing broader objectives [56,60–62]. Some Australian research suggests that operational restrictions on autonomous delivery drones, robots, and passenger drones are likely to be widely supported [39,40]. For example, one study found 64% support for limiting the number of autonomous delivery vehicles operating on footpaths and 62% support for limiting the number of passenger drones operating at any one time [40]. By comparison, financial measures such as levies and taxes only received 35–39% support [40]. Another study found 64% support for implementing a curfew for drone deliveries and 60% support for restricting the number of delivery drones operating at any one time, but only 39% support for constraints on the number of deliveries per day [39]. These results suggest that public receptivity may depend on whether AV policies target service providers or affect personal convenience and travel choice.

3. Methods

3.1. Data Collection

An ISO-accredited web panel provider (Pureprofile, Surry Hills, Australia) was commissioned to recruit a sample of 3000 Australian adults (see Table 1), applying quotas based on national distributions for gender, age, and location (metropolitan and regional). Data collection occurred between August and October 2025. Participants were reimbursed at the web panel provider's standard reimbursement rate of approximately $5. A University Human Research Ethics Committee granted ethical approval for the study and all participants provided informed consent.

Table 1. Sample profile (n = 3000).

Attribute	n	%
Gender		
Female	1498	50
Male	1498	50
Non-binary	2	<1
Prefer not to answer	2	<1
Age		
18–34	690	23
35–54	1081	36
55+	1229	41
Location (metropolitan)	2089	70
Socioeconomic status [ab]		
Low	870	29
Medium	811	27
High	1316	44
Transport type [c]		
Personal vehicle user (in a typical week) [d]	2776	93
Public transport user (in a typical week)	1008	34
Ride-hailing service user (in a typical week)	338	11
Any active transport participant (in a typical week) [e]	1501	50
Cycling	342	11
Walking	1401	47
E-biking, e-scooting	127	4

[a] Derived from postcode using Socio-Economic Indexes for Areas classification (Australian Bureau of Statistics. (2021). Socio-Economic Indexes for Areas (SEIFA), Australia https://www.abs.gov.au/statistics/people/people-and-communities/socio-economic-indexes-areas-seifaaustralia/latest-release (accessed on 6 January 2026)). [b] Three respondents missing due to missing postcode data. [c] Transport mode categories were non-mutually exclusive. [d] Car, truck/van, or motorcycle. [e] Bicycle, walk, or e-bike/e-scooter.

The survey instrument was designed to investigate public attitudes to future transport and delivery systems in the context of sustainable urban environments. The instrument included questions about travel and lifestyle behaviours and current use of delivery services. Three scenario vignettes for the years 2035, 2045, and 2055 were presented chronologically to all participants, each depicting the state of the urban environment, transport, and delivery services through text and images at the projected time point (see Figures 1–3). Images were created through an iterative process using Canva AI 2.0. Substantial increases in automation were described as the timeline progressed across the three scenarios. These scenarios were developed using expert predictions in relevant literature [37,39,63–70], combined with community member preferences and expectations concerning autonomous delivery options from previously conducted focus groups [71]. Similar scenarios have been used in other studies to help respondents visualise autonomous systems and services that currently do not exist and stimulate thoughtful responses [40,72]. A series of questions followed each scenario to assess overall reactions, intended transport and lifestyle behaviour choices, anticipated frequency of delivery service use, and potential changes in residential location.

Figure 1. Scenario 1 description of the year 2035.

Following exposure to these scenarios, participants evaluated a set of 20 potential transport and automation policies, 12 of which related to passenger transport and eight to product delivery. These policy options were also informed by the extant literature [35,37,39,40,73,74] and the prior focus group discussions [71]. For each policy, participants indicated the extent to which they agreed with its implementation on a 5-point 'Strongly Disagree' to 'Strongly Agree' scale.

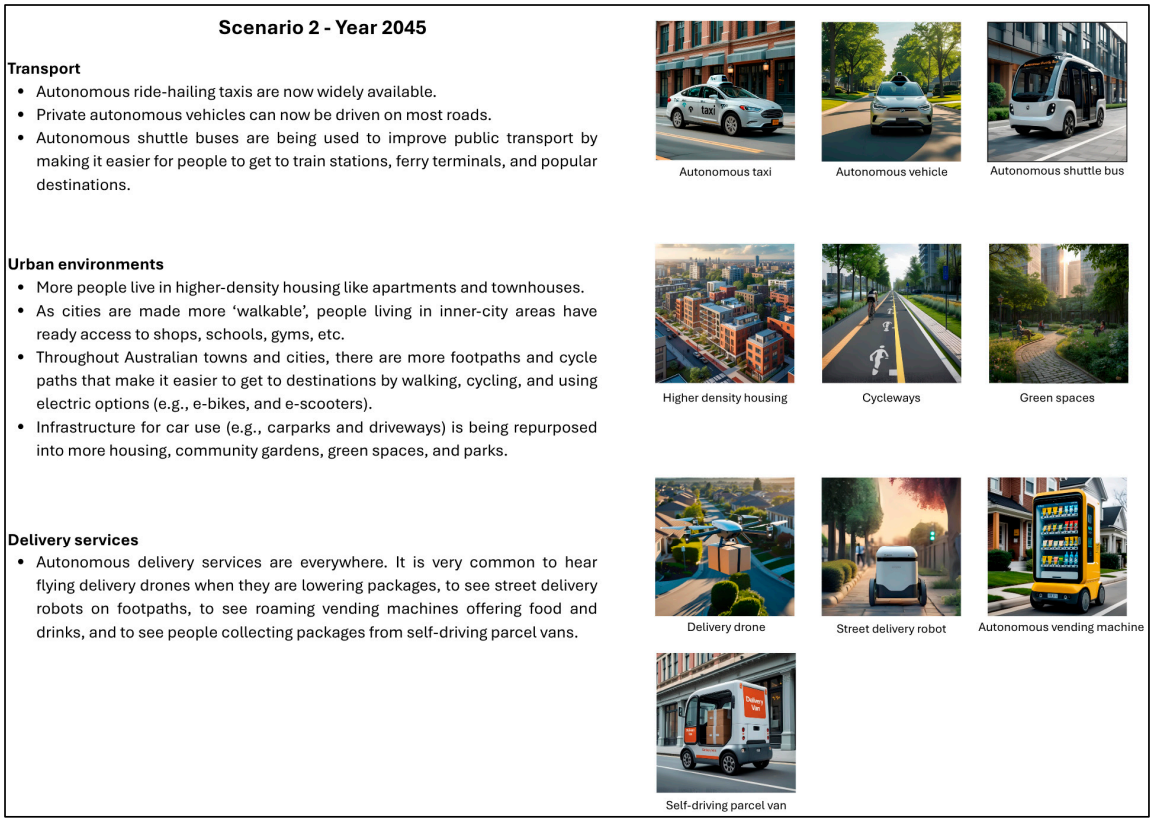

Figure 2. Scenario 2 description of the year 2045.

Figure 3. Scenario 3 description of the year 2055.

The 12 passenger transport policies included restrictive measures, pricing policies, education policies, social support policies, urban planning measures, and equity and

accessibility policies. The eight product delivery policies involved restrictive measures, operational restrictions, fiscal policies, advertising policies, public health measures, and environmental policies. The wording of the policy items and the relevance of each policy to environmental, social, and economic sustainability domains are shown in Table 2.

Table 2. Sustainability domains relevant to each assessed policy.

Policy	Sustainability Domains		
Passenger transport policies	Environmental	Social	Economic
Require autonomous ride-hail taxi service providers to comply with accessibility standards for people with disabilities, older adults, and those with mobility limitations		✔	
Provide training programs to assist people who become unemployed due to vehicle automation to upskill and gain new forms of employment		✔	✔
Limit the number of flying passenger autonomous vehicles operating in the air	✔	✔	
Create zones in central areas where only walking, cycling, and public transport are allowed		✔	
Provide public education programs to inform people about the emergence of autonomous transport options		✔	
Improve transportation accessibility and liveability in urban areas to discourage urban sprawl	✔	✔	
Subsidise autonomous ride-hailing fleets in regional and remote areas to increase access in these areas		✔	✔
Introduce economic incentives for companies to invest in ride-hailing fleets		✔	✔
Reduce parking spaces for cars in central business districts to discourage car use	✔	✔	
Charge extra for using private vehicles in busy areas and for short trips to encourage use of public transport and ease congestion	✔	✔	✔
Prohibit the use of privately owned vehicles in city centres	✔	✔	
Prohibit people from driving traditional cars once autonomous vehicles are widely available	✔	✔	
Product delivery policies			
Place curfews on drone deliveries so they cannot operate late at night	✔	✔	
Limit the number of delivery drones that can operate above a suburb at the same time	✔	✔	
Ban drone food and beverage deliveries to schools		✔	
Ban street delivery robots from operating on busy streets	✔	✔	
Prohibit advertising of unhealthy food and alcohol on autonomous delivery drones and vehicles		✔	
Ban the delivery of alcohol by autonomous vehicles and drones		✔	
Restrict the number of home deliveries each household can receive per day	✔	✔	
Apply a levy to deliveries of unhealthy food and beverages, including both traditional and autonomous delivery services		✔	✔

3.2. Data Analysis

Descriptive analyses were conducted using IBM SPSS Statistics Version 31.0.2.0 to determine overall support for the 20 assessed policies. Support was analysed across the total sample and then for the composite passenger transport and product delivery policy categories. Composite mean support scores and percentage agreement were created for the passenger transport and product delivery policy categories by averaging responses on the 5-point scales and averaging the agreement percentages, respectively. The internal consistency

of the transport and delivery policy categories was examined using Cronbach's alpha and McDonald's omega [75]. Both the transport (α = 0.85, ω = 0.84) and delivery policy composites (α = 0.78, ω = 0.77) demonstrated acceptable internal consistency. Support was also examined across the respondent demographic subgroups of age (18–34 years, 35–54 years, and 55+ years); gender (female and male); location (metropolitan and regional); and current use of any of the following transport modes in a typical week: personal vehicle, public transport, ride-hailing services, and active transport.

Independent-samples *t*-tests were conducted to identify significant differences in mean policy support by gender, location, and transport mode use, with transport mode variables dichotomised as users and non-users. One-way analyses of variance (ANOVAs) were conducted to assess differences in support across age groups. These analyses were appropriate because the individual policy support score and composite score distributions were normal, group sizes were large, and Levene's test detected no substantial violations of the homogeneity of variance assumption. Due to the large number of subgroup comparisons, statistical significance was set at $p < 0.001$ for all subgroup analyses to reduce the likelihood of false positive findings. Tukey's post hoc tests ($p < 0.001$) were performed to determine which age groups differed significantly.

Two multiple linear regression models were then estimated to identify factors independently associated with support for passenger transport or product delivery policies. The purpose of conducting these analyses was to simultaneously assess factors associated with policy support. The composite scores were used as the dependent variables in the regression models. As per previous similar studies [39,40], the independent variables for both models were age; gender; location; and typical weekly use of personal vehicles, public transport, ride-hailing services, and active transport. Age was entered as a continuous variable, while gender, location, and transport modes were entered as dichotomous variables. All independent variables were entered into the models simultaneously to account for shared variance among factors. Regression assumptions were assessed prior to model estimation. Multicollinearity was examined using Variance Inflation Factors (VIFs) and Tolerance values. Normality, linearity, and homoscedasticity were assessed through analysis of residual plots, and model fit was evaluated using R^2 and adjusted R^2 statistics.

4. Results

Across the 20 proposed policies, the overall mean support score for the sample was 3.51 on a 5-point scale, with similar average levels of support for passenger transport (M = 3.48) and product delivery (M = 3.57) policies. The mean scores for all policies were greater than the neutral mid-point of 3, except for three transport policies (see Table 3). Correspondingly, the range of mean scores was wider for passenger transport policies (2.61–4.04) than for product deliveries (3.06–4.00). Average percentage agreement (those selecting 'Agree' or 'Strongly Agree') was 57% overall, with comparable levels observed for transport (57%) and delivery policies (58%).

The most supported policy required autonomous ride-hailing service providers to comply with accessibility standards (76%). Two additional policies achieved 75% agreement: placing curfews on drone deliveries at night and providing training programs for people who become unemployed due to vehicle automation. The least supported policies related to passenger transport and were aimed at reducing reliance on traditional personal vehicles, which is perhaps not surprising at this moment in time. These included prohibiting people from driving traditional cars when autonomous vehicles become widely available (27%); prohibiting the use of privately owned vehicles in city centres (34%); charging extra for using private vehicles in busy areas and for short trips (38%); and reducing parking spaces in central business districts (40%).

Table 3. Policy support descriptive results: overall and by demographic characteristics (n = 3000).

Policy	Overall			Age (Years)									Gender ^						Location					
				18–34			35–54			55+			Male			Female			Metropolitan			Regional		
	n = 3000			n = 690			n = 1081			n = 1229			n = 1498			n = 1498			n = 2089			n = 911		
	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%
Passenger transport																								
Accessibility standards for AV ride-hailing	4.04	0.89	76	3.85 [a]	0.92	67	3.99 [b]	0.9	74	4.2 [c]	0.85	84	4.03	0.9	76	4.05	0.89	77	4.02	0.91	75	4.1	0.86	79
Retraining displaced workers	3.99	0.88	75	3.91 [a]	0.88	69	3.93 [a]	0.9	73	4.09 [b]	0.86	81	3.95	0.9	74	4.03	0.86	76	3.98	0.88	75	4	0.87	76
Limit flying passenger AVs	3.94	0.94	73	3.74 [a]	0.9	63	3.85 [a]	0.95	71	4.14 [b]	0.91	81	3.87 [a]	0.98	70	4.01 [b]	0.89	76	3.92	0.93	73	3.98	0.95	74
Walking, cycling and public transport zones	3.83	0.99	72	3.82	0.93	70	3.79	0.99	70	3.87	1.02	74	3.83	0.98	72	3.83	0.99	71	3.82	0.99	71	3.85	0.98	74
Public education about AVs	3.84	0.89	71	3.79	0.87	67	3.79	0.87	69	3.9	0.91	76	3.81	0.91	70	3.86	0.87	73	3.84	0.88	71	3.83	0.9	71
Improve transportation accessibility and liveability	3.74	0.91	66	3.73	0.86	65	3.75	0.89	66	3.74	0.97	68	3.75	0.93	67	3.74	0.9	65	3.75	0.92	67	3.73	0.9	65
Subsidise regional AV ride-hailing	3.55	1.04	59	3.62	0.95	58	3.56	1	59	3.49	1.13	59	3.52	1.05	58	3.58	1.03	59	3.56	1.01	59	3.52	1.12	58
Incentives for ride-hailing fleets	3.38	1.00	49	3.53 [a]	0.92	55	3.44 [a]	0.99	52	3.24 [b]	1.03	44	3.4	1.04	51	3.36	0.96	47	3.4	0.99	50	3.32	1.01	47
Reduce CBD parking	3.03	1.21	40	3.19 [a]	1.13	44	3.07 [ab]	1.19	41	2.9 [b]	1.25	38	3.11 [a]	1.22	44	2.94 [b]	1.19	37	3.09 [a]	1.19	43	2.89 [b]	1.24	35
Congestion and short trip charging	2.93	1.24	38	3.20 [a]	1.16	46	2.98 [b]	1.22	39	2.73 [c]	1.28	33	3.04 [a]	1.26	43	2.82 [b]	1.22	33	2.98 [a]	1.23	40	2.81 [b]	1.26	33
Ban private vehicles in city centres	2.85	1.23	34	3.04 [a]	1.19	38	2.9 [a]	1.21	37	2.71 [b]	1.25	30	2.94 [a]	1.25	38	2.77 [b]	1.21	31	2.91 [a]	1.22	36	2.72 [b]	1.24	30
Prohibit traditional cars	2.61	1.25	27	2.88 [a]	1.22	34	2.7 [a]	1.25	29	2.38 [b]	1.23	21	2.71 [a]	1.28	31	2.51 [b]	1.21	23	2.68 [a]	1.24	28	2.46 [b]	1.25	23
Composite	3.48	0.64	57	3.52	0.58	56	3.48	0.63	57	3.45	0.69	57	3.5	0.66	58	3.46	0.62	56	3.5	0.64	57	3.44	0.65	55
Product deliveries																								
Drone delivery curfews	4.00	0.96	75	3.67 [a]	0.98	62	3.89 [b]	1.01	70	4.29 [c]	0.83	87	3.97	0.98	74	4.04	0.95	77	3.99	0.95	75	4.03	0.99	77
Limit delivery drones over suburbs	3.93	0.93	74	3.73 [a]	0.91	65	3.81 [a]	0.95	69	4.15 [b]	0.88	83	3.87 [a]	0.96	71	4 [b]	0.89	77	3.92	0.94	72	3.97	0.9	77
Ban drone food deliveries to schools	3.73	1.06	62	3.5 [a]	1.06	53	3.69 [b]	1.04	60	3.9 [c]	1.05	69	3.66 [a]	1.07	59	3.8 [b]	1.05	65	3.71	1.06	61	3.78	1.06	65
Ban delivery robots on busy streets	3.72	0.97	62	3.59 [a]	0.96	56	3.56 [a]	0.98	55	3.92 [b]	0.92	72	3.66	0.99	60	3.77	0.94	64	3.71	0.96	61	3.73	0.98	64
Ban unhealthy food/alcohol advertising	3.60	1.08	57	3.5 [a]	1.03	52	3.52 [a]	1.07	55	3.72 [b]	1.12	63	3.56	1.11	56	3.63	1.05	59	3.59	1.08	56	3.62	1.09	60
Ban alcohol delivery by AVs	3.41	1.19	51	3.42	1.11	51	3.35	1.19	48	3.47	1.25	52	3.27 [a]	1.22	45	3.55 [b]	1.15	55	3.4	1.18	49	3.44	1.23	53
Restrict household deliveries	3.07	1.19	40	3.11	1.14	43	3	1.2	38	3.1	1.22	40	3.1	1.19	41	3.03	1.19	39	3.07	1.18	40	3.06	1.22	41
Levy unhealthy food deliveries	3.06	1.21	40	3.2 [a]	1.09	43	3.07 [ab]	1.19	41	2.98 [b]	1.29	37	3.13 [a]	1.22	43	2.99 [b]	1.2	37	3.1	1.2	41	2.98	1.23	38
Composite	3.57	0.68	58	3.47 [a]	0.62	53	3.49 [a]	0.68	55	3.69 [b]	0.68	63	3.53	0.68	56	3.6	0.67	59	3.56	0.67	57	3.58	0.7	59
Total	3.51	0.55	57	3.5	0.52	55	3.48	0.55	56	3.55	0.57	60	3.51	0.56	57	3.51	0.54	57	3.52	0.56	57	3.49	0.54	57

Note: M = mean, SD = standard deviation, % = percent agreement. Means calculated on a 5-point agreement scale (1 Strongly Disagree to 5 Strongly Agree). Percentage support proportions include those selecting 'Agree' or 'Strongly Agree'. Values with different superscripts (i.e., [a, b, c]) differed significantly according to $p < 0.001$ (e.g., support for prohibiting traditional cars was significantly lower among adults aged 55+ than among younger age groups). ^ Four participants were excluded from the gender analyses: two identified as non-binary and two preferred not to disclose their gender.

Statistically significant differences in support scores for the passenger transport and product delivery policies were observed across age, gender, location, and current transport mode use subgroups. In terms of transport policies, greater support was observed among older respondents for accessibility measures, retraining programs, and flying AV limitations. Meanwhile, younger respondents were more receptive to policies involving incentives for ride-hailing services or restrictions on traditional private vehicle use. Gender and location differences were modest, although some significant differences were found for certain policies.

For delivery-related policies, age represented the clearest demographic pattern, with participants aged 55+ years reporting particularly high support for multiple operational restriction measures on drones and delivery robots and for policies prohibiting unhealthy food and beverage advertising. Female respondents reported significantly higher support than male respondents for some of the delivery policies; however, males showed greater receptivity to levies on unhealthy food deliveries. Minimal differences in support were observed between metropolitan and regional respondents.

As shown in Table 4, respondents who used public transport, ride-hailing services, or engaged in active transport during a typical week reported significantly higher support for the transport-related policies compared with non-users. One notable exception, however, was limiting the number of flying passenger autonomous vehicles in operation, for which support did not differ significantly by transport mode. Conversely, personal vehicle users were significantly less supportive than non-users of congestion and short trip charging and reducing CBD parking.

Support for delivery-related policies only differed by public transport user status: compared with non-users, public transport users were significantly less receptive to banning drone food deliveries to schools and significantly more receptive to a levy on unhealthy food and beverage deliveries. Overall, however, the absence of significant differences in the composite product-delivery scores indicates that current transport-mode use was much less strongly associated with attitudes towards product delivery policies than with attitudes towards passenger transport policies.

The regression models were statistically significant (passenger transport model: $R^2 = 0.047$, Adjusted $R^2 = 0.045$, $F = 20.973$, $p < 0.001$; product delivery model: $R^2 = 0.030$, Adjusted $R^2 = 0.028$, $F = 13.232$, $p < 0.001$). Assumption testing indicated no evidence of concerning multicollinearity (VIFs < 1.5 and Tolerance values > 0.50). Inspection of residual plots suggested linear relationships and homoscedasticity, and histograms and normal probability plots indicated approximate normality of residuals.

Current transport mode use was the strongest correlate of support for transport-related policies (see Table 5). Respondents who used public transport, ride-hailing services, and active transport in a typical week were more receptive to the assessed policies than their non-user counterparts. Age, gender, and location were not significantly associated with support. For the product delivery policies, age was the only significant correlate of support, with older respondents expressing greater acceptance. No significant associations were observed for gender, location, or transport use in a typical week.

Table 4. Policy support descriptive results by current use of transport mode subgroups.

Policy	Overall n = 3000			Personal Vehicle User (Car, Truck/Van, Motorcycle/Moped) n = 2776			Public Transport Users n = 1008			Ride-Hailing Service Users n = 338			Active Transport Users (Bicycle, Walk, e-Bike/e-Scooter) n = 1501		
	M	SD	%	M	SD	%	M	SD	%	M	SD	%	M	SD	%
Passenger transport															
Accessibility standards for AV ride-hailing	4.04	0.89	76	4.04	0.89	76	4.06	0.9	78	4.16	0.82	83	4.09	0.86	79
Retraining displaced workers	3.99	0.88	75	3.99	0.88	75	4.07 ***	0.86	78	4.18 ***	0.84	82	4.07 ***	0.85	79
Limit flying passenger AVs	3.94	0.94	73	3.95	0.94	73	3.93	0.93	74	3.96	0.88	78	3.97	0.95	75
Walking, cycling and public transport zones	3.83	0.99	72	3.82	0.99	71	4.01 ***	0.91	79	4.07 ***	0.92	82	3.98 ***	0.94	77
Public education about AVs	3.84	0.89	71	3.83	0.89	71	3.96 ***	0.86	77	4.04 ***	0.82	80	3.93 ***	0.86	76
Improve transportation accessibility and liveability	3.74	0.91	66	3.74	0.91	66	3.9 ***	0.87	75	3.98 ***	0.89	77	3.85 ***	0.9	72
Subsidise regional AV ride-hailing	3.55	1.04	59	3.54	1.05	59	3.7 ***	0.99	66	3.85 ***	0.91	73	3.61 ***	1.04	62
Incentives for ride-hailing fleets	3.38	1.00	49	3.38	1.00	49	3.53 ***	0.95	57	3.75 ***	0.93	67	3.47 ***	0.97	54
Reduce CBD parking	3.03	1.21	40	3.01 ***	1.21	40	3.32 ***	1.15	51	3.44 ***	1.17	56	3.17 ***	1.21	46
Congestion and short trip charging	2.93	1.24	38	2.91 ***	1.25	37	3.26 ***	1.19	50	3.35 ***	1.17	52	3.09 ***	1.24	43
Ban private vehicles in city centres	2.85	1.23	34	2.84	1.23	34	3.08 ***	1.22	42	3.24 ***	1.20	46	2.97 ***	1.24	37
Prohibit traditional cars	2.61	1.25	27	2.6	1.25	27	2.83 ***	1.24	32	2.99 ***	1.27	39	2.68	1.26	28
Composite	3.48	0.64	57	3.47	0.64	57	3.64 ***	0.61	63	3.75 ***	0.57	68	3.57 ***	0.63	61
Product deliveries															
Drone delivery curfews	4.00	0.96	75	4.01	0.96	76	3.95	0.98	73	3.88	1.01	73	4.02	0.98	77
Limit delivery drones over suburbs	3.93	0.93	74	3.93	0.93	74	3.92	0.91	74	3.91	0.93	76	3.96	0.92	75
Ban drone food deliveries to schools	3.73	1.06	62	3.74	1.06	63	3.65 ***	1.07	58	3.57	1.1	57	3.71	1.07	62
Ban delivery robots on busy streets	3.72	0.97	62	3.72	0.97	62	3.68	0.99	61	3.61	1.02	60	3.71	0.97	62
Ban unhealthy food/alcohol advertising	3.60	1.08	57	3.59	1.08	57	3.62	1.07	59	3.62	1.11	60	3.64	1.09	60
Ban alcohol delivery by AVs	3.41	1.19	51	3.42	1.19	51	3.35	1.2	49	3.27	1.25	48	3.39	1.21	50
Restrict household deliveries	3.07	1.19	40	3.08	1.20	41	3.08	1.18	42	3.07	1.24	44	3.09	1.2	42
Levy unhealthy food deliveries	3.06	1.21	40	3.06	1.21	40	3.25 ***	1.19	46	3.24	1.23	51	3.13	1.22	43
Composite	3.57	0.68	58	3.57	0.67	58	3.56	0.67	58	3.52	0.70	59	3.58	0.69	59
Total	3.51	0.55	57	3.51	0.55	57	3.61 ***	0.54	61	3.66 ***	0.53	64	3.58 ***	0.55	60

Note: M = mean, SD = standard deviation, % = percent agreement. Means calculated on a 5-point agreement scale (1 Strongly Disagree to 5 Strongly Agree). Percentage support proportions include those selecting 'Agree' or 'Strongly Agree'. Transport mode categories were non-mutually exclusive. *** $p < 0.001$; significance testing was undertaken between mean scores for private vehicle users vs. non-private vehicle users, public transport users vs. non-public transport users, etc.

Table 5. Linear regression results (n = 2996).

Variable	Passenger Transport			Product Deliveries		
	B [95% CI]	**β**	***p*-Value**	**B [95% CI]**	**β**	***p*-Value**
Age	<0.001 [−0.001, 0.001]	0.002	0.923	0.007 [0.005, 0.008]	0.17	<0.001
Gender [a]	0.002 [−0.01, 0.01]	0.009	0.624	0.004 [−0.01, 0.01]	0.02	0.382
Location	0.006 [−0.05, 0.06]	0.004	0.826	−0.009 [−0.06, 0.05]	−0.006	0.743
Personal vehicle user [bc]	0.01 [−0.08, 0.1]	0.005	0.780	0.08 [−0.01, 0.18]	0.03	0.088
Public transport user [bc]	0.15 [0.09, 0.21]	0.11	<0.001	0.04 [−0.02, 0.1]	0.02	0.204
Ride-hailing service user [bc]	0.2 [0.12, 0.27]	0.1	<0.001	−0.03 [−0.11, 0.06]	−0.01	0.545
Active transport participation [bc]	0.11 [0.06, 0.16]	0.09	<0.001	0.04 [−0.01, 0.1]	0.03	0.116

Note: the dependent variables of Passenger transport and Product deliveries comprised the grand mean scores for the composites of these categories of policies. Reference categories were male, metropolitan, and non-user/non-participant for each transport mode. B = unstandardised coefficient; β = standardised coefficient; CI = confidence interval. [a] Four participants were excluded from the gender analyses: two identified as non-binary and two preferred not to disclose their gender. [b] Typical weekly use/participation. [c] Transport mode categories were non-mutually exclusive.

5. Discussion

The emergence of AV transport and delivery systems is expected to have far-reaching environmental, social, and economic implications [1–4]. To ensure the safe and equitable deployment of AV technologies, the proactive development of policies designed to optimise these outcomes is essential [39,40,68,76]. Public support for such policies is likely to be an important determinant of regulatory feasibility, sustainability, and political support [37]. While much of the existing AV literature focuses on the acceptability of the technology itself [77,78] or on stakeholder and expert attitudes towards potential regulatory measures [68,73,76,79], less attention has been given to public support for specific policy interventions. This study examined attitudes towards what appears to be the largest suite of AV-related policies assessed to date, thereby contributing to a growing body of research seeking to inform future policy decisions [39,40].

Majority support was found for many of the assessed potential measures. In particular, participants tended to be more supportive of policies that place restrictions or impose costs on AV service providers rather than impacting individual behaviours or convenience, although differences in policy wording limit definite conclusions. The former included policies requiring autonomous ride-hail providers to comply with accessibility standards, mandating training programs for workers displaced by vehicle automation, and imposing nighttime curfews on drone deliveries, while the latter included prohibiting traditional car use, banning private vehicles in city centres, reducing CBD parking, placing a levy on unhealthy food deliveries, and restricting household deliveries.

The identified strong support for AV ride-hailing services being required to accommodate accessibility needs is consistent with previous research suggesting that one of the principal benefits of AVs is their potential to improve mobility, accessibility, and independence for older adults and people with disabilities or mobility limitations [80,81]. Although AVs may offer substantial social benefits for these groups, further efforts are still needed to increase their intention to use these services [82]. Similarly, the strong support for retraining programs is aligned with previous research indicating that facilitating worker retraining and upskilling are likely to be critical components of economically sustainable AV governance [3,18,30]. The identified support for curfews on drone deliveries is consistent with previous research examining public acceptance of restrictions on drone-based food and beverage deliveries [39]. Nighttime curfews may represent a practical mechanism for

managing community concerns while preserving the social sustainability of autonomous delivery services.

The least accepted measures were those aimed at reducing dependence on traditional (i.e., non-autonomous) privately owned vehicles, regulating delivery volumes, and introducing levies on transport and product delivery systems. The lower support for these measures could be at least partly due to the fact that they require individuals to change their established travel or consumption behaviours, accept restrictions on convenience, or incur additional costs [83]. For instance, the significantly lower support for reducing the number of parking spaces in the CBD may reflect the large proportion of respondents who reported using personal vehicles in a typical week. Such restrictions may be perceived as limiting personal choice and have been associated with lower levels of public acceptability in previous research [83].

Public support for congestion and short trip charging measures was also consistently lacking. Such measures have typically proven challenging to secure public support for, despite evidence suggesting that they help to manage AV-related travel growth and reduce empty kilometres travelled [44,84–86]. Notably, these measures contribute to environmental sustainability by discouraging unnecessary vehicle use [44,87]. Equally, they may also support social and economic sustainability by helping to ensure that the broader costs associated with AV infrastructure and road use are borne by users rather than disproportionately subsidised by the wider community [30].

Understanding the demographic factors that influence AV policy support is critical for informing public engagement and policy implementation strategies. In the descriptive subgroup analyses, support for almost all policies was higher among older respondents compared with younger respondents. However, when demographic and transport-use variables were entered simultaneously into the regression models, age was only associated with support for product delivery policies. This pattern is largely consistent with existing policy-related research suggesting that older adults may be more receptive to regulatory and restrictive measures [40,83].

The descriptive analyses also revealed differences according to respondents' usual mode of transport. Specifically, public transport users, ride-hailing users, and active transport participants indicated higher levels of agreement for almost all the transport-related policies. Conversely, in the product delivery-related policy category, public transport users were less supportive of restrictions on drone food and beverage deliveries to schools compared with non-users. Of the delivery policies for which significant differences were found, the unhealthy food delivery levy was the only measure that received higher support among public transport users.

After accounting for age, gender, location, and transport mode use, the regression analyses found public transport use, ride-hailing use, and active transport participation to be independently associated with greater support for transport-related policies, but not product delivery policies. This finding relating to public transport users is consistent with previous research showing that this group is more likely to support sustainable transport initiatives [85,88]. Neither gender nor location was associated with policy support in the multivariate regression analyses. Although statistically significant, the regression models explained relatively small proportions of variance, suggesting that other factors not assessed in the study are likely to influence policy support.

5.1. Policy Implications

The findings of this study provide insights that may assist policymakers in designing publicly acceptable and sustainable AV governance measures. Given the potentially far-reaching environmental, social, and economic impacts of AVs, these policy measures should

be proactive and anticipatory [39,40,68,76]. The results of the present study suggest that measures that involve imposing restrictions on service providers rather than restricting personal travel or delivery behaviours are likely to be most acceptable to the Australian public. Policies that are clearly designed to promote the equitable integration of AVs to maximise the technology's social benefits are also likely to be considered more acceptable.

Australia has already taken steps towards nationally consistent AV regulation in the form of the development of a safety framework and broader programs supporting the deployment of autonomous vehicles [38,89]. By identifying publicly acceptable policy approaches, this study provides insights that can support the further development of effective and publicly supported governance frameworks. These findings may help policymakers prioritise regulatory measures that are likely to attract greater support and identify policies for which further public consultation may be particularly useful, including investigation into the reasons underlying lower levels of support. Such efforts may be particularly important for demographic groups that appear less receptive to certain governance measures.

5.2. Limitations and Future Research Directions

The study has several limitations. First, the survey design exposed respondents to illustrative future scenario vignettes prior to assessing their support for the proposed policies. This is likely to have shaped the context in which respondents assessed these policy measures, and as a result may have introduced some priming effects. However, due to the futuristic nature of the technology, the depicted scenarios may or may not reflect how AVs will actually emerge. Second, as transport and product delivery AVs are not widely available in Australia, participants were required to think hypothetically about the integration of AVs into society and the policy implications of this integration. Third, recruiting participants via a survey panel provider introduces the possibility of selection bias based on unmeasured characteristics, such as technological literacy and political ideology. These characteristics are difficult to observe and control for and may be associated with both participation in the survey and policy attitudes. Generalisability is further limited by the study's Australian context, as the findings are not necessarily applicable to other national contexts. Lastly, the heterogeneous nature of the proposed policies could mean that the transport and product delivery composite scores within the regression model may have masked some policy-specific preferences.

Future research could address these limitations by investigating policy support in other cultural and regulatory contexts. Longitudinal research designs would also be useful for assessing whether public attitudes to both AVs and their regulation alter as the technology becomes more familiar through direct and vicarious experience. Such research would strengthen understanding of the extent to which public preferences identified prior to widespread AV deployment persist as these systems become integrated into everyday urban environments.

6. Conclusions

The study results indicate that while a majority of participants agreed with many of the proposed measures, public support can vary considerably across proposed AV policies. The most strongly accepted measures pertained to accessibility, worker transition, and operational restrictions on both product deliveries and transport. In contrast, policies directly constraining private vehicle use or imposing taxes or levies received the least support. Differences in outcomes were observed across transport user groups, with public transport and ride-hailing users reporting greater support for most transport policies compared with

non-users. These insights can inform the development of publicly acceptable policies for autonomous transport and delivery systems that support sustainable urban environments.

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