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Research Article

Public perception of connected and automated vehicles: Benefits, concerns, and barriers from an Australian perspective

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ABSTRACT: This study investigates the attitudes and concerns of the Australian public toward connected and autonomous vehicles (CAVs), and the factors influencing their willingness to adopt this technology. Through a comprehensive survey, a diverse group of respondents provided valuable insights toward various CAV scenarios such as riding in a vehicle with no driver, self-driving public transport, self-driving taxis, and heavy vehicles without drivers. The results highlight the significant impact of safety concerns about automated vehicles on individuals' attitudes across all scenarios. Higher levels of concern were associated with more negative attitudes, and a strong correlation between concerns and opposition underlines the necessity of addressing these apprehensions to build public trust and promote CAV adoption. Interestingly, nearly 70% of respondents felt uncomfortable driving next to a CAV, but they displayed more confidence in adopting automated public transport in the near future. Additionally, around 40% of participants indicated a strong willingness to purchase a CAV, primarily driven by the desire to reduce their carbon footprint and safety considerations. Notably, respondents with health conditions or disability exhibited heightened interest (almost double those without health conditions) in CAV technology. Gender differences emerged in attitudes and preferences toward CAVs, with women expressing a greater level of concern and perceiving higher barriers to CAV deployment. This emphasizes the importance of employing targeted approaches to address the specific concerns of different demographics. The study also underscores the role of trust in technology as a significant barrier to CAV deployment, ranking high among respondents' concerns. To overcome these challenges and facilitate successful CAV deployment, various strategies are suggested, including live demonstrations, dedicated routes for automated public transport, adoption incentives, and addressing liability concerns. The findings from this study offer valuable insights for government agencies, vehicle manufacturers, and stakeholders in promoting the successful implementation of CAVs. By understanding societal acceptance and addressing concerns, decision-makers can devise effective interventions and policies to ensure the safe and widespread adoption of CAVs in Australia. Moreover, vehicle manufacturers can leverage these results to consider design aspects that align with passenger preferences, thereby facilitating the broader acceptance and adoption of CAVs in the future. Finally, this research provides a significant contribution to the understanding of public perception and acceptance of CAVs in the Australian context. By guiding decision-making and informing strategies, the study lays the foundation for a safer and more effective integration of CAVs into the country's transportation landscape.

KEYWORDS: connected and automated vehicles (CAVs), autonomous vehicles, public acceptance, stakeholder consultations, road safety

1 Introduction

Over the past decade, there has been a remarkable surge in investment and advancement in vehicle connectivity and automation technologies (Cohen et al., 2020). This progress has paved the way for the emergence of connected and autonomous vehicles (CAVs) that are expected to transform transportation in the coming years. According to expert projections, commercially available CAVs with high and full driving automation (Society of Automotive Engineers (SAE) Level 4 and Level 5 categories as presented in Table 1), are anticipated to be accessible starting in the 2030s (Gao et al., 2016; Litman, 2020). Furthermore, these projections suggest that by 2060, advanced vehicles could achieve market penetration rates ranging from 50% to 90%, depending on various technological, marketing, and policy factors.

The potential of CAVs to reshape cities and impact urban life is profound, promising, and complex. On one hand, these vehicles offer the potential to optimize travel time, enhance safety by mitigating human errors in driving, and improve energy efficiency by reducing road congestion (de Almeida Correia et al., 2019; Luttrell et al., 2015; Stanek et al., 2018). CAVs can also provide more affordable and accessible mobility services, catering to those who are unable or unwilling to drive. They can also address the first and last-mile challenges faced by conventional public transport (Bösch et al., 2018; Moorthy et al., 2017). Moreover, CAVs can facilitate the efficient use of road space which opens up opportunities for more walkable and vibrant urban environments. With reduced demand for parking, they would enable the transformation of city centers into green spaces and mixed-use

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Table 1 SAE vehicle automation levels (SAE, 2021)

Automation level	Key characteristics
Level 0	No automation available. The driver is always engaged, and entirely responsible for operating the vehicle. Some limited warning features such as automatic emergency breaking may available.
Level 1	Shared control between the driver and the system. The driver must remain alert and be ready to take control at any time.
Level 2	Automated systems assume complete control of the vehicle. However, the driver must maintain contact between hand and wheel to confirm readiness to take over if needed.
Level 3	The driver can safely divert attention from driving tasks but must be prepared to intervene within a predefined time if required.
Level 4	Driver attention is not mandatory. The vehicle is capable of completely autonomous self-driving within a limited area (geofenced) or under special circumstances, such as traffic conditions.
Level 5	No human intervention is required. The vehicle is fully autonomous and capable of operating in all situations without any driver involvement.

developments (Stead and Vaddadi, 2019).

However, the widespread adoption of CAVs also brings potential challenges and adverse impacts which need to be managed. Increased car dependence as a result of lower costs of running autonomous taxis can potentially lead to more car trips and longer commutes, resulting in higher vehicle miles traveled, more pollution and carbon emissions, as well as unsustainable urban sprawl (Auld et al., 2017; Guan et al., 2021). Physical inactivity arising from increased car usage may also lead to public health issues, such as cardiovascular diseases, diabetes, and cancers (Rojas-Rueda et al., 2017). Additionally, there are concerns that the adoption of CAVs could exacerbate mobility disparities between socially-advantaged and socially-disadvantaged groups, affecting their access to CAV technology and services (Bösch et al., 2018; Butler et al., 2021).

Cities, therefore, face both opportunities and challenges in harnessing the potential benefits of CAVs while minimizing their potential negative consequences. Adequate preparation of infrastructure, policies, regulations, and public awareness is essential for cities to adapt to mass adoption of CAVs successfully. This will ensure that CAVs can truly transform urban areas into more efficient, safer, sustainable, equitable, and livable environments. As the era of CAVs approaches, understanding and addressing these multifaceted implications become crucial for shaping the future of transportation and urban development.

In recent years, a few pioneering studies have taken a more comprehensive approach to investigate the intricate relationships between individuals' opinions about CAVs and their demographic characteristics (Bansal and Kockelman, 2017; Haboucha et al., 2017; Howard and Dai, 2014; Krueger et al., 2016). In Australia, however, research on public perception and acceptance of this groundbreaking technology remains limited. To bridge this gap, the present study conducted an extensive survey to gain insights into the complexities of Australian opinions regarding CAV technologies, their concerns, benefits, and barriers.

With a particular focus on Melbourne, one of Australia's largest and most populous cities, this research sought to gather and analyze representative public opinion data. The survey explored various aspects of CAVs, including general concerns, public awareness regarding the benefits and barriers of CAVs, as well as specific public policy issues such as safety and privacy. By examining these multifaceted dimensions of public opinion, this study contributes to the broader social science problem of understanding public acceptance of CAVs and categorizing the different concepts within public opinion.

The findings of this research help to shed light on the critical factors influencing individuals' attitudes toward CAVs, providing valuable insights for policymakers, industry stakeholders, and urban planners. By understanding public perceptions and concerns, the study can aid in shaping appropriate policies, regulations, and infrastructural developments to ensure a smooth and successful integration of CAVs into Australia's transportation systems. Ultimately, with a clearer understanding of public acceptance, pathways can be established for a safer, more efficient, sustainable transportation future in Australia.

The pace of adopting a new technology is heavily influenced by people's opinions and attitudes (Patel and Connolly, 2007). This fact holds significant implications for the adoption of CAVs and the realization of the benefits they offer.

1.1 Research objectives and contribution

The primary objective of this study is to determine if a representative sample from an Australian city is prepared for this technology. Additionally, the research aims to identify the user groups that are likely to be early adopters of this promising technology, while also uncovering the concerns that may hinder the widespread adoption of a technology that has the potential to save countless lives by reducing traffic crashes. To achieve these objectives, this study analyses responses from 495 participants to gain a comprehensive understanding of the participants' attitudes toward urban mobility, the role of connected and automated cars, their level of trust in technology, their perspectives on privacy, and their willingness to embrace CAVs in the future.

The following key research questions are postulated in this Australian-focused study:

RQ1. What are the main concerns that could hinder participants from adopting CAVs?

RQ2. What do participants perceive as the key benefits of CAVs?

RQ3. How much trust do participants have in technology, particularly in relation to CAVs?

RQ4. What are the opinions of participants regarding privacy concerns with the use of CAVs?

RQ5. To what degree are participants willing to embrace CAVs in the future?

RQ6. What policies should be considered to accelerate successful adoption and deployment of CAVs?

In addressing these questions, this paper provides insights into the Australian population's preparedness for CAVs. Specifically, it aims to identify potential early adopters, understand concerns hindering adoption, explore perceptions of urban mobility and trust in technology, and gauge willingness to embrace this transformative technology. The study's findings will be crucial in shaping strategies to facilitate a successful integration of CAVs into the transportation system and maximize the benefits they offer, such as saving lives through reducing traffic crashes. This research contributes to the broad social science challenge of comprehending the impacts of CAVs. It contributes further by analyzing the notion of public opinion, examining how various demographic groups correlate with distinct perceptions of the advantages and apprehensions associated with using CAVs.

1.2 Content structure

The structure of this paper is outlined as follows: Section 2 provides a summary of recent related studies. Section 3 presents the formulation of the research hypothesis. The methodology is detailed in Section 4, while Section 5 presents the survey. Section 5 outlines the survey results, including realized benefits, barriers, concerns, and the willingness to transition to CAVs. The correlation analysis of the evaluated research parameters is discussed in Section 6, followed by a comprehensive discussion in Section 7. The paper concludes with Section 8.

2 Literature review

Recently, there has been a notable increase in research exploring the versatile implications of fully automated mobility facilitated by CAVs. Scholars have examined various perspectives, including safety, efficiency, communication, and the integration of digitalization technology (Emory et al., 2022; Matin and Dia, 2022; Othman, 2022). Numerous surveys have been conducted by researchers and private enterprises to gauge public opinions regarding CAV technologies and related aspects. These surveys consistently revealed that the public remains cautious about the potential of driverless vehicles, expressing concerns mainly related to safety, affordability, and information security.

2.1 Concerns toward CAVs

In a survey by Schoettle and Sivak (2014a) involving 1,533 adults from UK, USA, and Australia, it was found that more than half of the sample had a generally positive opinion about the impacts of autonomous vehicles (AVs) (Schoettle and Sivak, 2014a). More than 25% of experts believed that AVs must be at least twice as safe as conventional vehicles, and over 75% believed that their safety should be socially acceptable if they are only involved in few crashes compared to human-driven vehicles (Underwood, 2014). A survey by Kyriakidis et al. (2015) with 4,886 respondents worldwide, identified information security and legal liability, and safety as the biggest concerns (Kyriakidis et al., 2015).

In another survey involving 450 participants, safety emerged as the biggest concern among the public followed by concerns related to legislation problems (Jardim et al., 2013). In focus group studies conducted in California, Illinois, and New Jersey, women showed a higher receptivity to the idea of autonomous vehicles (AVs), a finding that contrasts with earlier research (Klynveld Peat Marwick Goerdeler (KPMG), 2013). In a survey of 1,028 Americans revealed that 44% of men and 23% of women were concerned about giving up the joy of driving (Danise, 2015). Safety was the biggest concern for 55% of women and 37% of men. Only 6% of respondents would send their children alone to a friend's house in an AV. In another survey of 505 U.S. motorists, it was observed that young men had a greater preference for partial or full automation over no automation (Schoettle and Sivak, 2015). Surprisingly, in the same survey study, there was a greater concern for riding in Level 4 AVs compared to Level 3 AVs.

Moreover, Howard and Dai (2014) conducted a survey of 107 visitors to the Lawrence Hall of Science in Berkeley, California, to understand their opinions about AVs. The results indicated that safety was the most attractive feature of AVs, while the lack of control over the vehicle was the least attractive. In their analysis, they used logit and log-linear regression models to estimate the multivariate relationship between public opinions and their demographics. The study revealed that higher-income individuals were more likely to use SAVs and retrofit their cars with AV technologies. Similarly, Bansal et al. (2016) conducted a survey in Austin involving 347 participants to explore their opinions about CAV technologies (Bansal et al., 2016). They found that equipment failure was the primary concern among respondents, while learning to use AVs was of least concern. König and Neumayr (2017) conducted a case study on automated vehicles to look at people's opposition toward radical innovations. The study material was compiled through a quantitative online survey with the aim to include respondents from several different countries. Ultimately, the study received 489 responses from 33 countries and established that their hypothesis about the psychological barriers concerning automated driving does apply. On average, people were reluctant to hand vehicle control over to automation and most people feared potential cyberattacks and disruptions in automated systems. Another survey by Continental (2022) gathered the opinions of 6,000 car users (1,000 people per country) across six countries (Germany, France, USA, China, Japan, Norway). Results revealed that respondents across all six countries view automated driving as a beneficial advancement, with individuals in Asia exhibiting notably higher receptiveness. However, the findings indicate that 78% of all respondents find liability regulations unclear. Furthermore, while 82% of drivers in China express confidence in using automated driving during traffic jams, this confidence drops to 37% in Germany and France. Additionally, while 67% of individuals in China believe automated driving will become practical in a few years, over half of respondents in Europe and USA are skeptical regarding the reliability of the technology.

2.2 Willingness to purchase and use CAVs

In the study by Schoettle and Sivak (2014a), around 55% of Australian respondents reported a willingness-to-pay (WTP) of $0 for Level 4 Automation. Another survey conducted with 217 experts revealed the main barriers for Level 4 AVs were legal issues and technological limitations (Underwood, 2014). A 2011 survey involving 2,006 U.S. and British consumers revealed that 49% of the participants were comfortable using Level 4 AVs (Accenture, 2011). In the same survey study, around 48% of respondents in the remaining group said they might consider using AVs if the driver can regain control. The median WTP to add Level 4 automation to a $30,000 car was found to be $4,500 (KPMG, 2013). An insurance company survey with 2,000 American drivers found that 22.4% of respondents were ready to ride in a Level 4 AV, while 24.5% reported never wanting to use AVs (Masterson, 2023). However, the potential for an 80% discount on car insurance changed these numbers to 37.6% and 13.7%, respectively. Around 22% of respondents reported a WTP of $0 to add full (Level 4) automation, with only 5% willing to pay more than $30,000.

A 2015 survey found that only 21% of respondents reported a WTP of more than $5,000 to add Level 4 Automation (Danise, 2015). Similarly, in a survey by Bansal and Kockelman (2017), 2,167 Americans provided estimates of their WTP to add DSRC-based connectivity and Level 4 Automation. The results showed a WTP of $67 for connectivity and $5,857 for Level 4 Automation. More than 50% of respondents reported a WTP of $0 for both connectivity and Level 4 Automation, with 50% feeling uncomfortable sharing vehicle-to-vehicle information.

Among other noteworthy past studies, Krueger et al. (2016) carried out a stated choice experiment involving 435 Australian residents to explore their preferences for shared autonomous vehicles (SAVs) and ridesharing. The results indicated that around 36% of respondents were inclined to shift their travel mode to SAVs, with younger travelers and current carsharing users showing a higher propensity for SAVs with ridesharing. The preference for SAVs was more pronounced for work trips than leisure trips, and respondents who had used public transport on their recent trips were less likely to switch to SAVs. Krueger et al. (2016) reported that the findings from their study can be incorporated into existing frameworks to estimate more realistic environmental impacts and determine optimal SAV fleet sizes.

Another significant study, Haboucha et al. (2017) examined preferences for SAVs or privately-owned AVs for work- and education-related trips. Their survey involved 721 participants and utilized hybrid choice models for parameter estimation. The results revealed that only 75% of respondents showed interest in using SAVs, even if they were available for free. To encourage SAV usage, the researchers suggested the importance of educating the public about the benefits of SAVs and increasing the cost of using regular cars. The average willingness to pay for adding Level 3 and Level 4 automation was also assessed, and it was observed that more than 80% of respondents showed little interest in using SAVs at costs higher than current carsharing prices. Notably, wealthier and tech-savvy males exhibited a higher willingness to pay for CAV technologies, whereas older licensed drivers expressed less interest (Bansal et al., 2016). Respondents estimated the cost to add Level 4 automation to vehicles at US$5,000 with their willingness to pay (WTP) for this technology being US$1,000 (Jardim et al., 2013). Another study by Cisco (2013) that conducted a survey involving 1,514 adults across 10 countries showed that around 57% of the respondents expressed their willingness to ride in a driverless car.

3 Hypotheses

This study aims to investigate the concerns, perceived benefits, and barriers related to the deployment of CAVs in Australia. In order to structure this investigation, the formulation of the following hypotheses has been grounded in an extensive literature review:

Hypotheses for public concerns:

H1: Majority of the public expresses significant concerns about the safety of fully autonomous vehicles.

H2: CAV Information security and deterioration of privacy remains a primary concern among the public.

H3: Affordability is identified as one of the primary reasons to switch to CAVs.

H4: Women are more concerned than men regarding CAV safety issues.

H5: The public perceives improved road safety as a major benefit of CAVs due to automation.

H6: CAV adoption influenced by increased convenience, comfort and free time while travelling.

H7: The primary perceived benefit of CAV is the reduction of travel time and congestion on roads.

H8: Legal/regulatory barriers pose challenges to widespread CAV adoption particularly crash liability.

H9: Technological limitations such as system reliability can hinder CAV adoption.

H1 is based on the studies by Schoettle and Sivak (2014a), Underwood (2014), Kyriakidis et al. (2015), and Bishop et al. (2021) in which the respondents expressed their concern on the traffic safety of automated vehicles.

H2 is based on studies by Kyriakidis et al. (2015) and Bella et al. (2021). Kyriakidis et al. (2015) found that deterioration of privacy was considered a major concern with automated vehicles. The findings from Bella et al. (2021) underscored that the vast amount of data collected and processed by these vehicles can be vulnerable to cyberattacks, leading to potential safety breaches and misuse of personal information.

H3 is formulated based on studies by Lee and Hess (2022) and Fagnant and Kockelman (2015). Lee and Hess (2022) suggested that cost savings, both in terms of vehicle ownership and operational costs, can incentivize the public to embrace CAVs. Fagnant and Kockelman (2015) found that while there's anticipation of long-term cost savings due to reduced crashes and increased vehicle longevity, the initial investment required for CAVs might be a deterrent for many.

H4 is based on the study by Lee and Hess (2022) which highlighted that women tended to be more cautious and risk-averse in their approach to new technologies. Bansal et al. (2016) further supported this hypothesis, noting women's heightened concerns about system reliability and potential safety breaches. Schoettle and Sivak (2014a) found that women tended to be more cautious and expressed greater concerns about the safety implications of autonomous vehicles, compared to men.

H5 draws on research conducted by Lustgarten and Le (2018). In their survey, they identified that respondents ranked the "highest possible level of safety" as the single most important benefit of CAVs.

The aim of H6 was to evaluate the findings of these research studies. A study by Haboucha et al. (2017) found that respondents were keen on the idea of using travel time productively, whether for work, relaxation, or entertainment, without the need to focus on driving. Shin et al. (2019) and Golbabaei et al. (2020) highlighted that the ability to engage in other activities while traveling, without the need to focus on driving, can enhance the overall travel experience and make CAVs an attractive option.

H7 is formulated to evaluate the conclusions drawn by Lee and Mirman (2018) and Milakis et al. (2017) in their respective studies. Lee and Mirman (2018) suggested that the coordinated movement of CAVs, coupled with efficient route planning, can optimize traffic flow and reduce bottlenecks, leading to faster commutes. Milakis et al. (2017) discussed how CAVs, with their ability to communicate with each other and with traffic management systems, could lead to smoother traffic flow and reduced travel time.

H8 is based on studies by Kyriakidis et al. (2015) and Underwood (2014). Their findings underscored that the ambiguity surrounding responsibility in the event of a crash involving a CAV, as well as legal liability and regulations can deter potential users from adopting CAVs.

H9 is structured around the research conducted by Howard and Dai (2014). They pointed out that concerns about system malfunctions, software glitches, and the inability of CAVs to handle certain complex driving scenarios can make potential users hesitant to embrace this technology.

4 Methodology

4.1 Data collection

In this research, a comprehensive 44-question survey was

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designed and received approval from the institution's Human Research Ethics Committee (approval reference 20226366-10982, modification reference 20226366-11087). The survey gathered data on public perceptions of CAVs and related technologies. The survey sample was drawn from the Melbourne population using a specialist survey panel company, ensuring a representative and randomized selection of participants. Before the survey was made public, a pilot test was conducted internally to refine and clarify certain questions as needed. The survey instructions explicitly explained the objectives of the study and provided clear definitions of CAVs, levels of automation, and driver assistance technology.

The inclusion criteria for participation in the survey were as follows: (1) Respondents must be at least 18 years of age; (2) respondents must currently reside, work, or study in Melbourne; (3) respondents must have read the information statement and voluntarily agree to participate; and (4) at the end of the survey, respondents were required to provide final consent for their responses to be recorded. Participation in the survey involved completing an online questionnaire which typically took between 15 and 20 min. To ensure confidentiality and anonymity, no personally identifiable information was collected from the participants. While some demographic questions, such as age brackets and postcodes of residence and workplace were included, individual data was aggregated during the analysis to safeguard the privacy of respondents. A total of 562 responses were recorded but only 495 responses were deemed valid for analysis. The remaining 34 responses were incomplete with some questions unanswered, and 33 respondents did not meet the specified eligibility criteria.

4.2 Survey instrument

The survey was conducted using the web-based survey platform Qualtrics (www.qualtrics.com). Each participant in the survey panel received a unique link to access and participate in the survey. The survey gathered comprehensive information about participants, including household and sociodemographic details, travel behavior, opinions on new transport technologies, and driving habits. The survey was structured into six sections as follows:

Section 1: Determination of eligibility to participate in the survey.

Section 2: Obtaining informed consent from the participants.

Section 3: Collection of household and sociodemographic information such as age, gender, income level, educational level, and suburb postcode.

Section 4: Data collection about respondents' travel behaviors, including modes of transport they use for commuting and leisure activities, as well as the types of vehicles they own.

Section 5: Data collection about respondents' opinions on new transport technologies and CAVs, as well as their potential acceptance and willingness to pay for these technologies.

Section 6: Data collection about respondents' driving behavior, particularly focusing on their compliance with traffic rules such as driving within speed limits and maintaining safe headways. This data was necessary to develop more representative traffic simulation models for evaluating CAV impacts.

The main sources of information sought from the respondents included:

• Age, gender, residential location, levels of education, and health conditions.

• Familiarity with and general opinion about autonomous and self-driving vehicles.

• Familiarity with current autonomous vehicle technology in their vehicles (if applicable).

• Expected benefits of different levels of connected and automated vehicles.

• Concerns about using connected and automated vehicles.

• Concerns about different possible implementations of connected and automated vehicles.

• Overall interest in owning and willingness to pay for CAV technologies.

This paper only focuses on respondents' perspectives on CAV technology, specifically concerns, barriers, and benefits. To assess these views, a Likert scale question with five options (intensely interested, likely interested, undecided, unlikely to support these technologies, and strongly oppose the technology) were included in the survey. Additionally, respondents were asked to estimate the timelines for their likely adoption and transition to CAVs using a multi-ordinal question with options ranging from 10 to 25 years, with a 5-year interval. Respondents selected their preferred mode of transport (i.e., automated car, taxi, or public transport) along with their answer.

The survey data was analyzed using IBM SPSS Statistics software. The statistical analysis included cross tabulations to explore the factors influencing the responses and to identify any significant differences between variables with preference scales. To evaluate the statistical significance of the cross-tabulations, the Mann–Whitney U test and the Kruskal–Wallis H tests were utilized, as they are appropriate for testing differences in variables with preference scales.

5 Results

5.1 Demographic overview

Demographic information provides valuable insights into the participant's characteristics. Regarding gender distribution, 51.1% identified as male, while 48.5% identified as female, and a small fraction, 0.4%, preferred not to disclose their gender. In terms of household structure, the majority (40.8%) belonged to couples with children, followed by 29.3% being couples without children. Other household structures, such as multi-generational households, multifamily households, shared households, single occupants, and single parents, collectively accounted for the remaining percentages.

Education levels were diverse among the respondents, with the highest percentage (37.78%) holding a Bachelor's degree. Other education levels, including high school, trade school, graduate certificate, master's degree, and doctoral degree, were distributed among the participants. The income distribution revealed that a significant proportion of respondents earned between A$60,000 and A$100,000, with 15.96% falling within this range. Around 76.52% of respondents reported no restrictions on driving or disabilities. The majority (95.35%) possessed a valid driver's license, while 4.65% did not have a driver's license. As for daily vehicle kilometers traveled, 48.06% of respondents traveled 20–50 km per day, and a smaller percentage (0.65%) traveled more than 100 km per day. A more detailed analysis and breakdown of demographic variables is being published in another article, providing further insights into the relationship between respondents' characteristics and their perspectives on CAVs.

5.2 Benefits and concerns

Almost 75% of respondents expressed that all automated vehicles must have the option of being human driven (Fig. 1). Around

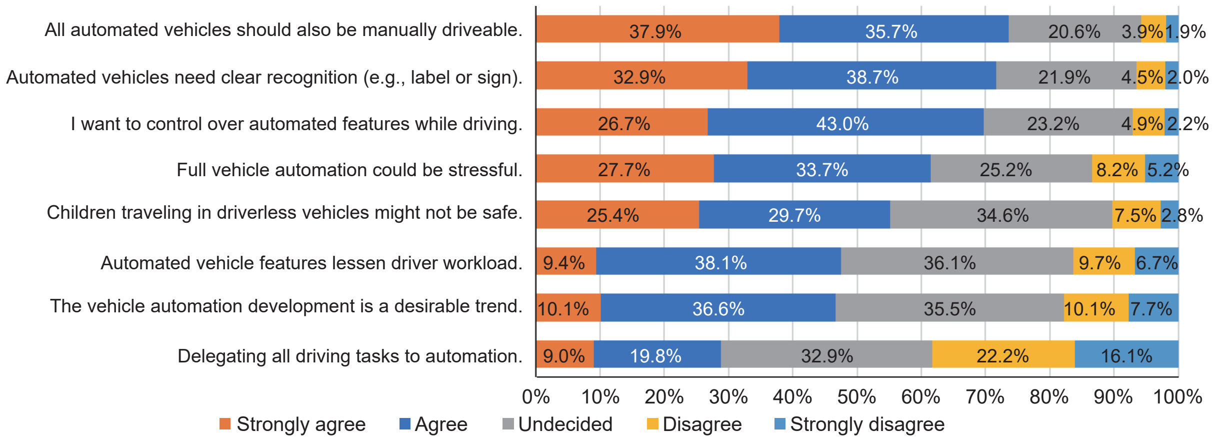

Fig. 1 Responses to statements on the development of vehicle automation.

72% of respondents also believed that automated vehicles must be recognizable from other vehicles, for example, by a specific label or sign. Around 70% of participants said they would also like to determine where and when to use the automated functions, and which functions to use which suggests that respondents may be uncomfortable with automated vehicles with no control devices. Giving the driving responsibility to a computer would make almost 62% of respondents feel stressed. Only 13% of respondents stated that they would feel relaxed about releasing the driving responsibility to a computer. However, almost 48% of respondents expressed that having automation in charge of driving would reduce driving workload. Approximately 16% of respondents disagreed with the statement. More than half of respondents (55%) expressed that it was unsafe for kids to travel in a driverless car, and just 10% disagreed. Based on the survey results, it is evident that a significant portion of the respondents, approximately 47%, hold a positive view on automation, specifically in the context of automated vehicles being seen as a desirable trend. Conversely, only about 18% of respondents disagreed with this statement.

Regarding preferences for automation to handle driving in all situations, approximately one-third of respondents (around 33%) expressed their inclination toward this concept. However, about 22% of respondents disagreed with this notion, and a further 16% strongly disagreed (Fig. 1).

These findings suggest that a considerable majority of respondents are hesitant about fully entrusting all driving tasks to automation, indicating that there is a notable lack of trust and concern about safety in this regard. This observation supports the validity of hypothesis H1, which implies that such concerns are indeed prevalent among the surveyed individuals.

5.2.1 Barriers to public acceptance

Fig. 2 presents the respondents' perceptions of the barriers to public acceptance of CAVs, ranked in order of significance. The most prominent concern expressed by approximately 46% of respondents was the technical reliability or trust in the technology, ranking it as the number one barrier. This particular concern claimed the top spot among the identified barriers. These findings provide support for H9, which posits that system reliability is a principal impediment to the adoption of CAVs, and answers RQ3. Following closely behind is the impediment of the high price of the technology, which was ranked as the second most significant barrier, followed by legal issues associated with CAVs which was ranked third. On the other hand, respondents ranked the lack of regulations about the technology as their least concern, placing it in the seventh position. The level of concern about the cyber security of automated vehicles and the potential erosion of privacy was found to be moderate, ranking fourth and fifth in priority, respectively. Interestingly, respondents held differing opinions on the matter of cyber security. This implies that H2 (which considers information security as a primary concern) is not fully supported by the results. Furthermore, these findings directly address RQ4, which focuses on the public's apprehensions about the privacy implications of CAVs. One potential explanation for this outcome is that as new technologies emerge and individuals become more accustomed to them, concerns related to information security will gradually decrease over time.

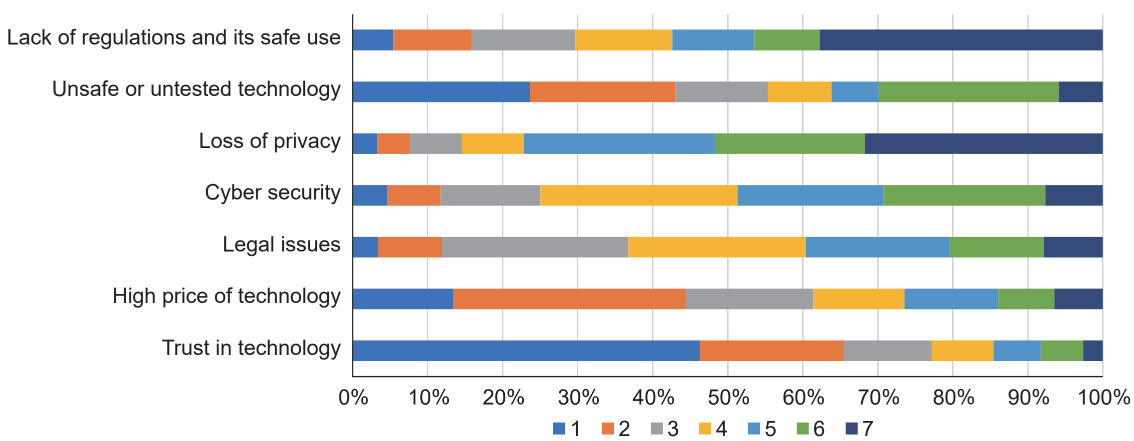

Fig. 2 Participants views on barriers to public acceptance of automated vehicles. Ranking 1–7 where 1 is most significant barrier and 7 is the least significant barrier.

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5.2.2 Public concerns

In relation to RQ1, which focuses on public concerns about CAVs, the general attitude toward automated vehicles somewhat affects the importance of related concerns. Those generally expressing a positive attitude toward automated vehicles are less concerned than others. Regarding participants' opinions on barriers to the deployment of CAVs, the results show that legal liability for owners/drivers, safety consequences or equipment failure, and interactions with pedestrians and bicycles were the top three main barriers voiced by participants (Fig. 3). The survey results indicate that certain factors are perceived as less likely to be potential barriers to CAV adoption. Specifically, learning to use self-driving vehicles, data privacy, and interacting with non-CAVs were considered the least concerning aspects. System performance in poor weather and system security from hackers were found to be of medium concern in this category.

Based on these findings, hypothesis H8, which posits that legal and regulatory barriers will impose significant challenges to the widespread deployment of CAVs, is supported by the data. It suggests that legal and regulatory considerations indeed hold weight in the public's perception of CAV adoption. In contrast, privacy concerns related to CAVs were considered to be of low priority in the Australian context. This finding does not support hypothesis H2, which posits that deterioration of privacy is a major concern associated with CAVs. The data indicates that privacy concerns may not be as prominent among respondents when it comes to CAV technology in Australia.

Table 2 presents the variations in perceived barriers to the deployment of CAVs based on gender. The data reveals that, overall, women express greater concerns about these barriers compared to men. This finding confirms the H4 hypothesis, which posits that women are more apprehensive than men when it comes to safety issues related to CAVs. The results indicate that gender plays a role in shaping the levels of concern that individuals have toward the safety aspects of CAVs, with women showing a higher degree of concern compared to their male counterparts.

Concerns related to the type of autonomous vehicle were assessed in a separate question (Fig. 4). Results showed that almost half of respondents (47% of participants) were strongly concerned about commercial autonomous vehicles such as heavy trucks or semi-trailers. Around 34% of respondents also voiced their strong concerns about autonomous buses and taxis, and around 32% were strongly concerned about riding in a vehicle with no driver.

Table 3 presents the results of the Kruskal–Wallis H test analyzing the differences in attitudes toward automated vehicles based on respondents' main concerns

Table 3 provides information on the mean rank,

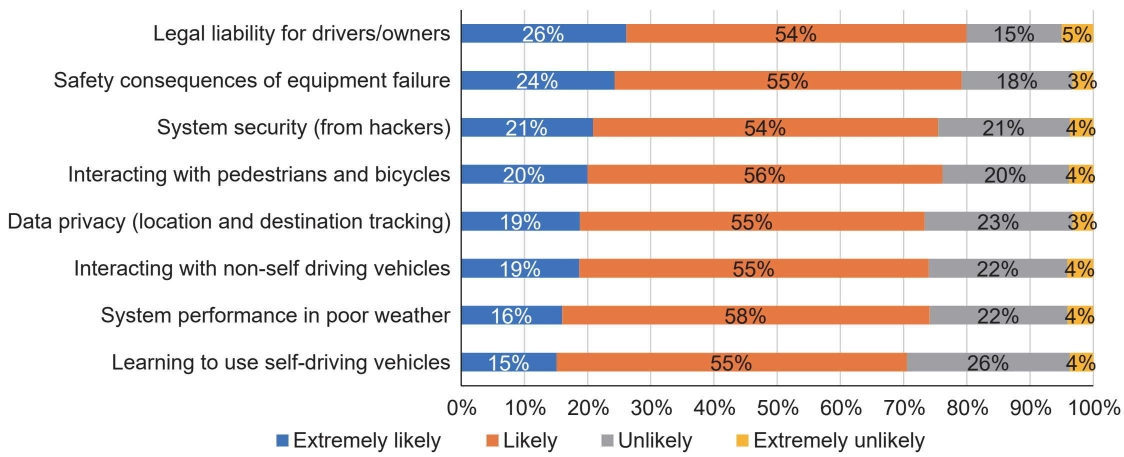

Fig. 3 Participants' opinions on barriers to CAV deployment.

Table 2 Differences in perceived barriers to deployment of CAVs according to gender*

		Extremely unlikely	Unlikely	Likely	Extremely likely
Learning to use self-driving vehicles	Female	1.2%	19.1%	58.5%	21.2%
	Male	5.2%	31.3%	53.1%	10.4%
System performance in poor weather	Female	0.9%	18.2%	62.3%	18.6%
	Male	6.8%	25.3%	54.6%	13.3%
Interacting with non-self-driving vehicles	Female	1.2%	19.1%	60.2%	19.5%
	Male	6.4%	24.5%	51.0%	18.1%
System security (from hackers)	Female	1.7%	16.1%	58.9%	23.3%
	Male	5.2%	25.3%	52.2%	17.3%
Safety consequences of equipment failure or system failure	Female	2.1%	12.7%	58.5%	26.7%
	Male	4.0%	22.1%	52.6%	21.3%
Data privacy (location and destination tracking)	Female	2.1%	21.2%	53.4%	23.3%
	Male	4.0%	26.1%	55.8%	14.1%
Legal liability for drivers/owners	Female	2.1%	12.3%	54.7%	30.9%
	Male	6.4%	17.7%	53.8%	22.1%

Note: * In this question, respondents were asked how likely they think the mentioned barriers will impact deployment of fully and highly connected and automated vehicles.

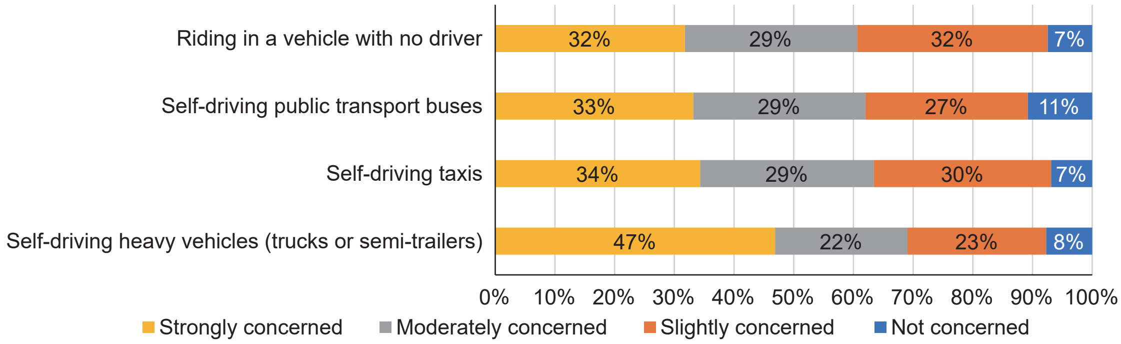

Fig. 4 Participants' concerns regarding autonomous vehicles.

Table 3 Kruskal–Wallis H test results on differences in attitudes toward automated vehicles in relation to respondents' main concerns

		N	Mean rank	Kruskal–Wallis H	DF	Asymp. Sig.
Riding in a vehicle with no driver	Not concerned	36	348.60	137.579	3	0.000
	Slightly concerned	155	303.01	—	—	—
	Moderately concerned	138	261.81	—	—	—
	Strongly concerned	157	144.55	—	—	—
Heavy vehicle with no driver	Not concerned	37	326.08	64.279	3	0.000
	Slightly concerned	112	295.28	—	—	—
	Moderately concerned	107	267.53	—	—	—
	Strongly concerned	230	193.82	—	—	—
Self-driving public transport	Not concerned	53	313.06	85.317	3	0.000
	Slightly concerned	131	294.31	—	—	—
	Moderately concerned	138	258.66	—	—	—
	Strongly concerned	164	167.69	—	—	—
Self-driving taxis	Not concerned	34	344.21	98.228	3	0.000
	Slightly concerned	143	302.35	—	—	—
	Moderately concerned	141	249.65	—	—	—
	Strongly concerned	168	167.87	—	—	—

Kruskal–Wallis H statistic, degrees of freedom (DF), and asymptotic significance (Asymp. Sig.) for each concern category. Table 3 is divided into four sections, representing different scenarios of automated vehicles: (1) riding in a vehicle with no driver, (2) heavy vehicle with no driver, (3) self-driving public transport, and (4) self-driving taxis. Within each scenario, respondents' concerns were categorized into four levels: (1) not concerned, (2) slightly concerned, (3) moderately concerned, and (4) strongly concerned. The key findings and important aspects of the results are as follows:

1) **Attitudes toward riding in a vehicle with no driver.** The Kruskal–Wallis H statistic is significant ($H = 137.579$, $p < 0.001$), indicating significant differences in attitudes based on respondents' concerns. The mean rank decreases as the level of concern increases, suggesting that individuals who are strongly concerned have the lowest attitudes toward riding in a driverless vehicle.

2) **Attitudes toward heavy vehicles with no driver.** The Kruskal–Wallis H test also revealed significant differences in attitudes ($H = 64.279$, $p < 0.001$) based on concerns. Similar to the previous scenario, higher levels of concern were associated with lower mean ranks, indicating less positive attitudes toward heavy vehicles without drivers.

3) **Attitudes toward self-driving public transport.** The Kruskal–Wallis H test showed significant differences in attitudes ($H = 85.317$, $p < 0.001$) based on respondents' concerns. As concerns increased, the mean ranks decreased, suggesting that individuals who are strongly concerned held more negative attitudes toward self-driving public transport.

4) **Attitudes toward self-driving taxis**. The Kruskal–Wallis H statistic is significant ($H = 98.228$, $p < 0.001$), indicating significant differences in attitudes based on concerns. Similarly, higher levels of concern were associated with lower mean ranks, implying that those respondents who were strongly concerned had less favorable attitudes toward self-driving taxis.

Overall, the results suggest that respondents' concerns about CAVs have a significant impact on their attitudes toward different scenarios. Individuals who expressed stronger concerns tended to hold more negative attitudes toward riding in vehicles without drivers, whether heavy vehicles, public transport, or taxis. These findings highlight the importance of addressing public concerns and building trust in order to facilitate the adoption and acceptance of automated vehicles in various contexts.

Participants' main concerns and general opinion toward automated vehicles is presented in Table 4. The results reveal an interesting trend regarding the relationship between concerns and interest in automated vehicles. Specifically, as the level of interest increases (e.g., interested and strongly interested), participants appear to be less concerned about the safety issues associated with CAVs.

• **Riding in a vehicle with no driver**

As the level of concern escalates from "not concerned" to "strongly concerned" across genders, there is a corresponding increase in the proportion of participants expressing opposition and strong opposition to riding in a CAV. This indicates a notable correlation between concerns and opposition levels.

Interestingly, among males, the group categorized as "slightly

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Table 4 Participants' main concerns and general opinion toward automated vehicles

			Strongly oppose	Oppose	Undecided	Interested	Strongly interested
Riding in a vehicle with no driver	Male	Not concerned	0%	0%	36%	12%	52%
		Slightly concerned	6%	5%	19%	46%	24%
		Moderately concerned	3%	9%	43%	32%	13%
		Strongly concerned	20%	34%	31%	8%	7%
	Female	Not concerned	0%	0%	18%	55%	27%
		Slightly concerned	1%	2%	38%	46%	13%
		Moderately concerned	0%	12%	42%	36%	10%
		Strongly concerned	16%	42%	32%	5%	5%
Heavy vehicle with no driver	Male	Not concerned	0%	5%	38%	19%	38%
		Slightly concerned	9%	3%	21%	42%	25%
		Moderately concerned	6%	15%	30%	32%	17%
		Strongly concerned	10%	21%	37%	21%	11%
	Female	Not concerned	0%	0%	18%	64%	18%
		Slightly concerned	3%	4%	42%	38%	13%
		Moderately concerned	0%	6%	46%	39%	9%
		Strongly concerned	12%	34%	30%	16%	8%
Self-driving public transport	Male	Not concerned	2%	6%	29%	17%	46%
		Slightly concerned	6%	7%	24%	44%	19%
		Moderately concerned	5%	11%	36%	33%	15%
		Strongly concerned	15%	25%	36%	14%	10%
	Female	Not concerned	0%	6%	44%	33%	17%
		Slightly concerned	1%	4%	32%	50%	13%
		Moderately concerned	1%	17%	39%	32%	11%
		Strongly concerned	15%	37%	34%	9%	5%
Self-driving taxis	Male	Not concerned	0%	0%	36%	12%	52%
		Slightly concerned	6%	6%	18%	45%	25%
		Moderately concerned	6%	12%	40%	31%	11%
		Strongly concerned	15%	26%	35%	14%	10%
	Female	Not concerned	0%	0%	33%	33%	34%
		Slightly concerned	2%	3%	38%	45%	12%
		Moderately concerned	1%	17%	36%	35%	11%
		Strongly concerned	14%	37%	35%	9%	5%

concerned" exhibited the highest proportion in the "interested" and "strongly interested" categories. This suggests that even individuals with some level of concern still showed significant interest in this scenario.

On the other hand, among females, the "slightly concerned" group had the highest proportion in the "undecided" category, highlighting uncertainty regarding their interest in riding in a driverless vehicle.

• **Heavy vehicles with no driver**

In line with the previous scenario, there is a correlation between the level of concern and the proportion of opposition and strong opposition among both males and females.

Among males, the group categorized as "not concerned" displayed a notable level of interest, with the highest proportion in the "interested" and "strongly interested" categories.

Similarly, among females, the "not concerned" group also exhibited a strong interest in heavy vehicles without drivers, with the highest proportion in the "interested" category.

• **Self-driving public transport**

As the level of concern rose, there was a corresponding increase in the proportion of opposition and strong opposition for both males and females.

Among males who were "not concerned," there was a notable level of interest, with the highest proportion in the "strongly interested" category.

Similarly, females categorized as "slightly concerned" showed the highest proportion in the "interested" category but also had a significant portion in the "undecided" category.

• **Self-driving taxis**

The level of concern correlated with the proportion of opposition and strong opposition for both males and females shows that the group of males categorized as "not concerned" had the highest level of interest, with the highest proportion in both the "interested" and "strongly interested" categories.

Similarly, among females, the "not concerned" group displayed an equal and high proportion in both the "interested" and "strongly interested" categories.

• **Key findings**

Participants who expressed lower levels of concern ("not concerned" or "slightly concerned") tended to have higher levels of interest in the different scenarios involving automated vehicles.

Additionally, there is a consistent relationship between concerns and opposition, with higher levels of concern associated with higher proportions of opposition and strong opposition.

Furthermore, males generally exhibited higher levels of interest compared to females, especially among those who were not concerned about the specific scenarios.

These findings underscore the importance of addressing concerns and promoting understanding to foster acceptance and interest in automated vehicles. They also highlight gender differences in attitudes and preferences, suggesting the need for targeted approaches when designing strategies to increase acceptance among different demographics.

5.2.3 *Perceived benefits*

In terms of perceived CAV benefits, the majority of respondents (51%) believed that CAVs would provide them with more time to complete other tasks while traveling (Fig. 5). Other perceived benefits included lower vehicle emissions, reduced crash severity, improved emergency response to crashes, more convenience, better quality of service, and fewer crashes. Participants agreed that safety benefits (H5 and H6) (improved convenience and comfort while travelling by providing extra time) are true statements. However, only 8% of respondents thought lower insurance rates for CAVs were extremely likely, compared to 12% of respondents who found it extremely unlikely. Similarly, only 9% of respondents thought CAVs were extremely likely to reduce congestion, compared to 11% who thought it would be extremely unlikely. When asked whether they perceived CAVs would reduce travel time, only 7% of respondents found it extremely likely compared to 8% extremely unlikely.

These results suggest that the majority of participants found it improbable that CAVs would have lower insurance rates or that they would reduce traffic congestion or cut travel time (Fig. 5). The H7 hypothesis which assumes the primary perceived benefit of CAVs is reduction of travel time and congestion on roads, is rejected. The crosstab analysis of benefit parameters and general attitudes toward CAVs illustrate that respondents with a more positive attitude toward this technology rated the perceived benefits higher (Table 5).

5.3 Willingness to switch to CAVs

In response to a question that asked respondents about the key factors that will influence their decision to buy a CAV, almost half of respondents found sufficient charging/maintenance facilities as a favorable option to buy a CAV (Fig. 6). Lower taxes and insurance rates compared to regular vehicles, and lower vehicle prices were the second and third top attractive incentives. According to these results, the third hypothesis (H3: Affordability is identified as one of the primary reasons to switch to CAV) is accepted. Notably, close to 40% of respondents expressed a strong inclination to purchase a CAV if it offered the dual benefits of reducing their carbon footprint and enhancing safety. These two factors emerged as the most influential drivers of willingness to adopt CAV technology. On the other hand, factors such as decreased travel time, personal interest in the technology itself, or the respondents' driving capabilities held lesser influence on respondents' decision to purchase a CAV. This outcome provides valuable information about the public's priorities when considering CAV adoption (answers RQ5). By understanding the factors that sway willingness to embrace CAVs, policymakers, manufacturers, and other stakeholders can focus on addressing these concerns and desires.

6 Correlation analyses

A correlation analysis was conducted (Table 6) to understand the relationships and interactions between a wide range of variables obtained from the surveys, and to identify and formulate connections between different aspects of the data. Correlation coefficients were computed to assess the strength and direction of these relationships. The table provides valuable insights into how various factors might influence one another, shedding light on potential patterns and trends within the dataset. Examining these correlations provides a better understanding of the complex interplay between different variables and their impacts on overall research findings. The overall correlations between demographics and survey questions were found to be relatively small, with all correlation coefficients (r) being less than or equal to 0.30. Such modest correlations are not surprising, as individual survey items are known to exhibit statistical unreliability. A relevant example is found in the earlier work of Kyriakidis et al. (2015), where research on AVs acceptability similarly reported correlations of a comparable magnitude, a trend evident in various other studies as well. Therefore, despite the modest size of the correlations, it is essential not to undermine the significance of these findings solely based on their magnitude.

Gender. Attitudes and beliefs toward CAVs were found to be influenced by gender, with males demonstrating a more positive outlook and greater belief in CAV benefits (reduced congestion and crashes). Females expressed higher safety-related concerns and were less willing to buy CAVs, also due to lower trust levels in new technology. Notably, women showed more concerns regarding scenarios involving riding in a vehicle without a driver, autonomous public transport, and self-driving taxis. Additionally, females preferred more individual control over automated features

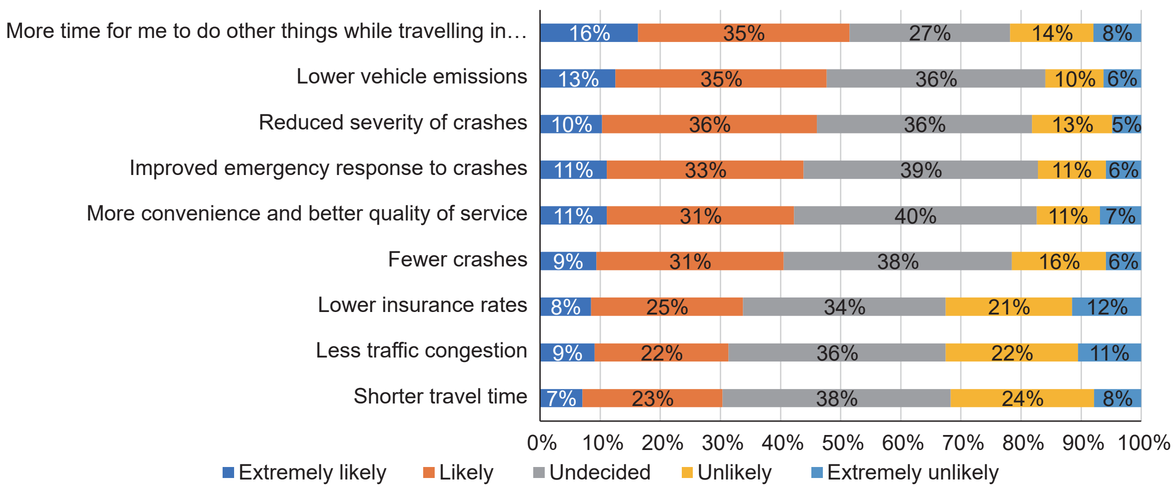

Fig. 5 Participants' opinions about CAV benefits.

Table 5 Participants' main concerns and general opinion toward automated vehicles

		Strongly oppose	Oppose	Undecided	Interested	Strongly interested
Fewer crashes	Extremely unlikely	33.3%	7.4%	3.1%	7.2%	0.0%
	Unlikely	36.1%	30.9%	16.6%	2.9%	6.6%
	Undecided	22.2%	51.9%	51.5%	17.4%	27.2%
	Likely	8.3%	7.4%	25.2%	33.3%	58.1%
	Extremely likely	0.1%	2.4%	3.6%	39.2%	8.1%
Less traffic congestion	Extremely unlikely	52.8%	18.5%	6.1%	4.3%	2.9%
	Unlikely	27.8%	39.5%	20.9%	10.1%	17.6%
	Undecided	19.4%	33.3%	50.3%	24.6%	30.9%
	Likely	0.0%	7.4%	19.6%	33.5%	33.8%
	Extremely likely	0.0%	1.3%	3.1%	27.5%	14.8%
Reduced severity of crashes	Extremely unlikely	30.6%	6.2%	2.5%	4.3%	0.0%
	Unlikely	36.1%	28.4%	10.4%	2.9%	7.4%
	Undecided	27.8%	46.9%	50.3%	14.5%	23.5%
	Likely	5.5%	18.5%	33.1%	39.2%	56.6%
	Extremely likely	0.0%	0.0%	3.7%	39.1%	12.5%
Improved emergency response to crashes	Extremely unlikely	27.8%	8.6%	3.6%	5.8%	0.7%
	Unlikely	27.8%	22.2%	11.7%	1.4%	3.7%
	Undecided	36.1%	50.6%	53.4%	17.4%	26.5%
	Likely	8.3%	17.3%	26.4%	44.9%	51.5%
	Extremely likely	0.0%	1.3%	4.9%	30.5%	17.6%
Shorter travel time	Extremely unlikely	41.7%	11.1%	4.9%	4.4%	2.2%
	Unlikely	33.3%	42.0%	22.7%	10.1%	17.6%
	Undecided	19.4%	35.8%	52.1%	18.8%	37.5%
	Likely	5.6%	11.1%	16.6%	40.6%	35.3%
	Extremely likely	0.0%	0.0%	3.7%	26.1%	7.4%
Lower vehicle emissions	Extremely unlikely	30.6%	9.9%	2.5%	4.3%	2.9%
	Unlikely	22.2%	13.6%	9.8%	4.4%	6.6%
	Undecided	30.6%	48.1%	46.0%	17.4%	29.4%
	Likely	16.6%	25.9%	34.4%	46.4%	40.5%
	Extremely likely	0.0%	2.5%	7. 3%	27.5%	20.6%
More time for me to do other things while travelling in a CAV	Extremely unlikely	33.3%	13.6%	4.3%	4.3%	2.1%
	Unlikely	33.3%	21.0%	15.3%	7.2%	5.9%
	Undecided	16.7%	34.6%	39.9%	5.8%	19.9%
	Likely	11.1%	27.2%	31.3%	36.2%	52.2%
	Extremely likely	5.6%	3.6%	9.2%	46.5%	19.9%
Lower insurance rates	Extremely unlikely	47.2%	17.3%	11.7%	7.2%	0.7%
	Unlikely	25.0%	33.3%	19.6%	8.7%	21.3%
	Undecided	13.9%	39.5%	42.9%	13.0%	33.1%
	Likely	11.1%	7.4%	21.5%	42.0%	36.8%
	Extremely likely	2.8%	2.5%	4.3%	29.1%	8.1%
More convenience and better quality of service	Extremely unlikely	36.1%	14.8%	3.1%	4.3%	0.0%
	Unlikely	27.8%	17.3%	12.9%	1.5%	3.7%
	Undecided	30.6%	55.6%	51.5%	18.8%	30.9%
	Likely	5.5%	9.9%	26.4%	39.2%	52.9%
	Extremely likely	0.0%	2.4%	6.1%	36.2%	12.5%

in CAVs and were particularly concerned about the safety of kids traveling in driverless vehicles and firmly believed that CAVs should be recognizable from other vehicles. In terms of barriers to the deployment of CAVs, women were more concerned about safety consequences, legal liability, system security, data privacy, interaction with other vehicles, system performance in poor weather, and especially learning to use AV.

Age. Younger individuals exhibited higher trust in the benefits compared to older individuals. Conversely, older age groups tended to identify safety as a major barrier to CAV adoption. As age increases, the willingness to buy CAVs diminishes as well. Older age groups showed greater emphasis on CAVs' ability to handle all driving situations and the importance of maintaining manual driving.

Education. Higher levels of education were associated with increased interest in CAVs and a stronger agreement with the potential benefits that come with this technology. As the level of education increased, the willingness to buy CAVs increased as well. Additionally, individuals with higher education tended to be less concerned about various issues related to CAVs in different scenarios. They were also less likely to agree with the statement that every CAV should have the option of manual driving. Instead, they viewed CAVs as a desirable trend in the automotive industry.

Average daily vehicle travel. Individuals with higher average daily vehicle travel demonstrated greater interest in CAVs and a

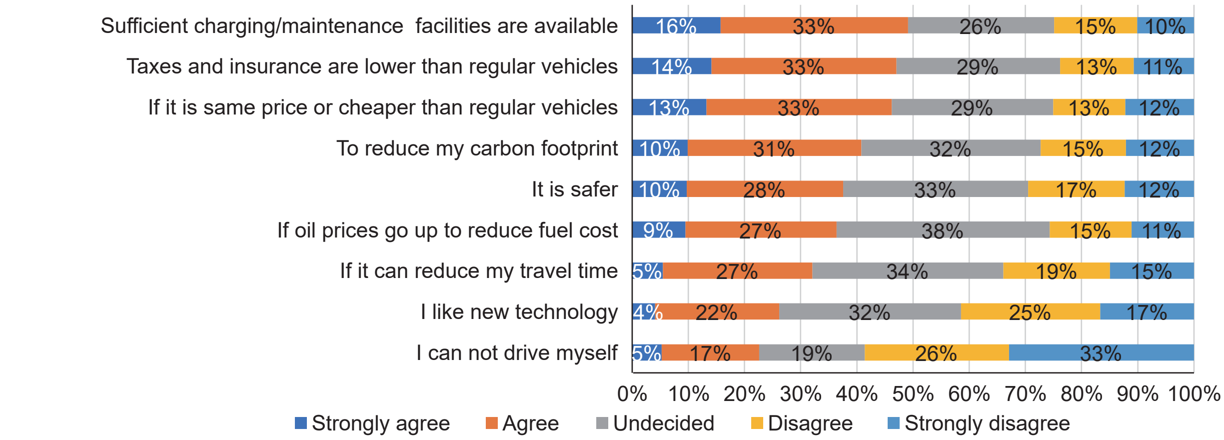

Fig. 6 Key factors that affect participants willingness to buy CAV.

Table 6 Spearman correlational matrix between variables of interest

	Gender	Age group	Drive a vehicle with DAS	Health condition	Familiarity with CAV	Engine specification	Levels of education	Income level	Household size	Residential location	Average daily vehicle travel
General attitude	−0.119**	−0.133**	0.239**	0.108*	0.236**	0.123**	0.108*	0.096*	0.132**	0.095*	0.236**
Benefit-fewer crash	−0.094*	0.000	0.185**	0.000	0.144**	0.025*	0.000	0.139**	0.109*	0.000	0.144**
Benefit-less congestion	−0.095*	0.000	0.192**	0.000	0.189**	0.178**	0.131**	0.122**	0.112*	0.000	0.147**
Benefit-reduce severity of crashes	−0.097*	0.000	0.203**	0.000	0.186**	0.000	0.093*	0.129**	0.151**	0.000	0.148**
Benefit-improve emergency response to crash	0.000	0.000	0.174**	0.000	0.198**	0.000	0.000	0.000	0.147**	0.000	0.000
Benefit-shorter travel time	0.000	−0.130**	0.140**	0.000	0.220**	0.153**	0.116*	0.000	0.146**	0.000	0.000
Benefit-lower vehicle emission	0.000	0.000	0.115*	0.000	0.159**	0.094*	0.000	0.093	0.111*	0.000	0.000
Benefit-more time to do other things	0.000	−0.107*	0.105*	0.000	0.134**	0.000	0.000	0.000	0.136**	0.000	0.112*
Benefit-lower insurance	0.000	−0.206**	0.149**	0.000	0.208**	0.157**	0.000	0.000	0.206**	0.000	0.132*
Benefit-more convenience and better qos	0.000	−0.094*	0.152**	0.000	0.231**	0.091*	0.000	0.000	0.157**	0.000	0.118*
Barrier-safety consequences	0.117**	0.130**	0.000	0.000	0.000	−0.103*	0.000	0.000	0.000	0.000	0.000
Barrier-legal liability	0.133**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Barrier-system security	0.141**	0.000	0.000	0.000	0.090*	0.000	0.000	0.000	0.000	0.000	0.000
Barrier-data privacy	0.126**	0.000	0.000	0.000	0.055*	0.000	0.000	0.000	0.000	0.000	0.000
Barrier-traffic interaction with other vehicles	0.099*	0.000	0.000	0.000	0.122**	0.000	0.000	0.000	0.112*	0.000	0.000
Barrier-interaction with pedestrian	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Barrier-learning to use av	0.194**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.110*	0.000	−0.116*
Barrier-system performance in poor weather	0.155**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.120*	0.000	−0.119*
Willingness to buy a CAV−I like new technology	0.113*	0.275**	−0.182**	−0.155**	−0.239**	−0.227**	−0.123**	−0.110*	−0.186**	0.000	−0.112*
Willingness to buy a CAV−reduce travel time	0.099*	0.251**	−0.164**	−0.092*	−0.179**	−0.165**	−0.093*	0.000	−0.155**	−0.092*	0.000
Willingness to buy a CAV−it is safer	0.096*	0.174**	−0.163**	−0.097*	−0.195**	−0.156**	−0.129**	−0.117*	−0.145**	0.000	−0.124*
Willingness to buy a CAV−I cannot drive	0.000	0.348**	−0.072*	−0.308**	−0.194**	−0.276**	−0.081*	0.000	−0.096*	0.000	−0.121*
Willingness to buy a CAV−same price or cheaper	0.000	0.142**	−0.107*	−0.092*	−0.116**	−0.116*	−0.076*	0.000	−0.116**	−0.107*	−0.151*
Willingness to buy a CAV−lower tax and insurance	0.000	0.148**	−0.132**	0.000	−0.148**	−0.105*	−0.094*	0.000	−0.082*	−0.112*	0.000
Willingness to buy a CAV−reduce fuel cost	0.000	0.199**	−0.115*	0.000	−0.126**	−0.149**	−0.092*	0.000	−0.151**	−0.093*	−0.137*

(*Continued*)

	Gender	Age group	Drive a vehicle with DAS	Health condition	Familiarity with CAV	Engine specification	Levels of education	Income level	Household size	Residential location	Average daily vehicle travel
Willingness to buy a CAV−sufficient charging/maintenance	0.000	0.094*	−0.158**	0.000	−0.142**	−0.100*	−0.099*	0.000	−0.115*	−0.097*	0.000
Willingness to buy a CAV−reduce carbon footprint	0.000	0.137**	−0.106*	0.000	−0.158**	−0.130**	−0.116**	0.000	0.000	−0.089*	0.000
Concern-riding in a vehicle with no driver	0.149**	0.216**	−0.161**	−0.093*	−0.094*	−0.104*	−0.142**	0.000	0.000	0.000	−0.144*
Concern-heavy vehicles with no driver	0.158**	0.309**	−0.142**	−0.162**	−0.170**	−0.137**	−0.165**	0.000	0.000	−0.091*	0.000
Concern-automated public transport	0.143**	0.201**	−0.116*	−0.062*	−0.112*	−0.160**	−0.178**	0.000	0.000	−0.067*	0.000
Concern-self driving taxis	0.144**	0.259**	−0.131**	−0.105*	−0.127**	0.000	−0.138**	0.000	0.000	−0.09*	−0.138*
Public opinion: I want to choose where, when and which automated features I use while driving	0.088*	0.247**	0.000	−0.149**	0.000	−0.149*	0.000	0.000	0.000	0.000	0.000
Public opinion: I want automation to handle every driving situation	0.000	−0.129**	0.000	0.093*	0.122**	0.115*	0.000	0.000	0.191**	0.000	0.130*
Public opinion: It would be stressful to let automated features be in control in every driving situation.	0.150**	0.200**	0.000	−0.165**	0.000	−0.148**	0.000	0.000	0.000	0.000	0.000
Public opinion: Automated vehicle features would reduce driver workload	0.000	0.007*	0.105*	0.000	0.135**	0.022*	0.000	0.129**	0.101*	0.000	0.159**
Public opinion: All automated vehicles should also be manually drivable	0.000	0.186**	0.000	−0.176**	0.000	−0.161**	−0.126**	0.000	0.000	0.000	0.000
Public opinion: The vehicle automation development is a desirable trend	−0.091*	0.000	0.133**	0.000	0.132**	0.093*	0.103*	0.188**	0.157**	0.000	0.177**
Public opinion: It is not safe that kids travel in a CAV	0.226**	0.116**	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	−0.117*
Public opinion: Automated vehicles must be recognizable	0.110*	0.186**	0.000	−0.134**	0.000	−0.128**	−0.095*	0.000	0.000	0.000	0.000

Note: * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).
Coding instruction:

Age group (19–25 = 1, 26–29 = 2, 30–34 = 3, 35–39 = 4, 40–44 = 5, 45–49 = 6, 50–54 = 7, 55–59 = 8, 60–64 = 9, 65+ = 10)
Riding a vehicle with driver assistant technology (DAS) (yes = 1, no = 0) Health condition (no disability = 0, disability = 1)
Familiarity with the technology (not familiar = 0, somewhat familiar = 1, completely familiar = 2)
Levels of education (high school = 1, trade school = 2, bachelor's degree = 3, graduate certificate = 4, master's degree = 5, doctoral degree = 6)
Benefit (extremely unlikely = 1, unlikely = 2, undecided = 3, likely = 4, extremely likely = 5)
Willingness to buy a CAV strongly agree = 1, agree = 2, undecided = 3, disagree = 4, strongly disagree = 5)
Public opinion: strongly disagree = 1, disagree = 2, undecided = 3, agree = 4, strongly agree = 5
Engine specification (internal combustion = 1, hybrid electric = 2, electric = 3)
Income (< \$19,000 = 0, \$19,000–\$40,000 =1, \$40,000–\$60,000 = 2, \$60,000–\$80,000 = 3, \$80,000–\$100,000 = 4, \$100,000–\$125,000 = 5, \$125,000–\$150,000 = 6, \$150,000+ = 7)
Residential location (sparsely populated remote area = 1, sparsely populated urban area = 2, densely populated urban area = 3)
Average daily vehicle travel (less than 20 km = 1, 20–50 km = 2, 50–100 km = 3, 100+ km = 4)
General attitude (strongly interested = 5, interested = 4, undecided = 3, unlikely interested = 2, strongly oppose = 1)
Timeline to switch to own, lease or ride in a CAV (10 years = 1, 15 years = 2, 20 years = 3, 25 years = 4)
Barrier (extremely unlikely = 1, unlikely = 2, likely = 3, extremely likely = 4)
Concern (not concerned = 1, slightly concerned = 2, moderately concerned = 3, strongly concerned = 4)

stronger belief in their potential benefits, including fewer and less severe crashes, reduced congestion, lower insurance costs, and improved convenience and service quality. As daily travel increased, there was a reduced consideration of barriers such as learning to use CAVs and concerns about system performance in poor weather. Interestingly, those with higher daily travel were less concerned about riding in a vehicle with no driver or self-driving taxis, suggesting a higher level of comfort and familiarity with automated technologies. Additionally, the willingness to buy a CAV due to reasons such as "like new technology", "it is safer", "I can not drive", "affordability", and "reduce fuel cost" increased with higher levels of daily travel. Individuals with higher daily travel also expressed greater confidence in automation's ability to handle all driving tasks, and viewed CAVs as a desirable trend. Additionally, they were less concerned about the safety of children in self-driving vehicles.

Income. Respondents' annual income generally demonstrated weak correlations across the survey items. However, it was observed that individuals with higher incomes showed greater interest in CAVs and tended to have a better perception of their benefits. This particular group viewed vehicle automation as a desirable trend and believed that it would effectively reduce driver workload. Interestingly, the willingness to buy a CAV because of curiosity about new technology or the safety of CAVs increased with higher levels of income. These findings suggest that income level influences the degree of interest and positive perceptions regarding CAVs, with higher-income individuals exhibiting more enthusiasm and optimism toward their potential advantages.

Residential location. The analysis revealed that respondents residing in densely populated urban areas exhibited a higher level of interest in CAVs. This could be attributed to the potential benefits that CAVs offer, particularly in managing traffic congestion and improving transportation efficiency in busy urban environments. Willingness to buy a CAV because of "affordability", "lower tax and insurance", "reduce fuel cost", "sufficient charging/maintenance facilities provided", "reducing travel time", and "reduce carbon footprint" increased in densely populated areas. Individuals in urban areas also expressed less concern about heavy vehicles with no driver and automated public transport and taxis, indicating a greater comfort with the idea of sharing the road with autonomous vehicles.

Familiarity with CAVs. Respondents more familiar with CAVs were more interested in this technology and agreed on all their benefits. They also agreed that system security, data privacy, and interactions with other vehicles were key barriers to CAV's widescale deployment. This group was also more willing to buy automated vehicles, and generally were less concerned about automated vehicles, particularly heavy commercial vehicles. They also found CAVs a desirable trend and were willing to hand over the driving tasks to automation.

Health condition. Participants with a health condition that limits their driving ability were more willing to buy a CAV because they appreciated the technology's potential because of their lack of ability to drive. They were also less concerned with automated driving technologies and did not consider that CAVs should have the capability and systems to allow them to be manually driven by a human. Additionally, they expressed lower concerns about handing over the driving tasks to automation and did not strongly believe that CAVs must be recognizable to other drivers by a mark or sign to differentiate them from human-driven vehicles.

Having a vehicle with driver assistance technology. Respondents' answers about having a vehicle with driver assistance technology revealed a pattern of correlations with survey items that were generally similar to their responses about familiarity with CAVs. They agreed on all the benefits and to buy CAVs based on all the mentioned advantages and were less concerned about other issues. They found this technology a desirable trend and believed that automation will reduce driver workload.

Vehicle type. Respondents with hybrid or battery electric vehicles were more interested in CAVs. They believed CAVs can reduce crashes, congestion and travel time, and lower emissions. They also considered that insurance rates will be lower, and the quality of service will be improved. This group did not consider safety a barrier to the deployment of CAVs and were willing to buy CAVs because of their benefits. They also felt less concerned about handing over driving tasks to automation and found CAVs a desirable trend. This group did not believe that CAVs must be recognizable by a mark or sign that differentiates them from human-driven vehicles.

Number of people living in a household. A positive correlation was observed between the number of people living in a household and their interest in CAVs. Larger households viewed vehicle automation as a desirable trend and agreed on all CAV benefits. They identified CAV interaction with human-driven vehicles and unreliable performance in poor weather conditions as barriers to adoption. As the number of people in the household increased, so did their willingness to buy a CAV, primarily due to affordability and financial reasons such as lower operating costs, tax incentives they may receive, and reduced fuel costs.

7 Discussion

The existing literature on public opinions about CAVs in Australia is limited, highlighting a significant knowledge gap in this area. To bridge this gap, this study undertook a comprehensive and nuanced examination of public opinions, focusing on crucial factors such as respondent concerns, perceived benefits, and barriers to the deployment of CAVs. An online survey was conducted, which reached a representative sample of 562 respondents residing, working, or studying in Melbourne. This section discusses the key findings and insights gained from our study.

7.1 Perceived benefits associated with CAVs

This research sheds light on the perceptions of a representative sample of Australian participants regarding the benefits of CAVs (answering RQ2). While certain advantages are widely recognized, some misconceptions and concerns require targeted education and communication efforts to ensure a more accurate understanding of the potential benefits of CAVs. Overall, Melburnians agreed with many of the potential benefits that are expected to materialize with the introduction and operation of CAVs. Results showed that respondents with a health condition expressed the highest interest (almost double those without health conditions) in CAV technology. This is one of the most celebrated (albeit expected) benefits associated with CAVs in the literature (Fagnant and Kockelman, 2015; Reimer, 2014). On the other hand, respondents were most reluctant to consider that CAVs will reduce congestion and travel time. It may be speculated that these views are, in part, attributable to a lack of public understanding of automated vehicle platooning (Liu et al., 2016) which is a driving formation (involving CAVs following each other very closely at a fixed distance) envisaged to become common among CAVs, increasing traffic efficiency and reducing congestion as a result (Bergenhem et al., 2012; Matin and Dia, 2022). Alternatively, it may be the case that respondents recognized that increased mobility may introduce additional vehicle travel and, therefore, increased traffic congestion, which could undermine any expected potential traffic efficiency benefits due to platooning (Litman, 2020). Interestingly, a similar finding was noted in a 2014 study where it was found that respondents were most confident about better fuel economy, but least confident about shorter travel time (Schoettle and Sivak, 2014a). These results support the findings from this study.

7.2 Perceived concerns associated with CAVs

The outcomes of this study directly address the first research question (RQ1), which aims to identify the primary concerns that deter individuals from adopting CAVs. Overall, participants exhibited notable concerns related to the implementation and functioning of CAVs. Among various aspects evaluated, respondents displayed the highest level of apprehension toward driverless commercial heavy vehicles. Approximately 70% of participants strongly or moderately expressed concern about this particular issue. Moreover, a majority of respondents (70%) indicated discomfort with riding in close proximity to CAVs and instead preferred a dedicated lane for these vehicles. Almost 75% of respondents expressed that all automated vehicles must have the option to be manually driven by a human (e.g., to have a steering wheel, acceleration and brake pedals). Most participants (72%) believed CAVs must be recognizable from other vehicles, such as by a specific label or sign. The majority of respondents (70%) wanted to determine where and when to use the automated functions, and which functions to use. Generally, respondents were uncomfortable with automated vehicles without control devices.

Giving the driving responsibility to a computer would make almost 62% of the respondents feel concerned. Only 13% of respondents stated they would feel comfortable releasing the driving responsibility to automation. Almost 48% of respondents thought automation would reduce driver workload (approximately 16% of respondents disagreed with this sentiment).

Almost 80% of respondents were most concerned about being legally and financially responsible. This issue emerged in many previous AV acceptance studies that have been undertaken internationally (Bansal et al., 2016; Howard and Dai, 2014; Schoettle and Sivak, 2014b), and is argued to be one of the most prominent barriers not only to CAV adoption but also deployment by industry and original equipment manufacturers (Fagnant and Kockelman, 2015). As vehicle automation develops further, vehicle control will shift increasingly from the human driver to automation. The liability issue would then become especially prominent as driving is shared between human and vehicle, and when there are more instances of transfer of vehicle control between human and machine. This issue of who (or what entity) will be responsible for the actions of an automated system at different levels of automation is still an ongoing debate in both academic and industry circles (Dia, 2016). The results also showed that safety and safety-related parameters, such as “interacting with pedestrians” and “system performance in poor weather” were the main barriers to widescale deployment of CAVs.

More than half of respondents (55%) expressed that it is unsafe for kids to travel in a driverless car, and just 10% disagreed. These results are akin to general concerns about unsupervised child travel documented throughout the literature, particularly regarding using public transport (Timperio et al., 2004). This may reflect parents’ general lack of trust in automated systems and concerns about what their children may do in critical situations such as a crash or breakdown. This was also confirmed in this study, as the respondents ranked “trust in technology” as the first barrier to deploying CAVs.

Interestingly, respondents were least concerned about the lack of regulations regarding CAVs. This is likely because Australia is one of just four countries with the highest AV regulations score. The Australian federal government was early in moving to reform driving laws to enable the use of AVs, and this work is continuing through the National Transport Commission’s Automated Vehicle Program (KPMG, 2020). Respondents were not highly concerned about data privacy and cyber security issues either. This finding parallels another study where respondents were not highly concerned about data privacy even for safety and efficiency applications (Kyriakidis et al., 2015). In addition, respondents in UK and Australia expressed less concern over data privacy and AVs than those in USA (Schoettle and Sivak, 2014a). It may be speculated that, in present times, because data transmission is repeatedly occurring in many facets of an individual’s life – whether it be through smartphone use, the Internet, or even navigation capabilities within the vehicle – this has helped to some extent normalize concerns regarding data privacy in the realm of CAVs. However, it should be noted that even though data privacy and cyber security were not the highest concerns, they still ranked fourth amongst seven key barriers. Almost 75% of respondents still believed that they would likely be a barrier to deployment to some extent.

7.3 Willingness to purchase CAVs

Willingness to purchase is critical to user acceptability (and acceptance). Automated vehicles will only reach high uptake rates if users are willing to pay and buy them. The survey results showed the top three reasons respondents would buy a fully automated vehicle were: (1) sufficient availability of maintenance and charging facilities (51%), (2) taxes and insurance rates are lower than the identical regular vehicle (47%), and (3) they would be the same price or cheaper than a non-automated vehicle (44%). These results are aligned with other studies, e.g., Schoettle and Sivak (2014a) where it was found that only 45.5%, 40.2%, and 44.8% of respondents in USA, UK, and Australia, respectively, would pay extra (majority would prefer to pay less). A survey in USA found that only 41% of respondents were willing to pay at least $1 more than the initial purchase price to get automated capabilities (Bansal and Kockelman, 2016). Other factors that affect the willingness to buy a CAV are reducing the carbon footprint (41%) and safety (38%). The results from this survey showed that there is a reluctance to buy an automated vehicle because it would result in “a reduction in travel time” or because of “interest in technology” – people familiar with CAVs and those who drive a vehicle with driving-assist technology chose these options – or “not being able to drive” – which was attractive for respondents with disability. Willingness to buy a CAV was also found to decrease with age. Men were more willing to buy a CAV than women. The willingness to buy a CAV was found to decline with higher ages. Additionally, men tended to be more open to purchasing CAVs compared to women. Those who had experience using automated technology like driver assistant systems, hybrid or electric vehicles, and higher education levels were more positively inclined toward buying CAVs. Moreover, people living in densely populated urban areas and those with higher daily travel were also more likely to embrace CAV adoption. Higher income levels were also associated with a greater willingness to buy CAVs.

7.4 Correlation analyses

The correlational analyses revealed many interesting findings. First, men tended to express lower levels of concern with CAV-related issues and reported a greater desire to use CAVs. They were also more comfortable allowing a CAV to take over all driving functions. Males generally had a more positive outlook toward CAVs and believed in their benefits, such as reduced congestion and crashes. Females expressed higher safety-related concerns and were less willing to buy CAVs. Women had more concerns about scenarios involving riding in a vehicle without a driver, autonomous public transport, and self-driving taxis. They preferred more individual control over automated features in

CAVs and were particularly concerned about the safety of kids traveling in driverless vehicles.

These findings are consistent with other research which revealed that men tended to be less concerned about AV safety issues compared to women (Hulse et al., 2018; Schoettle and Sivak, 2014a, 2015). Similarly, other studies demonstrated that men were more willing to purchase autonomous vehicles (AVs) (Bansal et al., 2016; Kyriakidis et al., 2015). Results from other studies indicated a higher intention to use AVs among men (Zmud et al., 2016). These insights emphasize the importance of gender-specific considerations in the design, marketing, and adoption of CAVs to create a more inclusive and successful future for autonomous vehicles.

Younger individuals showed higher interest and belief in CAV benefits compared to older individuals. Older age groups identified safety as a major barrier to CAV adoption, and the concerns increased with age, particularly regarding heavy vehicles without drivers. Willingness to buy CAVs decreased as age increased. These results are aligned with other studies that found young respondents were less concerned and that WTP for ownership is higher among younger adults (Bansal et al., 2016). Understanding these age-related differences in CAV attitudes, preferences, and concerns will be crucial for tailoring effective strategies that cater to diverse demographics and foster wider acceptance of this transformative technology.

Additionally, individuals with higher education levels were more likely to view CAVs positively with a greater understanding of their potential safety and efficiency benefits, and a reduced concern about issues related to their adoption. Their education and exposure to technological advancements probably had a role in shaping their attitudes and perceptions toward CAVs. These findings are supported by other research which found evidence of association between levels of education and positive attitudes toward AVs, and suggested that individuals with higher levels of education tended to exhibit more favorable perceptions and opinions regarding AV technology (Hudson et al., 2019).

Individuals with higher average daily vehicle travel showed greater interest in CAVs and a stronger belief in their benefits. As daily travel increased, barriers like learning to use CAVs and concerns about system performance in poor weather reduced.

Respondents with higher incomes showed more interest in CAV technology and had a better perception of its benefits, viewing vehicle automation as a desirable trend that reduces driver workload. This was also found in other studies that established a positive correlation between WTP for ownership and adoption with income levels (Bansal et al., 2016), and a strong correlation between income levels and WTP for ownership (Kyriakidis et al., 2015).

It is worth noting that people living in urban areas showed lower levels of concern regarding heavy vehicles without drivers, as well as automated public transport and taxis. This suggests that they are more at ease with the concept of sharing the road with autonomous vehicles. This positive attitude might be influenced by their exposure to advanced transportation systems and technology commonly found in urban settings. Two other studies revealed that urban residents demonstrated a greater inclination to use self-driving cars. The first study by Power (2012) focused on willingness to purchase AVs, and the second explored SAV adoption time (Bansal et al., 2016). Additionally, other studies found a preference for using the technology in urban-type monotonous driving scenarios (e.g., stop-and-go movements) on highways and congested urban networks (Bansal et al., 2016). Understanding the preferences and perceptions of individuals in densely populated urban areas is crucial for urban planning and policy development to accommodate the future integration of CAVs in urban transportation systems. By addressing their specific needs and concerns, policymakers and industry stakeholders can foster a more seamless and efficient adoption of CAV technology in urban settings, ultimately leading to more sustainable and enhanced transportation experiences in cities.

Respondents with familiarity with CAVs exhibited a heightened interest in the technology and unanimously acknowledged its array of benefits. Moreover, they showed a keen awareness of significant hurdles facing CAV deployment, including concerns related to system security and seamless interaction with other vehicles. Likewise, participants who had hands-on experience with driver assistance technology showed increased interest in CAVs, firmly agreeing on the advantages they offer. Their perspectives aligned with the growing consensus that automation is a favorable trajectory, leading to reduced driver workload and enhanced overall driving experiences. These results are aligned with the outcomes of another study which found that increased consumer familiarity and acceptance contributed to the technology self-growth (Liu et al., 2020). Similarly, another study evaluated public opinions about AVs, and found that familiarity with AVs had a significant influence on public acceptance (Piao et al., 2016). Another review study showed that people with previous experience with AV features were more positive toward adopting AVs (Othman, 2022). However, it is important to note that prior experience could potentially have an adverse impact on public acceptance when considering other factors such as AV crashes (Richardson and Davies, 2018).

Furthermore, respondents currently utilizing hybrid or battery electric vehicles expressed a notable interest in CAVs. They were confident that CAVs can effectively contribute to reducing road crashes, traffic congestion, travel durations, and harmful emissions. They were not primarily concerned about CAV safety and viewed them as a desirable and promising trend within the automotive landscape.

Participants with a health condition that limits their driving ability showed a higher willingness to purchase a CAV. They cited reasons such as their fondness for the technology, potential time savings, perceived safety benefits, affordability, and their inability to drive themselves. These individuals showed reduced concerns about automated driving and were less apprehensive about entrusting driving tasks to automation. These results align with Brinkley et al. (2017) study, which investigated the opinions of 38 participants with visual impairments. The participants expressed overwhelming optimism about the potential for self-driving vehicles to offer independence and mobility. However, they raised concerns about the technology's development not adequately addressing the needs of individuals with visual impairments. Another study by Bhalearo et al. (2022) conducted a routine task analysis of the end-to-end riding process for passengers with vision impairment. The target group reported being comfortable traveling alone in an AV and willing to travel more for work or other purposes in a Level-5 AV.

Households with more people showed greater interest in CAVs, agreeing on all CAV benefits. They also considered CAV interaction with human-driven vehicles and unreliable performance in poor weather barriers to adoption. While this particular factor remained underexplored in the existing literature and requires further investigation, it is evident that larger households tended to exhibit heightened interest in adopting

CAVs, particularly as a service, rather than owning one. This inclination can be attributed to several reasons:

1) Greater likelihood of having individuals who are familiar with CAV technology. Higher education levels can play a role in informing and educating other household members about the benefits, safety features, and potential advantages of CAVs.

2) Convenience and space. In larger households, coordinating transportation for multiple individuals can be challenging. CAVs offer the convenience of transporting several family members together without the need for separate vehicles.

3) Time efficiency. With more people to accommodate, the logistics of transportation can be time-consuming. CAVs' potential to optimize routes and reduce travel time can be particularly appealing to larger households with busy schedules.

4) Cost sharing. Owning and maintaining multiple vehicles can be expensive. CAVs offer cost-saving benefits for larger households, as they can share transportation expenses without the need for multiple cars.

5) Safety concerns. Families with children and elderly members often prioritize safety. CAVs' promise of enhanced safety features and reduced crash rates could make them more attractive to households concerned about their members' well-being.

6) Productivity. In larger households, there might be a greater need to multitask during commutes, such as catching up on work or assisting children with school tasks. CAVs could provide an opportunity to be more productive during travel.

7) The concept of shared mobility and mobility-as-a-service is gaining traction. Larger households might see CAVs as an extension of this trend, providing on-demand transportation without the burden of ownership.

8) Larger households in urban areas might face parking challenges. CAVs could alleviate this concern by minimizing parking space requirements.

In conclusion, while further research is warranted to comprehensively grasp this aspect, the factors outlined above collectively underscore the heightened interest demonstrated by larger households in embracing CAV technology.

7.5 Practical implications

The results reported in this paper can help inform what governments, vehicle manufacturers, and other stakeholders could do to facilitate the safe and successful deployment of CAVs (answers RQ6).

The public expressed heightened concerns about potential drawbacks, including cybersecurity threats, safety challenges, the learning process for AV usage, ethical dilemmas related to personal privacy and data sharing (such as tracking of location or destination), risks of equipment or system malfunctions, interactions with traditional vehicles and other transportation methods, the cost factor of AVs, diminished control during crashes, and possible health implications stemming from altered lifestyle requirements (Golbabaei et al., 2020). According to Sener and Zmud (2019), a majority of ride-hailing service users hesitant about AVs did not view them as consistently safer options. As a result, they leaned toward the ridesharing version of AVs, valuing the comfort of a "human override" feature, believing humans might perform better in spontaneous situations. On the other hand, those favoring personal ownership of AVs felt these vehicles might be safer than traditional ones (Shin et al., 2019; Ulahannan et al., 2019; Woisetschläger, 2016; Woldeamanuel and Nguyen, 2018).

There is potential interest in using autonomous shuttles during adverse weather conditions, within enclosed spaces like exhibitions, large factories, airports, university campuses, retirement homes, and hospitals. They might also be preferred in suburban areas typically lacking public transport, unfamiliar urban tourist spots, for goods and cargo transportation, or one-way journeys (Nordhoff et al., 2019). Gold et al. (2015) observed that a brief experience with highly automated driving in a simulator boosted users' trust in the technology and reduced their concerns about safety and the need for a driver's constant involvement.

In this survey, the results showed that Australians are concerned mainly about the safety of CAVs, particularly automated heavy vehicles, and their ability to drive more safely than human drivers. Drawing from the literature mentioned, it might be beneficial for governments to organize live demonstrations of this technology in controlled environments or via driving simulations to bolster public trust and enhance perceptions of safety.

Ye and Wang (2018) introduced a combined approach of designing traffic networks that incorporated both CAV lane deployment and congestion pricing to alleviate traffic jams. Their findings indicated that merging these strategies is more effective than implementing either CAV lane deployment or congestion pricing individually. In 2019, Liu and Song (2019) crafted a strategy to pinpoint the best road links for introducing CAV-specific lanes, allowing human driven vehicle (HDV) users to access these lanes for a fee. Their research highlighted that when considering reduced gaps between CAVs, the equilibrium flow might vary in mixed CAV and HDV traffic scenarios. Wu et al. (2020) pursued an optimal design for a compact network (consisting of HDV roads and CAV highways) under congestion pricing, aiming to cut down the overall system travel time expenditure, employing a two-tiered approach. Chen et al. (2016) delved into the optimal strategies for allocating dedicated lanes during the CAV transition phase, with the goal of reducing societal expenses, encompassing both safety and combined travel costs for traditional and autonomous vehicles.

Our research revealed that nearly 70% of individuals were uneasy driving alongside a CAV. Drawing from existing literature, it is suggested that policymakers prioritize establishing dedicated lanes and pathways for CAVs during the initial phases of their introduction. This approach could enhance public trust, as increased exposure to and familiarity with the technology can significantly boost acceptance levels. Dedicated lanes for CAVs, due to their reduced gaps and consequently enhanced capacity, can decrease travel time, and can motivate travelers to adopt CAVs (Shabanpour et al., 2017, 2018).

A higher interest in adopting AVs is often observed among individuals well-informed and familiar with the technology, particularly those knowledgeable about the diverse AV service modes and their various advantages (König and Neumayr, 2017; Kyriakidis et al., 2015; Penmetsa et al., 2019; Wang and Akar, 2019). Nevertheless, negative information can decrease the intention to use, while positive information may increase AV acceptance (Nordhoff et al., 2018; Sanbonmatsu et al., 2018; Yigitcanlar and Inkinen, 2019), and further emphasize the role of policymakers and governments in informing the public about the CAVs technology.

Hidrue et al. (2011) utilized a latent class random utility model, based on stated preference (SP) data from USA, to investigate the willingness to pay (WTP) for electric vehicles (EVs). Their findings suggest that factors such as youth, higher education, an eco-friendly lifestyle, and easy access to a charging plug increase an individual's likelihood of purchasing an EV. In a separate study, Smith et al. (2017) employed the Best–Worst choice design to study the adoption behavior of EVs among 440 participants in Western Australia. Their results indicated that 10.9% of the respondents ranked EVs as their top or most favored option.

Encouraging the use of EVs and Hybrid EVs through financial and non-financial incentives (e.g., lower taxes) and improving the maintenance and charging facilities could be critical factors for the successful deployment of CAVs. Concerns about pollutant emission impacts on global warming were found to have a positive influence on the decision to adopt electric AVs (Acheampong et al., 2019; Krueger et al., 2016; Lavieri et al., 2017; Wu et al., 2019).

Legal challenges play a pivotal role in the successful integration of vehicles with advanced automation capabilities. Piao et al. (2016) found that a significant portion (84%) of their sample expressed moderate to high concerns about "legal liability in the event of a crash". Similarly, in Lu et al. (2016), 68% of participants expressed apprehension about the introduction of fully automated driving systems, primarily due to uncertainties surrounding legal responsibility in the event of a crash. The question of legal liability of drivers or owners of autonomous vehicles was also a prominent concern in the survey by Schoettle and Sivak (2014a), with 73% of respondents indicating moderate to high levels of concern.

Recent studies further underscore these sentiments. Manfreda et al. (2021) identified safety, security, and concerns related to technology and legality as influential factors in the adoption of autonomous vehicles. Similarly, Wu et al. (2020) highlighted safety, legal liability, and the performance of these vehicles under adverse weather conditions as determinants affecting vehicle adoption.

In our study, respondents were also concerned with issues around legal liability in the case that CAVs are involved in a crash. Taking liability away from the "driver" may be an essential policy lever in adopting such vehicles. This position is supported by other analyses indicating increases in likely adoption rates of AVs in scenarios where the driver was not liable for crashes (Shabanpour et al., 2018).

The potential effects of AVs hinge on the likelihood of these technologies gaining acceptance and widespread use. Therefore, as emphasized by Pettigrew et al. (2019) and Sener et al. (2019), it is crucial to consistently monitor and track the public's intent to adopt emerging AVs as a key mobility solution.

Although people's opinions and attitudes toward CAVs are likely to change over time as they become increasingly exposed to the technology, vehicle manufacturers can start to consider what CAV designs (e.g., human-machine interface, interior design) might look like also to facilitate the uptake of CAVs.

8 Conclusions

As connected and automated vehicles (CAVs) gain broader acceptance, and as higher levels of automation become increasingly visible on the roads, public opinion is expected to develop as well. Advocacy groups will likely intensify their focus on key public concerns such as safety, privacy, and security. In Australia, state and federal departments of transport have already started plans for more comprehensive safety regulations for CAVs, while also giving some attention to privacy and security matters. Moreover, as CAV technology spreads globally, there will be a growing need for the international harmonization of CAV policies. This is a complex task, given the varying regulatory cultures across countries.

Examination of the landscape of public opinion regarding CAVs in Australia, explored in this study, addresses a notable gap in the existing literature. By investigating key factors such as respondent concerns, perceived benefits, and barriers to CAV deployment, valuable insights have been gained into the complexities of public sentiment toward this transformative technology. The diverse sample of 562 respondents from Melbourne has provided a nuanced perspective on the attitudes and perceptions that underpin the future of CAV adoption in Australia.

A crucial discovery from this study is that participants expressed a notable interest in the CAVs' capacity to assist those with health issues, indicating a bright prospect for enhanced mobility and CAVs.

However, respondents expressed skepticism about CAVs' ability to alleviate congestion and reduce travel time. This apprehension may stem from a lack of understanding regarding advanced traffic management techniques like platooning, pointing to the importance of effective public education in shaping accurate perceptions of CAV capabilities.

This study highlighted a range of perceived concerns associated with CAVs, echoing themes documented in prior research. Notably, driverless commercial heavy vehicles emerged as a significant concern among respondents, suggesting the need for targeted communication strategies to address these reservations. Safety remained a pivotal concern, impacting attitudes across various scenarios. Concerns about children's safety and the overall trustworthiness of CAV technology were key barriers to wider adoption. Furthermore, the liability issue looms large, raising questions about responsibility in shared human-machine driving scenarios.

Willingness to purchase CAVs emerged as a pivotal factor in shaping their adoption. Respondents' readiness to invest in a CAV was influenced by factors such as the availability of maintenance and charging facilities, lower taxes and insurance rates, and competitive pricing. This study reveals a substantial hesitancy among respondents to fully rely on automation for driving tasks, reflecting notable trust and safety concerns. The impact of legal and regulatory obstacles on CAV deployment is evident from the data, highlighting their significance in public perceptions. Additionally, around 40% of participants indicated a strong willingness to purchase a CAV, primarily driven by the desire for reduced carbon footprint and safety considerations. Notably, respondents with health conditions exhibited heightened interest (almost double those without) in CAV technology.

The study reinforced gender differences in attitudes, with men generally displaying lower levels of concern and greater interest in CAVs. Younger individuals exhibited more optimism, while education, technology familiarity, urban residency, and higher income levels correlated positively with acceptance. The correlation analyses underscored the significance of factors such as gender, age, education, technology familiarity, and urban residency. Men's relative ease with technology and decreased safety concerns contrasted with women's heightened apprehension, reflecting the importance of gender-specific considerations in CAV development.

The practical implications of these findings are profound. Government and industry stakeholders can use these insights to address concerns and enhance the positive perception of CAVs. Strategies such as live demonstrations and dedicated lanes and routes can help build trust, especially concerning safety. Policy

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interventions to address legal liability and financial incentives are likely to play a significant role in fostering CAV adoption. As attitudes evolve over time with increased familiarity, vehicle manufacturers can consider CAV designs that facilitate user acceptance, including aspects such as human-machine interfaces and interior layouts.

This study enriches the discussion on CAV adoption by offering a comprehensive understanding of public sentiments in the Australian context. These findings are poised to guide policymakers, industry players, and researchers in orchestrating a future where CAVs seamlessly integrate into the transportation fabric, addressing challenges and maximizing benefits for society as a whole.

While the questionnaire yields important insights, it is possible that the empirical analysis offers a more robust foundation. The questionnaire results serve as complementary perspectives, enriching our understanding. However, when addressing public adoption, we place significant emphasis on the empirical analysis to ensure that our conclusions are both robust and validated.

Replication and data sharing

The source survey data used in this study are not publicly available in compliance with privacy provisions stipulated in the research ethics approval. Only high-level aggregated data similar to what is included in this paper are available from the corresponding author upon request.

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The study was conducted in accordance with the Australian National Statement on Ethical Conduct in Human Research. The survey reported in this study is also compliant with the rules and guidelines outlined by Swinburne's Human Research Ethics Committee (SUHREC), approval reference 20226366-10982 (15 September, 2022), modification reference 20226366-11087 (27 September, 2022).

Declaration of competing interest

The authors have no competing interests to declare that are relevant to the content of this article.

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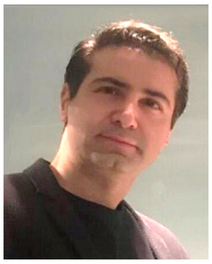

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