WAKA KOTAHI
NZ TRANSPORT AGENCY

The New Zealand public's readiness for connected- and autonomous-vehicles (including driverless), car and ridesharing schemes and the social impacts of these

May 2020

NJ Starkey and SG Charlton

ISBN 978-1-98-856162-2 (electronic)
ISSN 1173-3764 (electronic)

NZ Transport Agency
Private Bag 6995, Wellington 6141, New Zealand
Telephone 64 4 894 5400; facsimile 64 4 894 6100
research@nzta.govt.nz
www.nzta.govt.nz

Starkey, NJ and SG Charlton (2020) The New Zealand public's readiness for connected- and autonomous-vehicles (including driverless), car and ridesharing schemes and the social impacts of these. *NZ Transport Agency research report 663.* 159pp.

The School of Psychology, University of Waikato, was contracted by the NZ Transport Agency in 2017 to carry out this research.

Keywords: attitudes, autonomous vehicles, carsharing, connected vehicles, mobility as a service, ridesharing

An important note for the reader

The NZ Transport Agency is a Crown entity established under the Land Transport Management Act 2003. The objective of the Agency is to undertake its functions in a way that contributes to an efficient, effective and safe land transport system in the public interest. Each year, the NZ Transport Agency funds innovative and relevant research that contributes to this objective.

The views expressed in research reports are the outcomes of the independent research, and should not be regarded as being the opinion or responsibility of the NZ Transport Agency. The material contained in the reports should not be construed in any way as policy adopted by the NZ Transport Agency or indeed any agency of the NZ Government. The reports may, however, be used by NZ Government agencies as a reference in the development of policy.

While research reports are believed to be correct at the time of their preparation, the NZ Transport Agency and agents involved in their preparation and publication do not accept any liability for use of the research. People using the research, whether directly or indirectly, should apply and rely on their own skill and judgement. They should not rely on the contents of the research reports in isolation from other sources of advice and information. If necessary, they should seek appropriate legal or other expert advice.

Acknowledgements

The authors would like to thank all those who took part in this study, our research assistants who provided invaluable help with data collection, data entry and analyses, and members of the steering group (Barney Irvine, Automobile Association; Andrew Jackson, NZ Transport Agency, Peter Filbey, Auckland Transport; Jennifer McSaveney, Richard Cross, Lucia Sobiecki, Simon Kingham, Lee McKenzie, Ministry of Transport; Ryan Cooney, Christchurch City Council; Erik Zydervelt, Mevo). We would also like to express our thanks to the peer reviewers of this report Dr Jared Thomas, Opus International Consultants and Professor Kirsten Pammer, Australian National University.

Abbreviations and acronyms

ADAS	advanced driver assistance systems
AV	autonomous vehicle
CAV	connected autonomous vehicle
CV	connected vehicle
HTS	Household Travel Survey (Ministry of Transport)
MaaS	mobility as a service
SAV	shared autonomous vehicle
TNC	transport network companies
VMT	vehicle miles travelled

Contents

Executive summary **6**
Abstract **9**
1 Introduction **10**
1.1 Connected and autonomous vehicles (CAVS) 10
1.2 Carsharing/ridesharing 17
1.3 Summary 22
2 Attitudes and public readiness for automated vehicles in New Zealand **24**
2.1 Transport futures: connected and autonomous vehicles questionnaire: Method 24
2.2 Results 27
2.3 Transport technologies and you survey (Ministry of Transport 2016; 2017): Method 34
2.4 Results 36
2.5 Summary 42
3 Attitudes to carsharing and ridesharing **44**
3.1 Readiness for shared mobility survey: Method 44
3.2 Results 48
3.3 Transport sharing and you (Ministry of Transport 2017/ 2018): Method 79
3.4 Results 81
3.5 Summary 88
4 Shared mobility group interviews **91**
4.1 Method 91
4.2 Results 92
4.3 Summary 101
5 Adoption timeline for automated vehicles and MaaS **102**
5.1 Existing adoption and technology diffusion models 102
5.2 Adoption of vehicle technologies 104
5.3 Factors affecting adoption of transport technologies in New Zealand 106
5.4 Summary 107
6 Conclusions and recommendations **108**
7 References **113**
Appendix A: Transport futures: public perceptions of connected and autonomous vehicles – questionnaire **120**
Appendix B: Transport technologies and you (Ministry of Transport 2016; 2017) **132**
Appendix C: Readiness for shared mobility **137**
Appendix D: Transport sharing and you **155**

Executive summary

The overall purpose of the research described in this report was to explore the New Zealand public's readiness to adopt four key mobility changes: autonomous vehicles, connected vehicle technology, carsharing and ridesharing schemes.

The research had five main objectives, as explained below:

1 **Identify the main attitudinal and social impact issues recognised in overseas studies.**

We conducted a review of academic literature, government reports and internet posts/articles to address the first objective. Findings revealed that people had generally heard about autonomous vehicles but were less familiar with connected vehicle technology. Concerns about autonomous vehicles focused on safety and equipment failure, particularly in a car with no controls. The literature on carsharing and ridesharing is limited and focuses mainly on ride hailing service (such as UberX). Ride-hailing and ride share services were most commonly used in urban areas by young adults aged between 18 and 34 years, but few people had used carsharing services. The primary factor limiting use of these services was car ownership. The studies identified in the literature review were used to develop the survey and focus group discussion questions to allow a direct comparison between New Zealand and overseas data.

2 **Combine results from existing surveys of the New Zealand public.**

To address the second objective we analysed data from two existing New Zealand sources: *Transport futures: public perceptions of connected and autonomous vehicles survey* (Starkey and Charlton 2016) and the Ministry of Transport's *Transport technologies and you survey* (2016 and 2017).

These two surveys revealed that the majority (>90%) of respondents had heard about self-driving cars, electric cars, hybrid cars and electric bikes, but only 23% had used advanced driver assistance systems. The most commonly perceived benefit of connected autonomous vehicles (CAVs) was a reduction in crashes, followed by improved fuel economy, decreased traffic congestion and a reduction in emissions. The most frequently mentioned reason for wanting to use a CAV was to do other things during a journey, but increased safety and decreased congestion were also rated as important. Participants reported they were most likely to use the self-driving option on the motorway, and when they were tired, impaired or over the drink drive limit. Only a very small proportion of respondents would use a self-driving car to transport their children.

Only 20% reported they would feel safe, and in keeping with this a quarter of the sample reported they would never use a CAV. The greatest barriers to using CAVs were trust, safety, lack of control and higher cost, with a small but significant proportion noting they enjoyed the act of driving, which was a barrier to using CAVs.

In terms of the data sharing aspect of connected vehicle technology, respondents were generally happy to share and receive data if it was to their benefit (eg to avoid congestion) but were generally unwilling to share data with insurance companies.

3 **Identify remaining gaps in demographics and knowledge, collecting additional survey data if required.**

From the above analyses of existing New Zealand-based survey data, the gaps in knowledge appeared to be centred on car- and ridesharing. Given this, we addressed Objective 3 by carrying out the *Readiness for shared mobility survey* (developed and conducted specifically for this project) and supplemented it with data from MoT's *Transport sharing and you survey*.

The *Readiness for shared mobility survey* focused on participants' knowledge, experience, barriers and enablers of three new transport technologies: 1) app-based ride hailing, 2) ridesharing/carpooling and 3) carsharing (called car clubs in the MoT survey).

The analyses of these surveys revealed that over 80% of the respondents had heard of app-based ride hailing, with fewer having heard of ridesharing/carpooling (76%) and carsharing (64%). A third of the respondents had used app-based ride hailing, a quarter had used ridesharing/carpooling and a fifth had used carsharing. In terms of their likely future use of the services, 50% to 70% were not intending to use any of the services in the future, with older respondents being the least likely to report future use. Intended future use was highest for app-based ride hailing with those aged 25 to 44 years most likely to continue use at the current level or to increase use.

Barriers to using the services were reported as car ownership, lack of availability (particularly in rural areas), safety, cost, not being sure how to use the services, not wanting to share rides with others, inconvenience and loss of freedom. Enablers included convenience, availability and price.

4 **Conduct targeted focus groups to reveal underlying public attitudes.**

To meet Objective 4, we conducted 12 group discussions across New Zealand to explore attitudes to ridesharing in more detail with respondents from a diverse range of backgrounds.

These discussions reflected the findings from the surveys. It was agreed that for the transport sharing options to be a feasible alternative to using a private car the service needed to be comfortable, convenient, cost-effective, flexible, and meet the needs of the traveller. One of the greatest motivators for using shared transport was not needing to worry about parking. Key issues in terms of barriers, were lack of availability and not knowing about the service or how to use it. To increase use, the service needed wider dissemination and the provision of non-app-based booking systems for those who were less technologically skilled. Participants were positive about a wider range of transport options being available but highlighted that the new services were often not suitable for older people or those with disabilities. They hoped these new transport options would develop to ensure they were accessible to diverse users, rather than simply providing more options for city-based commuters.

5 **Review existing adoption and technology diffusion models for autonomous vehicles and mobility as a service (MaaS) to determine their applicability for New Zealand.**

Finally, to address Objective 5, we reviewed existing adoption and technology diffusion models, and examined estimates of the costs of adopting new vehicle technologies, with a particular focus on AVs and MaaS. Estimated timelines for 40% to 90% market penetration have ranged from one to five decades. However, these may be over optimistic as many existing models tended to be inaccurate, possibly because of the influence of numerous other factors including perceived safety, time, cost etc that cannot readily be taken into account. The findings from our surveys supported this as participants had concerns about the safety of CAVs, they were uncomfortable with the lack of control, and they liked driving. Furthermore 25% of participants reported they would never use a CAV. For ridesharing, one of the biggest barriers was availability, in addition to knowing about the service and how to use it. To develop more accurate predictions of likely adoption timelines, more complex and realistic models needed to be developed.

Conclusions

To summarise, New Zealanders have a good knowledge of CAVs and app-based ridesharing, but few have heard about ridesharing and carsharing schemes. There are also widespread safety concerns alongside issues of availability, cost and convenience. However, comparisons with international data suggest that at the time of writing this report the New Zealand public was more aware and ready to use

CAVs than some overseas jurisdictions. To further prepare the New Zealand public for use of CAVs we recommend action to improve awareness of advanced driver assistance systems and their safety benefits (to increase uptake) and to increase education about the security of CAVs to allay public fears about vehicle hacking and technology failure. Even though the New Zealand public appears to be more CAV ready than other countries, widespread adoption is some time away, and cannot be relied upon to solve current transport safety issues. To increase the use of transport sharing services, additional advertising needs to be undertaken as well as providing other non-app based booking services; this would also offer the opportunity to address some of the safety concerns (via a frequently asked questions section, for example). Provision of a system that allows users to compare costs of the same journey using different transport options, would also help them make an informed choice about how to travel.

Rather than advocating that these new transport sharing schemes completely replace the private car (which is unrealistic in the current climate), the initial focus should be on ensuring these alternatives are well integrated with the existing transport network, and encouraging people to explore the best transport option for each type of trip they are taking. To increase use of the transport sharing options we suggest the following steps:

1 Prepare/produce cost and time information for different journeys (eg work commute, trip to airport) for each of the new transport modes and a private car. This information will allow people to make an informed choice about how to travel (and could include transport options not covered by this report such as e-bikes and scooters).

2 Advertise the services widely across different media platforms and include information about safety checks/processes.

3 Develop transport sharing options that better meet the needs of those living with a disability.

4 Have more accessible booking systems and better cater to the needs of a diverse population that allows people to make regular bookings.

5 Run community-based workshops to show people how to access and use the new transport options.

6 Ensure the services advertised are available and provide travellers with a good experience to encourage further use.

Abstract

The purpose of this research was to explore the New Zealand public's readiness to adopt four key mobility changes: autonomous vehicles, connected vehicle technology, carsharing and ridesharing schemes. We analysed data from five surveys; three focused on connected and autonomous vehicles (total n = 2616) and two focused on ridesharing (total n = 1766). We also conducted group interviews with 58 participants and reviewed existing adoption and technology diffusion models for AVs and MaaS. The surveys and group interviews revealed CAV technology was better known than ridesharing and carsharing schemes. Respondents had widespread concerns about each of the new transport technologies, in particular, their safety, cost and convenience. A significant proportion of respondents were not interested in using the new transport sharing technologies, unless it was 'as convenient as using their own car'. For other respondents, transport sharing options did not meet their needs due to the booking systems (app-based) and/or the inability of the schemes to cater for children and/or those with a disability. Rather than these new transport sharing schemes replacing the private car, the initial focus should be on ensuring these alternatives are well integrated with the existing transport network, and encouraging people to explore the best transport option for each type of trip they are taking.

1 Introduction

The advent of new technologies and services has enabled new possibilities for delivering and accessing transport. In order to fully realise the potential benefits offered by these emerging transport models, they need to be taken up by the public. Understanding the public's attitudes towards these mobility options, and estimation of the likely timeline for their adoption is necessary for effective planning and investment. Thus the purpose of this research was to explore the New Zealand public's readiness to adopt four key mobility changes: autonomous vehicles, connected vehicle technology, carsharing and ridesharing schemes. The literature review includes published literature up to 2017; the surveys were carried out between 2016 and 2018. There were five objectives for the research:

1 Identify the main attitudinal and social impact issues recognised in overseas studies.

2 Combine results from existing surveys of the New Zealand public.

3 Identify remaining gaps in demographics and knowledge, collecting additional survey data if required.

4 Conduct targeted focus groups to reveal underlying public attitudes.

5 Project the likely adoption timeline of these four mobility services/transport technologies.

The new transport technologies are rapidly changing, and their availability has been accompanied by a significant (and ever increasing) amount of research on public perceptions of these new technologies. This chapter reviews overseas research on public attitudes towards connected and autonomous vehicles, carsharing and ridesharing schemes and other emerging vehicle technologies summarised in the following sections: public awareness; degree of knowledge; expected benefits; concerns and obstacles; likely use and trip type and; factors involved in mode shifts (including willingness to pay).

1.1 Connected and autonomous vehicles (CAVS)

Car companies are rapidly integrating new technology into their vehicles with the aim of making driving safer, reducing fuel consumption and easing congestion. The available technology varies from systems that provide assistance in particular situations (eg the intelligent parking assistant system which helps drivers park their cars) to total automation (self-driving), where the driver only needs to provide details of the destination. Technology is also enabling cars to 'talk' (or connect) to each other and the road network around them, which can provide information about cars suddenly braking in front of them or traffic congestion. Vehicle automation is a continuum and is typically described by the widely used taxonomy set out in SAE International (2018). According to this taxonomy, level 0 is no automation, the driver is in control of the car at all times. This includes vehicles with systems that provide warnings only (eg collision warnings) and cannot exert control over the vehicle. Level 1 (function specific automation) involves one or more specific control functions that operate independently of each other (eg adaptive cruise control). Level 2 (combined function automation) involves automation of at least two primary control functions that work together (eg adaptive cruise control with lane keeping). At level 2, the driver is temporarily relieved of some driving functions, and could have their hands off the steering wheel and foot off the brake/accelerator pedal at the same time. Level 3 automation (limited self-driving automation) enables the driver to give full control of all critical safety functions to the vehicle under certain conditions. The vehicle monitors the driving conditions and alerts the driver when they need to take over control. At level 4 (full self-driving automation), the vehicle performs all critical safety driving functions and monitors the road conditions for an entire trip (the driver is not expected to take control at any time, and the car can be

unoccupied). The studies examining perceptions and attitudes towards new transport technology reviewed in the remainder of this section have used a variety of definitions of connected and/or autonomous vehicles but where possible these are linked to the SAE International (2018) taxonomy described above.

1.1.1 Public awareness of CAVs

A number of studies have investigated public awareness of CAVs and, given the increasing publicity, it is unsurprising that awareness has risen over time. Interviews by Continental AG found that 67% of respondents from Germany, 64% from China, 50% from the USA and 29% from Japan had heard about automated driving (Sommer 2013). Slightly more recently, Schoettle and Sivak (2014) carried out an international survey (Australia, UK, US, China, India and Japan) focusing on public opinions (n= 3,255) about self-driving vehicles. Overall, the majority of respondents had heard of autonomous or self-driving vehicles (AVs) but this differed by country. Respondents in China were most likely to report having heard of AVs (87%), followed by 73.8% of respondents from India, 70.9% from the US, 66.0% from the UK, 61% from Australia and 57.4% from Japan. Interestingly only 25% of respondents from the UK, US and Australia had heard about connected vehicles (CVs) (Schoettle and Sivak 2014). Studies conducted in the US show a similar increase in public awareness of CAVs. In 2015, 59% of respondents to a survey in Texas had heard of Google self-driving cars but only 19% had heard about CVs (Bansal and Kockelman 2015). A study a year later by the same authors in Austin, Texas found that 80% of respondents had heard of Google's self-driving car and 53% had heard of CVs (Bansal et al 2016). Overall these findings suggest the majority of the public is aware of self-driving or AVs, but fewer are aware of CV technology.

1.1.2 Degree of knowledge

The research also looked at peoples' knowledge and experience of different levels of automation as presented in the literature. Sanbonmatsu et al (2018) examined the accuracy of respondents' (n=114 recruited via Mechanical Turk) knowledge of autonomous vehicles by asking them to respond true (T) or false (F) to a series of statements: Fully autonomous (self-driving) vehicles will…i) rely heavily on GPS for navigation (T); ii) require a human driver in inclement (bad) weather conditions and bumper to bumper traffic (F); iii) require the installation of an extensive network of beacons embedded every 10 to 20 yards in all roads and streets to guide traffic (F); iv) may not even offer a steering wheel (T); v) utilise radar, laser sensors and cameras to detect and track other vehicles (T); vi) are being developed not only by automobile manufacturers but also by tech companies such as Google (T); vii) Some states such as California have passed laws allowing fully autonomous (self-driving) vehicles to operate on the road, including those without an accelerator pedal or brake pedal (T); viii) Most fully autonomous (self-driving) vehicles will have electrical rather than gas combustion engines (T). Less than half (42.1%) of the respondents scored 5 (slightly above chance) or less, indicating that respondents were not very knowledgeable about the fully automated cars. In addition, only a third (32.5%) knew that a self-driving car may not have a steering wheel, and almost half (44.7%) thought a human driver would be required to take over in bad weather. Interestingly, respondents knew less about the least favourable views of autonomous vehicles.

Other studies have focused on knowledge and experience of advanced driver assistance systems (ADAS). A large survey (n=2662) in Canada found that around two thirds of respondents (63%) were familiar with advanced ADAS technology (cruise control and lane keeping) but less than half (39%) rated themselves as familiar with the systems used to develop self-driving cars (Robertson et al 2016). Similarly, over half (60%) of the respondents in an Austin-based survey correctly considered anti-lock braking lock systems as a form of vehicle automation (Bansal et al 2016).

Focusing on the use of ADAS, Rödel et al (2014) evaluated respondents' (n=336) experience of eight ADAS, including a navigation system, cruise control, automatic transmission, parking assist, automatic parking system, collision avoidance system, blind spot detection and adaptive cruise control. Over 50% of respondents had 'some' or 'substantial' experience with navigation systems, just over 40% with cruise control, 40% with parking assistance, and 30% with automatic transmission. In contrast, less than 5% of respondents had 'some or substantial' experience of the more recent ADAS (automatic parking systems, collision avoidance systems, adaptive cruise control and blind spot detection). A large study (n=1,000) conducted in Germany reported similar findings with over two thirds (67%) of the sample indicating they had heard of ADAS. Of the respondents who drove a car every day (82% of the sample), the most frequently used ADAS were cruise control (50%), acoustic parking assistants (46%) and high beam assistants (automatically dips high beam when oncoming traffic is detected). Other ADAS, including adaptive cruise control, night vision assistant, head up displays[1] and attention assistants were only used regularly by a minority of the sample (<15%) (Wolf 2016). In keeping with these findings, Bansal and Kockelman (2015) found that only 7% of respondents' households (in Texas) owned a vehicle with level 2 automation.

There is also evidence that demographic factors play a role in knowledge and experience of CAVs and ADAS, with men reporting greater experience than women, and older age groups having more experience of integrated ADAS systems than younger drivers (Owens et al 2015; Robertson et al 2016; Rödel et al 2014).

1.1.3 Expected benefits

Vehicle manufacturers and experts have suggested that widespread adoption of CAVs has the potential to improve road safety and decrease congestion. More specifically CAVs may reduce the road toll (driver error plays a role in 90% of crashes), decrease road infrastructure (as the vehicles will communicate with each other), increase capacity, improve safety for pedestrians and cyclists, improve accessibility and mobility, and eliminate (or reduce) the need for parking (Wither 2017; Robertson et al 2016). While the benefits of CAVS proposed by manufacturers are compelling, realising these benefits is dependent on public acceptance and use of these new transport technologies.

Studies examining road-users' perspectives of CAVs reveal that the most commonly reported benefit anticipated for fully automated CAVs is improved safety, in particular fewer and less severe crashes (eg Begg 2014; Bjørner 2015; Bansal et al 2016; Hulse et al 2017; Schoettle and Sivak 2014). Other benefits identified by survey and focus group respondents include: improved emergency response to crashes; shorter travel times; lower vehicle emissions; better fuel economy; lower insurance rates; improved transport accessibility for older or disabled people or those unable to drive; and less traffic congestion (Bansal and Kockelman 2015; Bjørner 2015; Hulse et al 2017; Robertson et al 2016; Schoettle and Sivak 2014). However, some reports suggest that the public is somewhat sceptical about CAVs reducing congestion and leading to shorter travel times (Bansal et al 2016; Schoettle and Sivak 2014; Smith 2016). The endorsement rates of the most and least likely benefits of CAVs vary by country as shown in table 1.1. Interestingly, the benefits of CAVs were endorsed by the largest proportion of respondents in China, while the endorsement rate in Australia was the lowest. The most frequently endorsed benefit differed for each county, apart from the UK and India who ranked better fuel economy as the most likely benefit. There was more consistency with regard to the least likely benefit of CAVs with 4 of the 6 countries identifying shorter travel times as least likely (Schoettle and Sivak 2014).

[1] Transparent display of dashboard data projected onto the windscreen so the driver does not have to lower/move their eyes

Table 1.1 The highest and lowest ranked benefits of CAVs by country (adapted from Schoettle and Sivak 2014)

	Most likely benefit (% of respondents)	Least likely benefit (% of respondents)
China	Improved emergency response to crashes' (88.8%)	Less traffic congestion (72.0%)
India	Better fuel economy (85.9%)	Lower insurance rates (69.3%)
Japan	Fewer crashes (81.1%)	Shorter travel time (42.4%)
US	Improved emergency response to crashes (71.6%),	Shorter travel time (45.9%)
UK	Better fuel economy (75.9%)	Shorter travel time (39.3%)
Australia	Reduced severity of crashes (73.5%)	Shorter travel time (44.8%)

Other researchers (Howard and Dai 2014) asked respondents to rate features of CAVs that they found the most and least *attractive*. Specifically, respondents (n=107) recruited at a public science museum were asked to complete a survey about their current driving and travel habits, watch a short video about the potential benefits and issues with CAVs, and then answer a series of questions. The respondents identified the three most attractive aspects of CAVS as increased safety, convenience (eg no need for parking), and amenities (eg being able to do other things when travelling). The most commonly reported other activities that could be carried out when using a CAV were looking out of the window and talking with friends (Bansal et al 2016).

Findings from a large analysis of online articles (827 comments on 16 articles) about autonomous vehicles were similar to the results outlined above; approximately 70% of comments noted the potential benefits of CAVs and included: i) safety, reliability; ii) flexibility, comfort; iii) contribution to traffic optimisation; iv) integrative transport use; v) progress; vi) sustainability; and vii) cost savings (Fraedrich and Lenz 2016).

1.1.4 Concerns and obstacles

From the literature reviewed above it is clear the public is aware of the potential benefits associated with the widespread use of CAVs, but there are also widespread concerns. Schoettle and Sivak's survey (2014) asked respondents how concerned they would be driving or riding in a vehicle with level 4 (ie fully automated technology). Across the six countries surveyed almost a third (27%) of respondents indicated they would be 'very concerned'. The lowest levels of concern were in China (12.3% of the sample) and the highest in India (40.4%). Interviews with drivers revealed they were concerned that fully autonomous vehicles would not be reliable (74% of Chinese, 50% American, 48% German and 43% of Japanese respondents) and the thought of fully automated driving scared them (66% of American, 52% of Chinese and German, and 42% of Japanese respondents (Sommer 2013). Similar rates were reported in the UK with 53% of respondents reporting they would be afraid to travel in a self-driving car (Smith 2016).

Other studies have explored more specific concerns about CAVs. Findings from online surveys report that the main concerns about CAVs were equipment or system failure, interaction with conventional vehicles, affordability, legal liability, privacy and hacking (eg Bansal and Kockelman, 2015; Bansal et al 2016; Hulse et al 2017; Kyriakidis et al 2015; Regan et al 2017). Interestingly, respondents were not particularly concerned about learning to use the new technology, and privacy was of greatest concern when information was to be shared with insurance companies or tax agencies (Bansal et al 2016; Kyriakidis et al 2015). A recent national survey in Australia (n=5,263) found that respondents were concerned about all the issues raised about fully autonomous vehicles, including driving and including riding in a car with no driver (>40% very concerned), cars moving by themselves from one location to another while unoccupied

(>45% very concerned), allowing your child to ride in a car by themselves (>60% very concerned), the ability of the car to perform safely in all conditions (45% very concerned), vehicle security (>30% very concerned), data privacy (>30% very concerned), and legal and financial responsibility for crashes or mistakes (>50% very concerned). Female respondents indicated greater levels of concern about all these issues except legal liability (Regan et al 2017).

The international survey conducted by Schoettle and Sivak (2014) revealed that the level of concerns about CAVs differed by country (table 1.2). Respondents were asked to rate their level of concern about a range of issues related to self-driving (level 4) autonomous vehicles (safety consequences of equipment/system failure; legal liability for drivers/owners; system security (from hackers); vehicle security (from hackers); data privacy (location and destination tracking); interacting with non-self-driving vehicles; interacting with pedestrians and bicyclists; learning to use self-driving vehicles; system performance in poor weather; self-driving vehicles confused by unexpected situations; self-driving vehicles not driving as well as human drivers. As shown in the table, respondents from China showed the highest levels of concern and those from Japan the least. The two most concerning issues were the safety consequences of equipment failure and self-driving vehicles being confused by unexpected situations. The issues of least concern were learning to use self-driving vehicles, self-driving vehicles not driving as well as human drivers, and interacting with non-self-driving vehicles.

Table 1.2 The most and least concerning issues related to CAVs by country (adapted from Schoettle and Sivak 2014)

	Most concerning (% of respondents)	Least concerning (% of respondents)
China	Safety consequences of equipment/system failure (68.0%)	Self-driving vehicles not driving as well as human drivers (35.1%)
India	Safety consequences of equipment/system failure (59.0%)	Interacting with non-self-driving vehicles (35.5%)
Japan	Self-driving vehicles confused by unexpected situations (32.3%)	Learning to use self-driving vehicles (9.6%)
US	Self-driving vehicles confused by unexpected situations (53.1%)	Learning to use self-driving vehicles (29.1%)
UK	Safety consequences of equipment/system failure (44.8%)	Learning to use self-driving vehicles (15.4%)
Australia	Safety consequences of equipment/system failure (44.4%)	Learning to use self-driving vehicles (20.8%)

Respondents were also asked to rate their concern about a number of scenarios involving fully autonomous vehicles (riding in a vehicle with no driver controls available; self-driving vehicles moving from one location to another while unoccupied; self-driving commercial vehicles such as heavy trucks or semi-trailer trucks; public transportation such as buses that are completely self-driving; and taxis that are completely self-driving). As can be seen in table 1.3, respondents from five of the six countries were most concerned about riding in a vehicle with no driver controls available; the scenario of greatest concern for Australian respondents was self-driving commercial vehicles. The least concerning issue for most of the countries (apart from China) was self-driving vehicles moving whilst unoccupied. Interestingly the endorsement rates of these scenarios across the six countries was much more similar than the ratings of the CAV-related issues shown in table 1.2.

Table 1.3 The most and least concerning scenarios involving CAVs by country (adapted from Schoettle and Sivak 2014)

	Most concerning (% of respondents)	Least concerning (% of respondents)
China	Riding in a vehicle with no driver controls available (58.9%)	Self-driving commercial vehicles such as heavy trucks or semi-trailer trucks (40.3%)
India	Riding in a vehicle with no driver controls available (49.5%)	Self-driving vehicles moving from one location to another while unoccupied (40.0%)
Japan	Riding in a vehicle with no driver controls available (41.0%)	Self-driving vehicles moving from one location to another while unoccupied (29.2%)
US	Riding in a vehicle with no driver controls available (60.1%)	Self-driving vehicles moving from one location to another while unoccupied (41.5%)
UK	Riding in a vehicle with no driver controls available (51.8%)	Self-driving vehicles moving from one location to another while unoccupied (36.6%)
Australia	Self-driving commercial vehicles such as heavy trucks or semi-trailer trucks (53.0%)	Self-driving vehicles moving from one location to another while unoccupied (39.4%).

A range of other concerns about CAVs has also been identified, for example, participants in Robertson et al's (2016) focus groups suggested that widespread use of CAVS might reduce family interactions, as many incidental conversations occur when taking family or friends to work or school. They also expressed concern that CAVs would lead to job losses for professional drivers, and that they might actually be bad for the environment as they would need to drive back to their depot after completing a drop off. Bjørner (2015) conducted 13 in-depth interviews with participants while they watched videos depicting vehicles with different levels of autonomy (levels 2 and 3) in varied traffic situations (on the highway, reverse parallel parking, in congested traffic) and a future scenario (level 4) where the car was fully autonomous. Reflecting the findings of the online surveys, participants reported a lack of trust in the technology and had concerns about safety in the event of failure, particularly in the high-speed highway driving scenario. Other concerns included missing out on the enjoyment of driving, whether or not they would be able to retake control quickly enough if needed, liability if there was a crash and the behaviour of pedestrians (would they just step out in front of traffic if they knew the car was autonomous and would stop?). This latter issue was also raised as a concern by respondents providing open-ended comments in an online survey; however, their concerns also extended to the behaviour of other drivers and cyclists (Hulse et al 2017). Other comments suggested that until 80% of the vehicle fleet was autonomous, all vehicles should be fitted with emergency manual braking and steering, and that education about their capabilities should be provided before they were used on the road. Other respondents reported lack of control was the biggest barrier, and given the lack of reliability of computers, they would not trust autonomous vehicles (Hulse et al 2017).

Analyses of comments related to online articles about CAVs found that approximately 30% of the comments were negative; as with the survey and interview data, the comments raised concerns about the social consequences of CAVs (eg job losses), the potential for misuse of data, problems with the infrastructure and vehicles, cost increases and uncertainties/mistrust of how the self-driving technology actually worked (Fraedrich and Lenz 2016).

There is evidence that acceptance and trust in fully autonomous vehicles has been decreasing over time (possibly as a result of the widely publicised crashes involving autonomous vehicles).

A survey of 2,976 respondents in 2017 found that fewer respondents reported they would be comfortable using a fully automated car, compared with 2016 data (24% vs 13%) and this trend was particularly pronounced in those aged 16 to 44 years. In contrast, the proportion of drivers who reported they would be comfortable using 'features that actively help the driver while the driver remains in control' showed a

substantial increase (from 40% to 59%). Almost half the respondents (49%) reported they would never buy a fully autonomous vehicle, with the most commonly cited reason being loss of control (37%), lack of trust (29%), belief it 'won't work perfectly' (25%) and the technology is unsafe (21%). Although respondents have concerns about CAVs, studies have explored when people are most likely to use CAVs and who is most likely to adopt this new technology.

1.1.5 Likely use and trip type

Survey findings reveal that half to two thirds of respondents intend to use fully autonomous transport at some point (Bansal and Kockelman 2015; Payre et al 2014; Smith 2014). Using a nuanced analysis approach, Sommer (2013) classified their respondents as 'fans' (highly likely to use automated technology), 'wait-and-sees' (would use CAVs in some situations) and 'sceptics' (would generally not use a CAV). The proportion of 'fans' ranged from 17% in Germany to 22% in Japan; the greatest proportion of 'wait-and-sees' was in China (72%) followed by Germany (54%), Japan (48%) and USA (43%). In contrast the greatest proportion of 'sceptics' were from the USA (37%), followed by Japan (30%), Germany (29%) and China (10%).

When those who were interested in using CAVs (or shared autonomous vehicles (SAVs) were asked when they would choose to use them, journeys on high-speed motorways or highways, were the most commonly endorsed (typically by over 60% of respondents) (Bansal and Kockelman 2015; Robertson et al 2016; Payre et al 2014; Sommer 2013). People would also be interested in using them when visiting scenic areas (58.6%) but would be less likely to use them on congested city roads (28% to 36%) or for social and recreational trips (25%) (Bansal and Kockelman 2015; Sommer 2013). Survey respondents also reported they would use CAVs for trips with a variety of different purposes; travelling when they were impaired (eg over the legal drink drive limit or tired; 71%) (Payre et al 2014), to run errands and to do shopping (Robertson et al 2016).

1.1.6 Factors involved in attitudes to CAVs

Factors related to more favourable attitudes to CAVs, include male gender, younger age, higher level of education, more interest in technology, urban resident, crash history, non-driver, higher levels of sensation seeking, higher levels of extraversion, and lower levels of neuroticism (Bansal et al 2016; Haboucha et al 2017; Hoff and Bashir, 2015; Hulse et al 2017; Payre et al 2014; Robertson et al 2016; Smith 2014; Smith 2016). Factors positively influencing the future use of SAVs are similar; younger age, living further from work, living in a densely populated areas, usually travel as a passenger, high levels of environmental concerns, and having more than one child in the household (Bansal et al 2016; Haboucha et al 2017; Krueger et al 2016). Factors associated with lower likelihood of CAV use include; older age, holding a driving licence, having own vehicle, enjoyment of driving, a large number of trips or errands each day, and a negative view of public transport (for SAVs) (Bansal et al 2016; Haboucha et al 2017).

Clearly the cost of these new technologies will be a major predictor of uptake. A number of studies have explored how much people are willing to pay for automated technology. A study in the US found that people were willing to pay, on average $US3,300 to $US4,607 for level 3 automation and $US7,253 to $US7,589 for level 4 automation (Bansal and Kockelman 2015; Bansal et al 2016: note $US1 ≈ $NZ1.5). Interestingly though, a large proportion of respondents, 31.7% and 26.6%, would not pay more than $US1,500 for level 3 or level 4 automation (Bansal and Kockelman 2015). In another US-based study 4% of respondents were willing to pay less than $24,999 for a fully automated vehicle, 27% would pay $25,000 to $49,999, 15% selected $50,000 to $74,999, 4% chose $75,000 to $99,999 and 1% chose more than $100,000 (Abraham et al 2017). In general, people were willing to pay more for higher levels of automation (Bansal and Kockelman 2015; Kyriakidis et al 2015).

The amount people are willing to pay differs by country; those in China were willing to pay the most for fully automated technology (25% were willing to pay >$8,000), in contrast the same proportion of respondents in the Japanese sample were only willing to pay $465. Japan had the greatest proportion of respondents who would not be willing to pay extra for completely self-driving technology (67.5%), followed by the UK (59.8%, Australia (55.2%), US (54.5%), India (29.8%) and China (21.6%) (Schoettle and Sivak 2014). A nationwide study in Australia found that just over 40% of respondents would be willing to pay 'more' and just over 20% would be willing to pay 'a lot more' for a fully automated vehicle (compared to the same model without automation). Half of those who were willing to pay for fully automated technology would pay at least $AUS5,000 ($US3,500) more than their current car; 25% were willing to pay $AUS10,000 ($US7,000) or more (Regan et al 2017). Sommer et al (2013) asked respondents how much they would expect to pay for specific autonomous features. For 'automated freeway driving', respondents from Germany expected to pay the most (€2,900 ≈$US3,300), followed by China (€2,600 ≈$US3,000), Japan (€2,300 ≈$US2,616) and the USA €1,100 euros ≈$US1,251). The cost expected for 'automated driving in a traffic jam on the freeway' was highest in Japan (€2,400 ≈$US2,730) and lowest in the USA (€800 ≈$US910). Respondents in China expected to pay the most for 'automated parking in a covered parking garage' (€1,900 ≈$US2,161) and those in the USA the least €900 ≈$US1,023) (Sommer 2013).

A number of factors have been identified that may influence willingness to pay, for example Bansal et al 2016 found that being male, having more children, living in a high income area and frequently driving alone for social reasons were related to being willing to pay more for level 3 and level 4 automated technology. In addition, those who lived further away from work were willing to pay more for level 4 automation, possibly because they could use their travel time for other activities (Bansal et al 2016; Kyriakidis et al 2015). Others have suggested that the relative cost between CAVs and standard cars is the key to predicting whether or not people will use them, rather than the absolute cost of the technology (Haboucha et al 2017).

Note to the reader: The literature review was completed in 2017. Since then several New Zealand-based reports on autonomous vehicles have been published (Curl et al 2018; Fitt et al 2018a; Fitt et al 2018b; Fletcher et al 2018). While these publications were not used in the design of the surveys or focus groups in this report, they may be of interest to the reader.

1.2 Carsharing/ridesharing

Compared with the plethora of studies about attitudes and perceptions towards CAVs there are fewer studies focusing on carsharing and ridesharing schemes – possibly because these schemes are already available. Carsharing has been available since the 1940s in Europe (the first schemes ran from 1948 to 1998 in Zurich, Switzerland), and a number of schemes were set up across Europe but most were short-lived. Since then carsharing has grown and in 2008, an estimated 348,000 people shared 11,700 cars (Shaheen and Cohen 2008). Carsharing can be offered via a fleet or peer-to-peer, where a user supplies their vehicle to another user. The latter is more recent but may improve the viability of carsharing in rural areas (Circella et al 2018). Ridesharing (or carpooling), in its widest sense (ie sharing a journey with a passenger), has been available since car ownership was possible. More recently ridesharing and carpooling have become more formalised and widespread, for example, carpooling schemes for the work commute are often associated with priority parking, or access to shared public transport lanes. With the advances in technology and smartphone applications, more rideshare/carpooling schemes have become available (eg UberPool) allowing rideshare opportunities to be identified in real time.

Studies in this area tend to use slightly different terminology which makes a review of the literature rather challenging. In addition, there are a wide variety of different services, which often overlap with the

autonomous vehicle literature (eg SAVs), and as these services are already available the literature is nowhere near as extensive as for CAVs.

1.2.1 Public awareness

International studies suggest that public awareness of shared mobility varies by type and location. For example, Bansal and Kockelman (2015) report that around 66% of respondents (n=1,088) from Texas were familiar with Transport Network Companies (TNC) services including UberX and Lyft but only a quarter of respondents were aware of carsharing programmes. In contrast, in a subsequent survey a year later in Austin, Texas (n=347), a large proportion of respondents had heard of both carsharing (95%) and ridesharing (85%) possibly because both services were popular and available in Austin (Bansal et al 2016). Similarly, a study in Australia (n= 435) found that 84.6% of their respondents had heard of carsharing (Krueger et al 2016). More recently Circella et al (2018) surveyed respondents (n=1,975) in California and found that between 4% (Central Valley) and 21% (Sacramento) had not heard of ride hailing services such as Uber or Lyft. In contrast, between 18% (San Francisco Bay Area) and 44% (Central Valley) had heard of carsharing. Awareness of carsharing did not appear to be influenced by age, but those living in urban as opposed to rural locations were more likely to have heard of the service (Circella et al 2018) There is also evidence that the availability of ride hailing services influences the acceptability/uptake of ridesharing, for example in San Francisco, where Uber has operated for some time, almost 50% of Uber trips are taken using Uber POOL (which connects travellers going in the same direction) (Uber 2016).

1.2.2 Degree of knowledge/use

Although awareness is relatively high for some of the transport options, the percentage of people using each of the new transport options is relatively low and also varies by location (partly as a result of availability). Over half the respondents in a large survey (60% to 64%) had heard of app-based ride hailing (eg Uber and Lyft) but had not used it. Of those who used the service, the greatest proportion used it while travelling and when at home (ie they used the service regardless of their location). Use varied with age, with 'independent millennials' (18 to 34 years) most likely to use the service (Circella et al 2018).

Shifting the focus to carsharing, of the respondents to the survey in Texas who had heard of carsharing programmes (25% or the overall sample), only 14.8% were members. In contrast, twice as many (30%) had used an app-base ride hailing service as a passenger (UberX or Lyft) (Bansal and Kockelman 2015). Similarly, an Australian study reports that 84.6% of their respondents knew about carsharing, but only 8.7% of the sample had used it. Of these, over half (55.3%) used it at least once a week (Krueger et al 2016). A large survey in California (n=1,975) found that between 54% and 72% (depending on location) had heard of carsharing but not used it. Of those who had used carsharing, rates were highest for hometown use (5% in San Francisco Bay area) and about half that for use away from home (2.5% in San Francisco Bay area) (Circella et al 2018).

For ridesharing (or carpooling), a recent meta-analysis focusing on commuting highlighted the variability in the use of carsharing globally, with a low of 3.1% in the UK to a high of 47% but these differences might be partly a result of participant recruitment strategies (Neoh et al 2017). New Zealand appears to fall somewhere between these two extremes, with a recent survey in Auckland reporting that up to a quarter of respondents would not be willing to use shared transport options (International Transport Forum (ITF) 2017). A recent study of university students found that 7% rideshare with friends or family and 4% used rideshare apps for their regular commute. For longer or one-off trips the numbers were higher with 25% ridesharing and 3% using a rideshare app (Amirkiaee and Evangelopous 2018).

1.2.3 Expected/actual benefits

Carsharing has been found to have a number of benefits. Members of carsharing clubs report lower fuel consumption than non-members and their trips are more likely to include passengers (Cervero et al 2007) which results in reduced carbon emissions of 27% to 56% for each individual (Shaheen and Cohen 2013). Carsharing also leads to decreased vehicle ownership with 16% to 34% of carshare club members selling a car after joining and between 12% and 68% delaying the purchase of, or not buying another car (Katzev 2003; Shaheen and Cohen 2013). The reduction in car ownership as a result of carsharing is supported by other studies. Car ownership showed a significant reduction from 0.47 vehicles per household prior to joining a carsharing club to 0.24 per household afterwards (Martin et al 2010). In addition, vehicle ownership among members of carsharing programmes is 10% to 14% lower compared with non-members (Mishra et al (2015). There is also evidence to suggest that non-car owning members of carsharing programs take fewer and shorter shopping trips (Le Vine et al (2014) Kopp et al (2015) cited in Circella et al 2018). Members of carsharing programs take a greater proportion of trips either on foot or by bike compared with non-members (Mishra et al (2015) Kopp et al (2015) in Circella et al 2018). Finally, carsharing members report that the key reasons for joining were that it was an economical option for those who do not travel extensively as well as being environmentally friendly (Bansal and Kockelman 2015; Shaheen and Cohen 2008).

The increased use of app-based ride hailing services (Uber and Lyft) in New York has been associated with a decrease in the number of taxi trips and the number of vehicles on the road. Interestingly, the shift towards using app-based ride hailing has been observed for both personal and business use, probably as a result of more competitive pricing (Licea et al 2015 and Hu 2017 in Circella et al 2018). According to a recent Reuters/Ipsos opinion poll around 10% of users of app-based ride hailing intend to sell a vehicle in the near future and use ride hailing services as their primary form of transport (Henderson 2017 in Circela et al 2018). This suggests that their positive experience of the service (reliability and availability) has convinced them that app-based ride hailing it is a viable alternative to vehicle ownership.

The newer app-based ridesharing services (eg UberPOOL and Lyft Line) are also increasing in popularity (multiple users share a ride in the same vehicle) and with a continued increase it is predicted that this will lead to an overall reduction in vehicle miles travelled (VMT) (Taylor et al 2015 in Circella et al 2018). More recently, a submission by Uber to the Land Transport Amendment Bill estimated that UberPOOL has eliminated 145 million km of driving where it is available, saving 16,000 tons of carbon dioxide emissions. They also reported that up to 10% of young people either chose not to buy a car or sell their current car in places where UberPOOL services were available (Uber 2016).

1.2.4 Concerns and obstacles

Concerns and obstacles in relation to the use of carsharing are diverse, ranging from public perceptions of the ‘image’ of carsharing to very practical issue such as accessing pick up and drop off points. A number of studies have indicated that good public transport to get to the carshare pick and drop-off points are key to the success of such programmes (Cervero et al 2007). In effect, this means that carsharing is only a viable transport option in densely populated cities with multiple types of alternative transport options for trips to/from the carshare site (Shaheen et al 1998). Other users have expressed concerns about the types of car that are available (Cervero et al 2007) as well as difficulties with booking vehicles due to lack of availability or the time taken to make multiple booking for frequent travellers (Shaheen et al 1998).Surveys of the general public indicate that some people are put off by the ‘green’ image of carsharing when walking or cycling are more sustainable transport options. Concerns were also raised that the widespread availability of carsharing may threaten the viability or provision of public transport

(Bonsall 2002). Finally respondents to Bansal and Kockelman's survey (2015) reported they did not need to become a member of a carsharing club because they already had other means of transportation.

There is ongoing debate about whether app-based ride hailing and ridesharing will increase or decrease in the number of trips individuals make. This is partly a methodological issue as it is challenging to isolate the effects of new transport modes from other factors that influence transport choice including residential location, availability of public transport, age and vehicle ownership. For example, use of an app-based ride hailing system may reduce the amount of driving the user does, but travel to the pick-up destination and from the drop-off point may increase the overall VMT (Cooper et al 2010). The full effect of these services on VMT will differ by location (layout of the city) and the distribution and number of drivers that are available (Anderson 2014 in Circella 2018).

Personal factors also play a significant role in use of ride hailing services. A large survey conducted by Circella et al (2018) found the primary factor that limited use of these services was car ownership, followed by concerns about comfort, safety and cost. These issues are also reflected in studies of ridesharing; a 2017 study of shared mobility simulations for Auckland found respondents were not willing to give up the convenience and flexibility of using a private car, unless it was significantly cheaper (ITF 2017). Other concerns/barriers about ridesharing included the unpredictable journey time, particularly detours to collect or drop off other passengers, which might result in people being late for appointments or meetings (Agatz et al 2012). There were also concerns about the reliability of the service as a result of users or drivers cancelling and the service not turning up as booked. Finally several studies have highlighted that sharing a ride with a stranger is a significant barrier and ideally users would be matched in some way (Agatz et al 2012; Bansal and Kockelman 2015). Interestingly though, Auckland survey and focus group participants reported they would be more comfortable sharing with a larger number of passengers as there was less pressure to talk (ITF 2017).

1.2.5 Likely use and trip type

A survey of carshare club members found the most common use was for shopping (30%), then for social-recreational purposes (20%) and personal business trips (eg to the bank – 18%) (Cervero et al 2007). Travelling to work (11.0%), 'other' (15%) and using it for medical appointments (4%) were among the least-used categories. Many members cycled or walked (47.8%) or used public transport (41%) for daily commuting. In terms of usage patterns, a study of members of Carsharing Portland found that demands tended to be slightly higher on weekends than weekdays, with most trips taking place in the morning or afternoon (37% and 39% respectively), with much fewer in the evening (19%) or in the early morning (midnight to 6am – 5%) (Katzev 2003). Overall usage was influenced by private vehicle ownership, length of membership and distance between residential location and the carshare depot (Katzev 2003). A recent study in Canada found that use of carsharing was most common in the respondents' hometown compared with when they were travelling. Highest rates of hometown use were observed in those aged 18 to 34 years (3.7%) and those residing in urban areas (7.1%). With regard to frequency of use, no-one reported using a carsharing service more than five times a week, and less than 1% reported using it three to four times a week. In urban dwellers approximately 45% used carsharing less than once a month and 19% used it one to three times a month (Circella et al 2018).

Use of app-based ride hailing is higher than carshare services with up to 82% of respondents reporting they never use ride hailing compared with 98% reporting they never use a carsharing service (Circella et al 2018). The majority (50%) of app-based ride hailing users reported using it less than once a month, 24% to 31% used it one to three times a month (depending on age), 2% to 11% used it once or twice a week and less than 3.5% used it three or more times a week. Use of app-based ride hailing away from

home was much greater than for carsharing. Use only at home ranged from 7% to11% depending on age, and 6% to7% away from home; use both home and away ranged from 5% to13%, (highest in those aged 18 to 34 years). Unsurprisingly urban dwellers were most likely to use app-based ride hailing services, with 20% using it both at home and when travelling (Circella et al 2018).

1.2.6 Factors involved in willingness to use carsharing, ride hailing and ridesharing

A number of studies have indicated that the adopters of new mobility services are most likely to be well-educated young adults who live in urban areas (Buck et al 2013; Rayle et al 2014; Taylor et al 2016; Circella et al 2016; 2017a cited in Circella et al 2018). This group is also the most likely to live in cities, have lower rates of car ownership and use other forms of transport (ie non-private vehicles) (Kuhnimhof et al 2012; Polzin et al 2014; Brown et al 2016 cited in Circella et al 2018), all of which are factors that have been identified as important in the adoption of new mobility solutions.

A survey of members of a carshare scheme found the most commonly identified reasons for joining the service were that they needed access to another vehicle because they either did not have a vehicle and/or did not want to own one (or purchase another) (Katzev 2003). The second most frequent reason was that they expected to save money. A Canadian survey found carshare users were most likely to be aged 18 to 34 years and live in urban areas where the service was available (Circella et al 2018).

Factors important in the adoption of ride hailing included higher levels of education, age (those aged 25 to 34 years were most likely to use the service, followed by those aged 35 to 50 years), and being located in a densely populated urban area. Use of the service was also more common in those who made more long-distance trips, were frequent plane users and did not own a vehicle. Unsurprisingly, those who were more comfortable using app-based transport information (including map-based functions) were more likely to used app-based ride hailing, as were those who had a history of taxi use and/or carsharing. Private car ownership was also an important factor in frequency of use with car owners using the service less frequently. Those least likely to adopt the service tended to live rurally, have lower levels of education and/or low income (Circella et al 2018). Existing users reported that ease of use and the quality of the service were the most important factors in their continued use of the service (90% of users). Other important factors included avoiding parking problems at their destination (80%), and to avoid drinking and driving (60%) (Circella et al 2018).

Limited research has been carried out with existing users of ridesharing (carpooling), but a number of studies have focused on hypothetical shared transport scenarios and shared autonomous vehicles. The International Transport Forum (ITF) (2017) report on shared mobility simulations for Auckland included focus groups (3 x 7 people) and a stated preference survey (respondents were drawn from the focus groups, n=16; and the Household Travel Survey (HTS) panel, n = 97) about two hypothetical shared transport modes: a shared taxi (six seats) with a door-to-door service and real-time booking; and a taxi-bus (8–16 seats) with boarding up to 400 m away and needing to be booked 30 minutes in advance.

Interestingly, up to 25% of respondents reported they would never use a shared mobility service when provided with an accurate estimation of the cost of using their car (this rate was the highest for those living outside the city). Of those who were willing to use shared transport services, 7% of the focus group participants and 4% of the panel would be willing to pay a fee similar to their current car-related costs; current bus/rail users were willing to pay the same as their current public transport costs. Walking up to five minutes to reach the shared mobility stop was acceptable for 45% of the focus group and 35% of the car using HTS panel participants. The largest group of respondents thought detours of up to five minutes were acceptable (55% of focus group participants and 25% of the HTS panel); however, 10% would not

accept detours and would only use a direct service. Car drivers were most willing to share with three or four others but a quarter of respondents were happy to share with up to 10 others. Participants acknowledged that this type of service might be particularly valuable as a feeder service to existing public transport hubs, although 20% or car drivers said this was not relevant for them.

All respondents owned a car, and the majority (70%) would keep the same number of cars even if shared transport was available. The key factors in shifting to this type of service were cost and reliability. For existing car users to shift to shared mobility the cost must be substantially lower than their car-related costs to counteract the loss of convenience and flexibility provided by a private vehicle. In addition, once launched the service had to be well advertised, comfortable and reliable to ensure a positive experience.

Building on the findings of the ITF report, at the time of writing, Auckland Transport was conducting a 12-month trial of a shared electric bus service (AT LOCAL, https://at.govt.nz/local) from peoples' homes in Devonport to the ferry wharf and back (essentially a feeder service); however, numbers are not yet as high as anticipated (see https://www.stuff.co.nz/auckland/110930828/publiclyfunded-13m-uber-service-needs-rain). Feedback has been generally positive with regard to the quality, ease of using the booking system (an app) and the price ($2.50 per trip as a result of a $14 subsidy). The trial presents a unique opportunity to evaluate shared mobility in the local context.

Other studies have focused on people's willingness to use SAVs. Price appeared to be the key factor in people's decision making. For example, respondents in Texas would use SAVs frequently if they were priced at $1 p/h and $2 p/h but not at $3 p/h; over 80% of respondents would not be willing to pay more than they pay their current rideshare provider (Bansal et al 2016). Unsurprisingly the percentage of respondents who said they would not use SAVs increased as the prices did; for $1/mile 41% would not, for $2/mile this increased to 48.6% and again increased at $3/mile to 59.1%, and only 7.3% would rely entirely on SAVs even at the lowest price (Bansal and Kockelman 2015).

1.3 Summary

In summary, the advent of new technologies and services has enabled new ways of delivering and accessing transport. In order to fully realise the potential benefits offered by these emerging transport models, they need to be taken up by the public. Understanding the public's attitudes towards these mobility options, and the likely timeline for their adoption is necessary for effective planning and investment.

The first of the five objectives set out at the beginning of this chapter was addressed in this literature review. The subsequent chapters of the report present the data addressing the remaining objectives. Objective 2 was addressed by analysing data previously collected in the *Transport futures: connected and autonomous vehicles questionnaire* (Starkey and Charlton 2016 – see appendix A) and the *Transport technologies and you survey* (Ministry of Transport 2016; 2017 as cited in Wither 2017; Patterson 2018) – see appendix B. Analyses of the data for Objective 2 highlighted that the gaps in knowledge were centred on car- and ridesharing. Given this, Objective 3 was addressed by carrying out the *Readiness for shared mobility survey* (conducted specifically for this project – see appendix C) and supplemented by data from MoT's *Transport sharing and you survey*[2], Jennifer McSaveney, MoT, pers comm 2017 – see appendix D. Group interviews were also conducted to explore attitudes to ridesharing in more detail with participants from a diverse range of backgrounds across New Zealand. To address Objective 5, existing

[2] This is a sub-survey of the HTS, see www.transport.govt.nz/mot-resources/household-travel-survey/panels/

projections of likely adoption scenarios were reviewed and their applicability in the New Zealand context was assessed.

2 Attitudes and public readiness for automated vehicles in New Zealand

This chapter contains the findings from the *Transport futures: connected and autonomous vehicles questionnaire* and the *Transport technologies and you survey*.

2.1 Transport futures: connected and autonomous vehicles questionnaire: Method

2.1.1 Participants

Respondents were recruited via advertisements circulated by email, social media and word of mouth. Table 2.1 summarises the demographic characteristics of the respondents completing the survey. The final sample consisted of 1,076 respondents (55% male), with an average age of 49.14 years (ranging from 16 to 88 years, SD=16.31). In the sample, 98.7% indicated they had a current driving licence, and of these 93.5% held a full New Zealand driving licence (others included learners, restricted, or overseas licence holders). The respondents had an average of 31.01 years of driving experience (ranging from 0 to 77 years (SD = 16.51)). The majority of respondents self-described as New Zealand European (73.6%), with 6.5% identifying as Māori. In terms of personal income, the largest proportion of respondents reported a personal income of $50,000 to $60,000 or $80,000 to $100,000 (14% did not respond), as compared with the New Zealand median annual income of $34,917 in 2017 (Statistics New Zealand 2018b). The survey respondents were based in locations throughout New Zealand, with the largest numbers based in Auckland (28.8%), Waikato (28.4%), Wellington (11.8%) and Canterbury (7.0%). It should be noted this was an opportunity sample and no attempt was made to recruit a representative sample. Thus, when reading the results from the survey the reader should be aware that the sample was older and had a higher median income than the New Zealand population overall. The sample also included a high proportion of respondents from the Waikato region of New Zealand.

Table 2.1 Demographic characteristics of the respondents for the transport futures survey

Characteristics	N = 1076
Age in years (mean, SD, range)	**49.14; 16.31; 16-88**
Gender (n, %)	
Male	592 (55.0)
Female	475 (44.1)
Prefer not to say	9 (0.8)
Ethnicity (n, %)	
New Zealand European	771 (71.7)
Other European	118 (11)
Maori	68 (6.3)
Samoan	3 (0.3)
Cook Island Maori	2 (0.2)
Niuean	1 (0.1)
Chinese	16 (1.5)
Indian	30 (2.8)
Other (eg Japanese)	38 (3.5)
Prefer not to say	29 (2.7)

Characteristics	N = 1076
Annual personal income ($) before tax (n, %)	
Less than $5,000	25 (2.3)
$5,001 – $10,000	25 (2.3)
$10,001 – $15,000	29 (2.7)
$15,001 – $20,000	34 (3.2)
$20,001 – $25,000	28 (2.6)
$25,001 – $30,000	43 (4.0)
$30,001 – $40,000	61 (5.7)
$40,001 – $50,000	94 (8.7)
$50,001 – $60,000	100 (9.3)
$60,001 – $70,000	85 (7.9)
$70,001 – $80,000	80 (7.4)
$80,001 – $100,000	129 (12.0)
$100,001 – $120,000	82 (7.6)
$120,001 – $150,000	53 (4.9)
$150,001 or more	56 (5.2)
Prefer not to say	152 (14.1)
Place of residence (n, %)	
Northland	24 (2.2)
Auckland	309 (28.7)
Waikato	306 (28.4)
Bay of Plenty	46 (4.3)
Gisborne	6 (0.6)
Hawkes Bay	20 (1.9)
Taranaki	14 (1.3)
Whanganui	7 (0.7)
Manawatu	30 (2.8)
Wairarapa	10 (0.9)
Wellington	127 (11.8)
Nelson Bays	10 (0.9)
Marlborough	6 (0.6)
Canterbury	75 (7.0)
Timaru-Omaru	11 (1.0)
Otago	28 (2.6)
Southland	11 (1.0)
Prefer not to say	36 (3.3)

2.1.2 Procedure and questionnaire design

The study received approval (#16–24) from the School of Psychology Research and Ethics Committee at the University of Waikato, and data was collected in May 2016. The survey was developed on the Qualtrics online survey software. As described above, an advertisement containing a link to the survey was circulated via email and posted on various social media sites including Facebook. Upon clicking the web-link the respondents were provided with a short overview of the purpose of the research, reassured that their responses would remain anonymous and that they had the ability/right to withdraw at any time. They were then asked to indicate if they would like to take part. Respondents were then presented with the survey questions which took approximately 15 minutes to complete (a copy of the survey can be found in appendix A).

The questionnaire was developed on the Qualtrics platform (www.qualtrics.com/au/). The questions in the survey were based on those used in previous studies (Bansal et al 2016; Payre et al 2014; Schoettle and Sivak 2014). Each question offered a 'prefer not to respond' option and the validation rules were set to 'request a response' to minimise the amount of missing data.

The first section of the questionnaire focused on awareness and knowledge of, a range of new vehicle technology including self-driving cars, adaptive cruise control, automatic lane keeping and intelligent parking assistant systems. Respondents were then presented with four scenarios depicting different trip purposes and levels of transport technology (Scenario 1: Routine errands in a car with automatic lane keeping and adaptive cruise control; Scenario 2: Daily commute in busy traffic in a car with automatic lane keeping and adaptive cruise control; Scenario 3: Driving on a motorway or open road hands-free in a car with automatic lane keeping and adaptive cruise control; Scenario 4: Need to travel to a busy urban area, request a ride from fully automated car with automatic billing). After each scenario the respondents were asked to rate (from 1, not at all to 5, very) how enjoyable, safe, and interesting they found the trip compared to the same drive in a manual car. For the first three scenarios they were also asked to rate how likely they would be to switch back to manual control (1, not at all to 5, very likely).

The next section focused on autonomous vehicles; the first question asked respondents to indicate which occasions they would like to travel in a fully autonomous vehicle (when driving is stressful, for commuting, when tired, everyday journeys, boring trips, to take kids to school, when impaired by drugs/alcohol, or, I would not like to travel in a fully autonomous vehicle). Respondents were then asked to indicate their level of agreement (on a 5 point scale from strongly disagree to strongly agree) with a series of statements about AVs (I would delegate the driving to the AV if over the drink drive limit, or tired; I would send my children to school in an AV; I would use an AV owned by someone else; and I would use an AV without a steering wheel). Respondents were then asked to indicate why they would like to use a fully automated vehicle (safer, spend time doing other things, speed up travel, reduce congestion, consume less fuel, better for the environment, or they would not like to use an AV) and when they would let the vehicle drive itself (motorway, rural state highways, in town with light traffic, in town with heavy traffic, scenic areas, parking or other).

The subsequent section asked respondents to rate (from 1, not at all to 5, a great deal) how AVs would improve their access to services (eg doctors), employment, and recreational activities and indicate how willing they would be to receive and share data from their vehicle with a range of organisations (receive data from road controlling authorities to learn about road works, receive data to find out about delays and alternate routes, send and receive data with surrounding vehicle, send data to organisations that maintain the road, vehicle developers, and insurance companies). After this respondents were asked to rate how worried they were about six potential problems with CAVs (equipment failure, legal liability, hacking of vehicle, privacy breach, interaction with conventional vehicles, learning to use CAVs) and the potential benefits of CAVs (fewer crashes, less congestion, lower emissions, better fuel economy). The final CAV related question asked how much they would be willing to pay (on top of the normal vehicle price) for fully automated vehicle technology. The last section of the survey sought demographic information from the respondents including age, gender, ethnicity, residential location, income, driving history and presence of disabilities). On completion of the survey respondents were given the opportunity to provide their email address if they wanted to receive a summary of the research findings, and they were thanked for taking part.

2.1.3 Analysis

The questionnaire data was downloaded from the Qualtrics website into Excel and IBM SPSS (version 25) for analysis. The responses were first screened for missing data. Of the 1,288 original responses, 14

respondents had not provided consent to participate and demographic data was missing for 198 respondents, leaving a sample of 1,076 for use in the analyses.

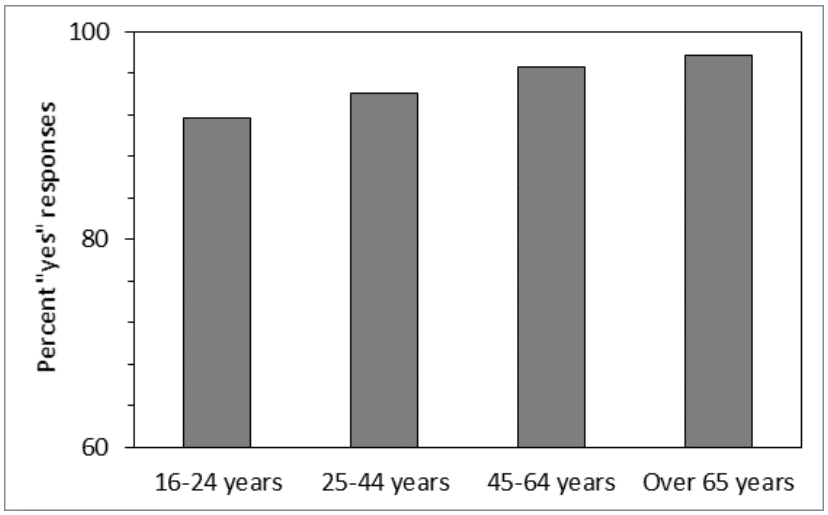
Responses to each question were summarised as frequency counts and percentages for the sample overall, and by gender and age group (16 to 24 years, 25 to 44 years, 45 to 64 years, over 65 years). Chi square tests were used to test for significant associations between gender and age group for each of the relevant survey questions. The findings are presented in the same order as the information in the literature review for ease of interpretation: public awareness, degree of knowledge, expected benefits, concerns and obstacles, likely use and trip type; and willingness to pay.

2.2 Results

2.2.1 Public awareness

When asked whether or not they had heard of self-driving cars such as the Google car, nearly all respondents answered Yes (95.6%). A significantly greater proportion of men (98.1%) compared with women (92.4%) had heard of self-driving cars (X^2 (1, N=1,066), = 20.56, $p < .001$). Interestingly, the proportion of respondents answering Yes showed a trend for older drivers to be more aware of self-driving cars than younger drivers, as shown in figure 2.1 (X^2 (3, N=1068), = 8.21, $p = .042$)

Figure 2.1 The percentage of respondents by age group reporting they had heard of self-driving cars

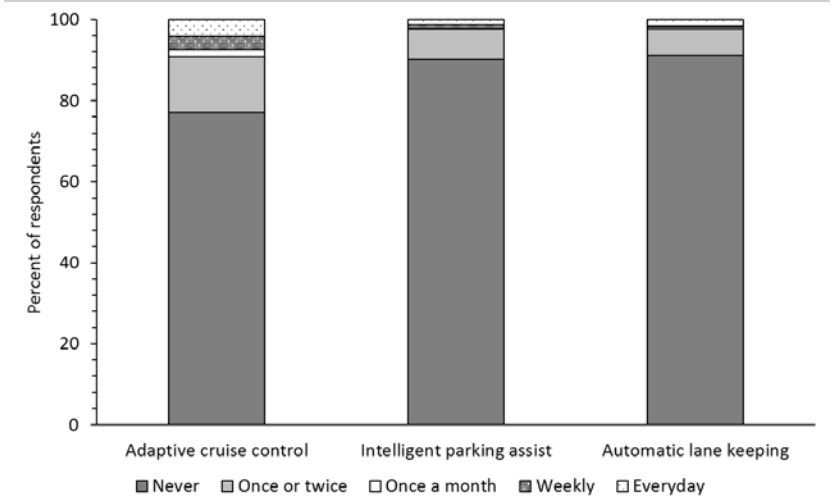


We also asked respondents about their knowledge of some of the currently available driver assistance systems (components of fully self-driving cars). In comparison, somewhat fewer respondents indicated they had heard of other driver assistance systems such as intelligent parking assistance (90.4%, 94.8% of men and 85.2% of women) or adaptive cruise control (71.4%, 83.2% of men and 56.8% of women). Substantially fewer had heard of automatic lane keeping systems (58.2%, 77.4% of men and 34.4% of women). A significantly greater percentage of men had heard about each of the systems compared with the number of women (intelligent parking assistant, X^2 (1, N=1066), = 27.89, $p < .001$; adaptive cruise control X^2 (1, N=1065), = 90.55, $p < .001$; automatic lane keeping X^2 (1, N=1066), = 199.93, $p < .001$).

2.2.2 Degree of knowledge

Although a substantial number of respondents had heard of various forms of driver assistance systems, very few had had any direct experience with them. As shown in figure 2.2, of the 767 respondents who indicated they had heard of adaptive cruise control, only 22.9% had ever driven a car with it. Similarly, of the respondents who had heard of intelligent parking assistance and automatic lane keeping, only 9.8% and 8.8% (respectively) had ever driven a car with them. This pattern was not appreciably different when male and female respondents' experience was contrasted; for adaptive cruise control, only 23.4% of men and 22.7% of women had any experience driving with it. For intelligent parking assistance the percent with direct experience were 11.4% of men and 7.7% of women, and for automatic lane keeping 10.1% of men and 5.5% of women had any direct experience of driving with it.

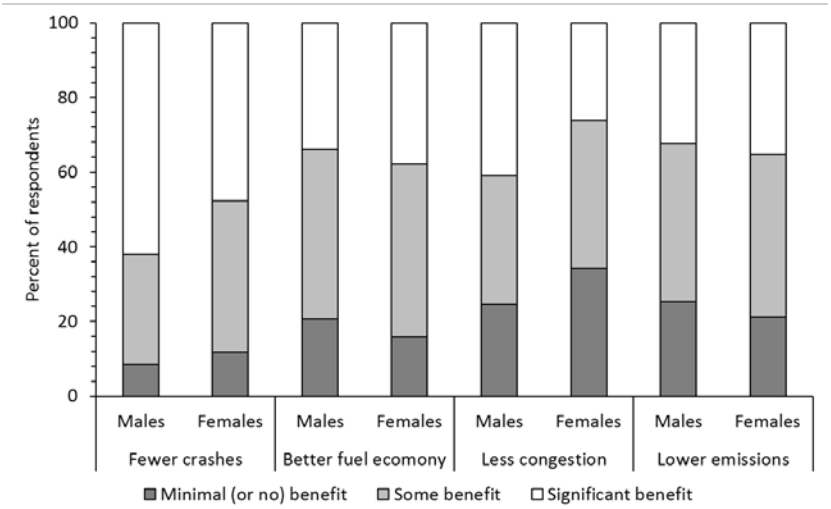
Figure 2.2 The percentage of respondents with experience of the three types of new vehicle technology (note: the percentage is of those who had heard of the new technology)



2.2.3 Expected benefits

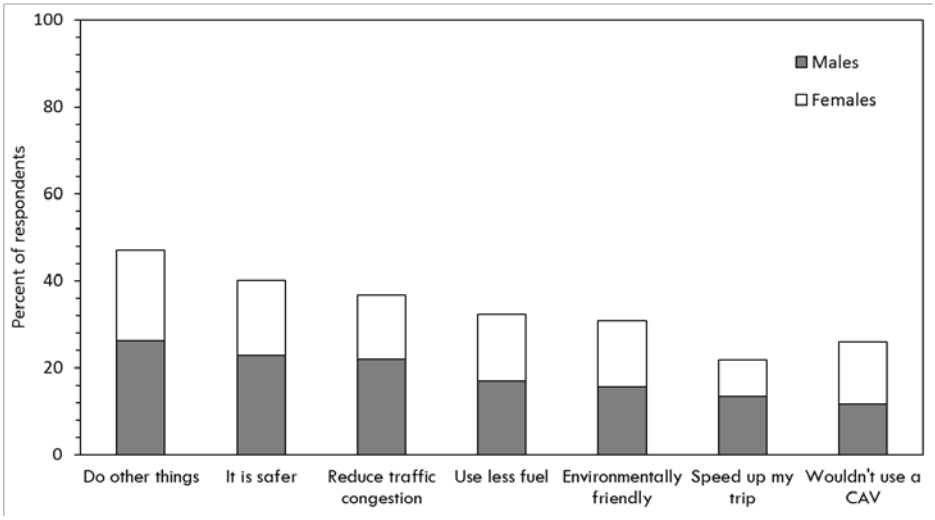
We asked respondents to rate their expectations about some of the likely benefits of CAVs (see figure 2.3). The most highly rated benefit was a reduction in crashes, with 55.5% of the respondents (62% of males and 47.7% of females) rating this as likely to be a significant benefit. This was followed by better fuel economy (35.4% rated as a significant benefit, 33.9% of men and 37.9% of women); less congestion (34.3% significant benefit, 40.9% of men and 26.1% of women), and lower emissions (33.2% significant benefit, 32.2% of men and 35.2% of women). A significantly greater proportion of males rated reduced crashes X^2 (2, N=1,048), = 21.37, $p < .001$) and less congestion X^2 (2, N=1,066), = 26.50, $p < .001$) as being a significant benefit of CAVs compared with ratings by women.

Figure 2.3 Respondents' perceptions of the likely benefits of CAVs (data is presented as a percentage of male and female respondents)



We also asked the respondents to tell us the reasons they might like to use a fully automated vehicle. As shown in figure 2.4 the perceived benefit most often identified by the respondents (47.61% of respondents) was that they could do other things while travelling (instead of drive). This was followed closely by the perception that it would be safer than an ordinary car (40.68%) and that there would be less traffic congestion (37.49%). It is worth noting that over one quarter (25.59%) of the respondents said they would not use a CAV for any reason.

Figure 2.4 The percentage of respondents selecting each of the seven reasons for why they would use a CAV

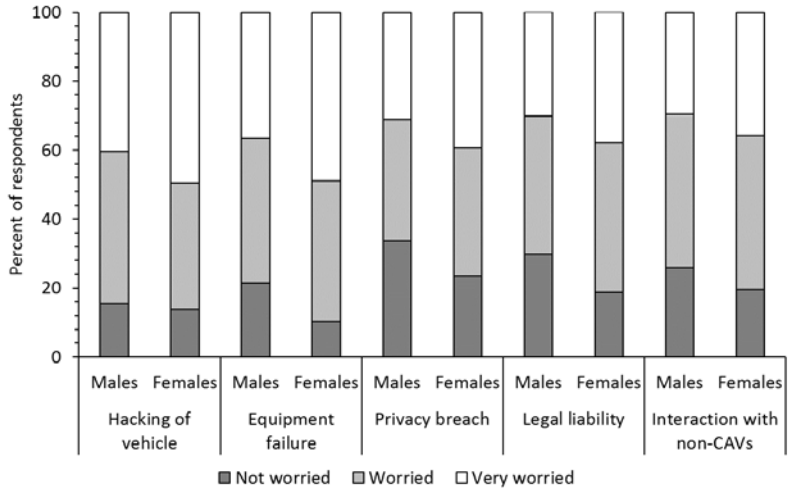


2.2.4 Concerns and obstacles

We asked the respondents to rate the degree to which they were concerned about various aspects of CAVs (identified in previous surveys). Overall, 85.3% of respondents rated themselves as 'very worried' or 'worried' about the possibility that CAVs would be 'hacked' (44.4% and 40.9 % very worried and worried respectively). The second greatest concern was equipment failure, with 82.6% of respondents 'very worried' or 'worried' about this possibility (42.0% and 41.6% very worried and worried respectively).

Figure 2.5 shows the percentage of males and females rating themselves as 'not worried' 'worried' or 'very worried' for each of those aspects. In all cases, female respondents tended to be more concerned about these issues than male respondents with Chi squared statistics for the gender difference ranging from 7.52 to 41.29 (*p*s ranged from < .023 to < .001). In contrast, learning to use CAVs was not regarded as a major obstacle, with 65% of respondents (71.6% of males and 52.4% of females) saying they were 'not worried' by this aspect of CAVs.

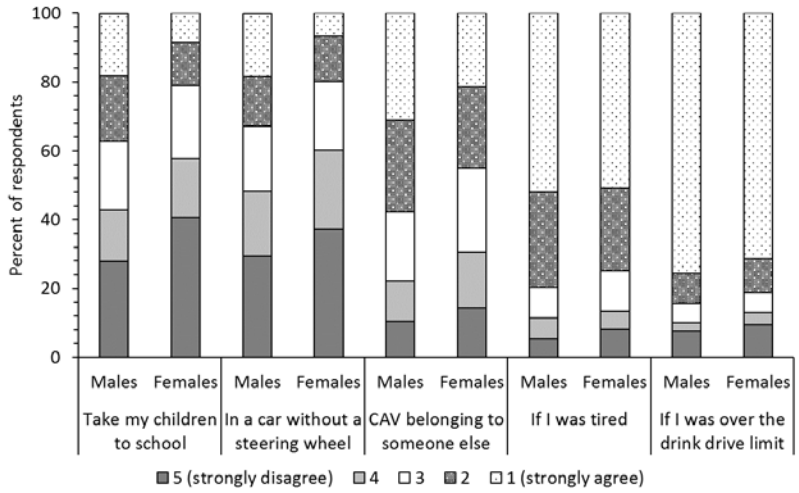
Figure 2.5 The percentage of males and females rating themselves as 'not worried' 'worried' or 'very worried' about various aspects of CAVs



In addition, the respondents indicated they would be uncomfortable using CAVs in some situations. For example, 49.3% of the respondents disagreed or strongly disagreed with the statement 'I would be willing to put my children in a fully automated car that would take them to school'. Interestingly, as shown in figure 2.6 there was a significant gender difference in the respondents' willingness to use CAVs in this situation, with 57.6% of females disagreeing compared with 42.7% of males disagreeing (X^2 (1, N=1,066), = 27.01, $p < .001$). Similarly, 53.5% of the respondents disagreed or strongly disagreed with the statement that 'I would be willing to drive a fully automated car without a steering wheel'. Once again there was a significant gender difference (48.5% of males disagreeing, 60.2% of females; X^2 (1, N=1066), = 33.58, $p < .001$)

The respondents were more positive about their willingness to use a fully automated car with 83% agreeing or strongly agreeing with the idea of using a CAV if they were over the drink driving limit, and 77.5% agreeing or strongly agreeing with using one if they were tired. There were no significant gender differences for either of these situations (ps > .171). Finally, the respondents were generally in agreement (52.2% agree or strongly agree) with the idea of using a fully automated car that belonged to someone else, like a taxi company. There was a small but significant gender difference for this situation, with males in greater agreement than females X^2 (4, N=1,066), = 19.97, $p < .001$).

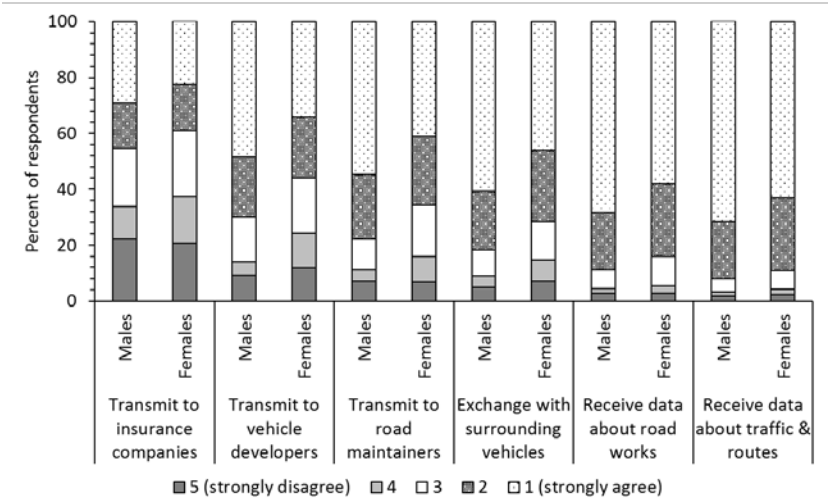
Figure 2.6 Respondents' ratings to a series of statements about the use of CAVs in different situations



Some respondents were also concerned about the connected nature of CAVs with 35.4% of the respondents disagreeing or strongly disagreeing with the statement that 'I would be willing to allow my vehicle to transmit data to insurance companies'. The male respondents were somewhat less comfortable with this idea than females, as shown below in figure 2.7 (X^2 (4, N=1,066) = 10.85, p =.028). Transmitting information to vehicle developers and road maintainers were viewed as more acceptable (63.8% and 72.4% respectively) with men more likely than women to agree or strongly agree in both cases (X^2 ps <.001). The idea your CAV would transmit and receive data with surrounding vehicles to coordinate paths was also agreed or strongly agreed with by the majority of respondents (77.3%) with men once again more likely to be in favour (X^2 (4, N=1,066) = 25.45, p < .001)

The respondents were very much in favour of letting their CAV receive information about traffic delays and alternative routes (90.8% agree or strongly agree), and receive information from road controlling authorities about road works and other problems (86.6% agree or strongly agree). A slight gender difference was observed only for the second of these two scenarios, with men being somewhat more likely to be in agreement (X^2 (4, N=1,066) = 14.01, p = .007).

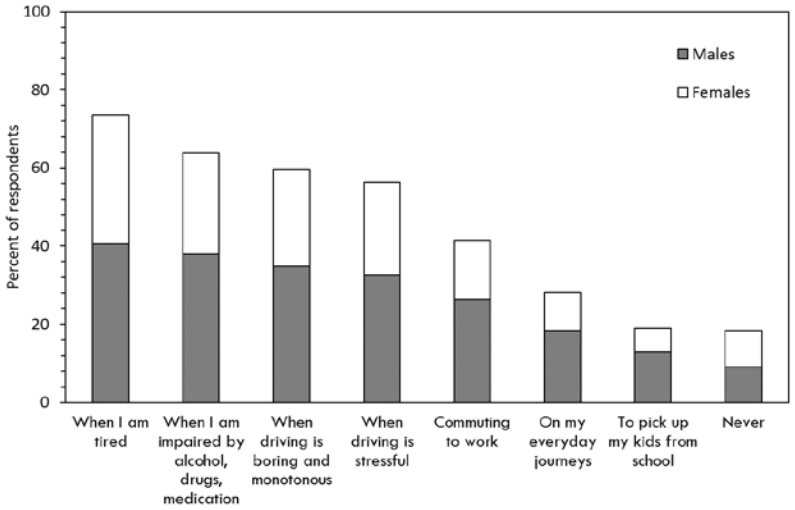
Figure 2.7 Participant' ratings to a series of statements about data sharing when using a CAV



2.2.5 Likely use and trip type

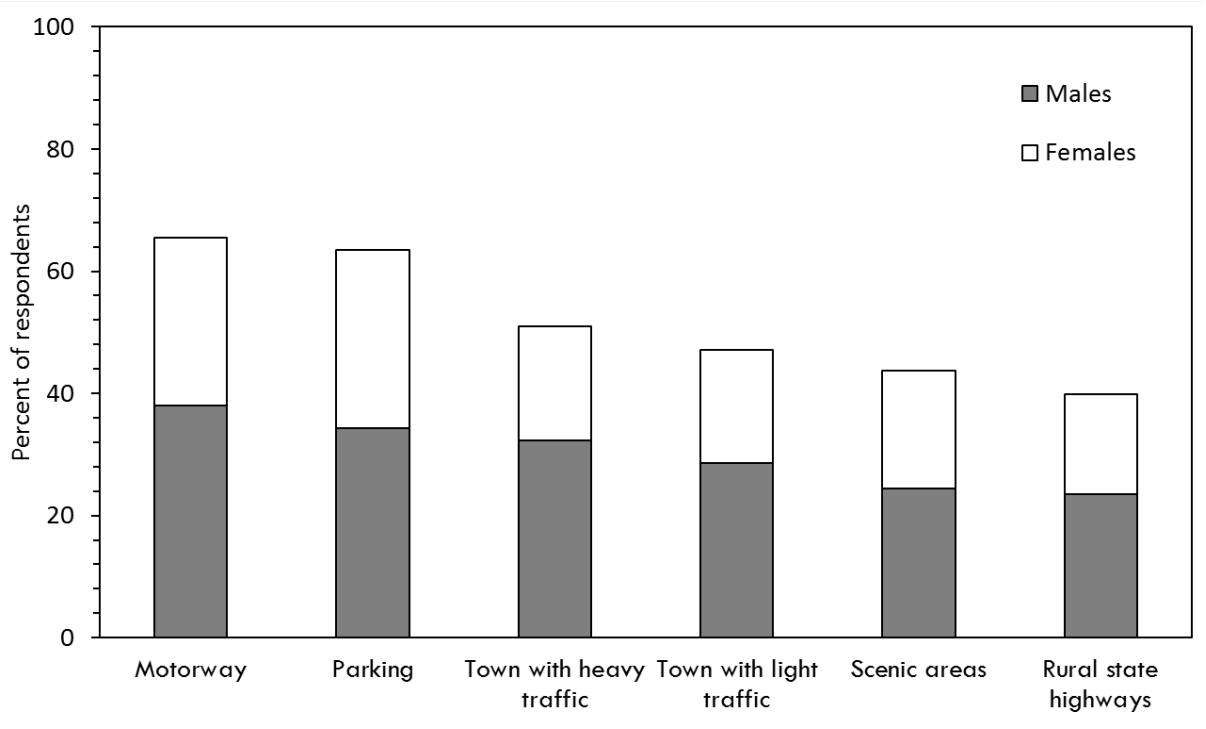
We asked drivers when they would like to drive in a fully automated vehicle, with the respondents identifying the occasions and types of trips as being when they were tired (73.48%); when they were impaired by alcohol, drugs, or medication (63.82%); on boring or monotonous trips (59.61%); and when driving was stressful (56.23%) (as shown in figure 2.8). Fewer respondents were interested in using a CAV when commuting to work (41.42%) or on their everyday journeys (28.21%), and very few would use a CAV to pick up their children from school or take them to soccer practice (18.84%). In each case, men were significantly more likely than women to be willing to use a CAV, but the gender difference was greatest for picking up children, with men being twice as likely as women to use a CAV for this purpose (23.31% of males, 10.64% of female respondents, X^2 (1, N = 1,066) = 17.40, p <.001). Similarly there was a significant gender difference for commuting (47.47% of males, 27.19 of females X^2 (1, N = 1,066) = 20.01, p < .001) and for everyday journeys (32.94% of males, 17.91% of females, X^2 (1, N = 1,066) = 14.69, p < .001).

Figure 2.8 The percentage of respondents reporting they would like to use a CAV for various occasions and trip types



When asked in which situations they would let their CAV drive itself, the respondents were most likely to choose driving on a motorway (65.51% of respondents) and parking (63.54%). In town with heavy traffic (50.98%) and light traffic (47.05%) were followed by scenic areas (43.77%) and rural state highways (39.93%) was identified by the fewest respondents (figure 2.9). Some gender differences were found, with males somewhat more likely to choose driving in town with heavy traffic (58.11% of men, 42.11% of women, X^2 (1, N = 1,066) 27.01, p < .001) and driving in town with light traffic (51.52% of men, 41.47% of women, X^2 (1, N = 1,066) = 10.68, p = .001). Interestingly, women were more likely to say they would let their car park itself (65.68% of women, 61.82% of men) but this difference was not statistically reliable (X^2 (1, N = 1,066) = 1.69, p = .193).

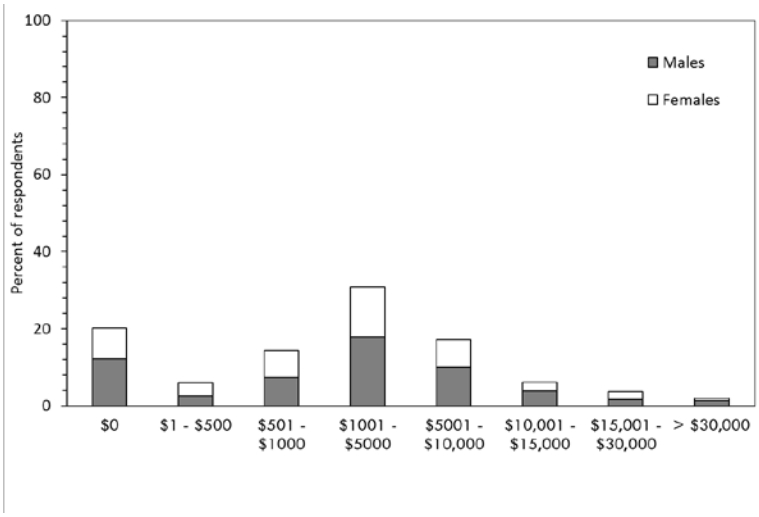
Figure 2.9 The percentage of respondents indicating when they would let their CAV drive itself



2.2.6 Willingness to pay and incentive for mode shifts

Figure 2.10 shows the respondents' answers to the question 'How much money would you be willing to pay (on top of the price of that vehicle) for fully automated driving technology?' As can be seen, the answer is not very much. The largest number of respondents (30.76%) indicated the range from $1,001 to $5,000; there was good agreement between men and women here, with 31.49% of men and 29.81% of women choosing this price range. As can also be seen, a large number of the respondents (20.13%) indicated they would not be willing to pay anything additional for a driverless vehicle (21.55% of males, 18.27% of females). Participants' knowledge of CAVs (ie having heard of self-driving cars) did not show a significant association with willingness to pay for fully automated driving technology (*FET* (N=966) = 5.00, *p* = .678, nor did experience with adaptive cruise control (*FET* (N=698) = 12.76, *p* = .078). [Note: Fisher's Exact Test (FET) is reported rather than chi square because of cell counts less than 5]. In contrast, experience with automatic lane keeping (*FET* (N=581) = 25.59, p <.001) and intelligent parking assistance (*FET* (N=878) = 21.23, *p* =.003) both showed significant associations with willingness to pay. Those without experience of the technology were more likely to report they would not be willing to pay an additional amount for automated and connected vehicle technology compared with those with experience (automatic lane keeping 22.20% vs 6%; intelligent parking assistance 20.6% vs 14.4%). In addition, a greater proportion of those with experience of automatic lane keeping and intelligent parking assistance were willing to pay more than $10,000 for the technology compared with those who had not used either system. For automatic lane keeping, 10% of those who had used it were willing to pay $15,001 to $30,000 compared with 2.80% who had not used this technology. For intelligent parking assistance, 7.80% with experience were willing to pay $15,001 to $30,000, compared with 2.80% who had not used it.

Figure 2.10 The additional amount (on top of the vehicle price) that respondents would be willing to pay for connected and automated vehicle technologies.



2.3 Transport technologies and you survey (Ministry of Transport 2016; 2017): Method

2.3.1 Participants

Household Travel Survey panel respondents who had agreed to be contacted about other studies received an invitation to complete the survey(s) via text and/or email during November 2016 and 2017. For the 2016 survey, 2,200 invitations were sent to HTS panel members and 614 completed surveys were received (a 28% response rate). In 2017, 3,740 invitations were distributed and 935 surveys were completed (response rate of 25%). The demographics of respondents completing the 2016 and 2017 surveys are presented in table 2.2. As shown in the table, the 2016 sample was 51.5% female, with an average age of 50.5 years (ranging from 15 to 90 years, SD=15.92). In 2017 the sample consisted of 935 respondents (53.7% female), an average age 50.4 years (ranging from 15 to 87 years, SD=15.27). The majority of the respondents identified as New Zealand European and were based in the main New Zealand urban centres (Auckland, Waikato, Christchurch and Wellington).

Table 2.2 Demographic characteristics of the respondents for the 'Transport technologies and you' surveys.

Characteristics	2016	2017
	N = 614	N = 935
Age in years (mean, SD, range)	50.53; 15.92; 15-90	50.40; 15.27; 15-87
Gender (n, %)		
Male	297 (48.3)	433 (46.3)
Female	317 (51.5)	502 (53.7)
Ethnicity (n, %)		
New Zealand European	461 (75.1)	696 (74.4)
Maori	43 (7.0)	91 (9.7)
Samoan	7 (1.1)	7 (.8)
Cook Island Maori	0	4 (.4)
Tongan	1 (0.2)	2 (.2)

Characteristics	2016	2017
Niuean	1 (0.1)	2 (.2)
Chinese	15 (2.4)	20 (2.1)
Indian	14 (2.3)	20 (2.1)
Other (eg Japanese)	72 (11.7)	91 (9.7)
Don't know	0	1 (0.1)
Prefer not to say	0	1 (0.1)
Annual personal income ($) before tax (n, %)		
Less than $5,000	43 (7.0)	70 (7.5)
$5,001 – $10,000	7 (1.1)	24(2.6)
$10,001 – $15,000	27 (4.4)	33 (3.5)
$15,001 – $20,000	22 (3.6)	43 (4.6)
$20,001 – $25,000	32 (5.2)	50 (5.3)
$25,001 – $30,000	22 (3.6)	35 (3.7)
$30,001 – $35,000	23 (3.7)	37 (3.9)
$35,001 – $40,000	24 (3.9)	20 (2.1)
$40,001 – $50,000	25 (4.1)	63 (6.7)
$50,001 – $60,000	41 (6.7)	55 (5.9)
$60,001 – $70,000	36 (5.9)	52 (5.6)
$70,001 – $100,000	63 (10.3)	77 (8.2)
$100,001 – $150,000	35 (5.7)	62 (6.6)
$150,001 or more	24 (3.9)	22 (2.3)
Don't know	70 (11.4)	103 (11.0)
Prefer not to say	120 (19.5)	199 (21.3)
Place of residence (n, %)		
Northland	10 (1.6)	29 (3.1)
Auckland	170 (27.7)	155 (16.6)
Waikato	66 (10.7)	106 (11.3)
Bay of Plenty	45 (7.3)	81 (8.7)
Gisborne	5 (0.8)	32 (3.4)
Hawkes Bay	19)3.1)	35 (3.7)
Taranaki	16 (2.6)	36 (3.9)
Manawatu	24 (3.9)	55 (5.9)
Wellington	81 (13.2)	112 (12.0)
Nelson/Marlborough/Tasman	19 (3.1)	58 (6.2)
Canterbury	90 (14.7)	125 (13.4)
Otago	43 (7.0)	63(6.7)
Southland	23 (3.7)	29 (3.1)

2.3.2 Procedure and questionnaire design

The procedure and questionnaire were the same in 2016 and 2017. As explained above, a subset of the Household Travel Survey panel members were invited (via email and/or text message) to complete the online 'Transport technology and you' survey. In the 2017 survey, half the sample was the chance to win one of three $100 value prezzi cards upon completion of the survey, but this did not have an impact on the response rate. Further information can be found on the Ministry of Transport website www.transport.govt.nz/mot-resources/household-travel-survey/panels/

The survey questions were initially developed as part of a wider question bank for tracking changes in transport related attitudes over time (Wooliscroft et al 2016). A copy of the survey can be found in appendix B. The first questions asked respondents to indicate (yes/no) if they had heard about four new transport technologies (electric cars, hybrid cars, electric bikes, self-driving cars). They were then asked to rate their knowledge of the four technologies from 1 (I know nothing about this) to 7 (I know a great deal about this), and the attractiveness of the same technologies (from 1, not at all attractive to 7, extremely attractive). Respondents were then asked to select the three biggest barriers that would prevent them from buying an electric car in the next 12 months from a list including: electric cars are too expensive; the second-hand petrol/diesel market is much cheaper; electric cars cannot travel far enough; electric cars are not visually appealing; there are not enough charging stations available; other/s. The next question asked them to rank the three most important factors that would enable them to buy an electric car in the next 12 months from a list including: if I had enough money; if purchasing and electric car was subsidised; if I could try/test one; if they could go as far and as fast as typical petrol and diesel cars; if charging stations were more available; if charging stations were affordable; other/s. Respondents were then asked two open-ended questions; to describe the biggest barriers for them in using a self-driving car, and the most important factors that would enable them to use a self-driving car.

The next section asked how often the respondents had used electric cars, hybrid cars, electric bikes, self-driving cars or other new transport technologies in the last month (1=every day/almost every day; 2=several times a week; 3=once a week; 4=once or twice in the last month; 5=not used in the last month). They were then asked if they intended to use new/emerging transport technology in the next 12 months (no/ yes but less than now/ yes the same as now/ yes and more than now). The last question asked respondents to indicate how safe they would feel travelling in a self-driving car (from 1=extremely unsafe to 7=extremely safe). On completion of the survey respondents were presented with a thank you message and asked to close the web page.

2.3.3 Analysis

Given the nature of the current study, analyses focused on the questions relating to self-driving cars (see Wither 2017 and Patterson 2018 for a summary of the full survey results). The analyses were conducted in a similar way to the previous survey; responses to each question were summarised as frequency counts and percentages for the sample overall, and by gender and age group (16 to 24 years, 25 to 44 years, 45 to 64 years, over 65 years). Chi square tests were used to test for significant associations between gender and age group for the relevant survey questions. Mann Whitney U tests were used to compare ratings of knowledge and safety by gender and age group.

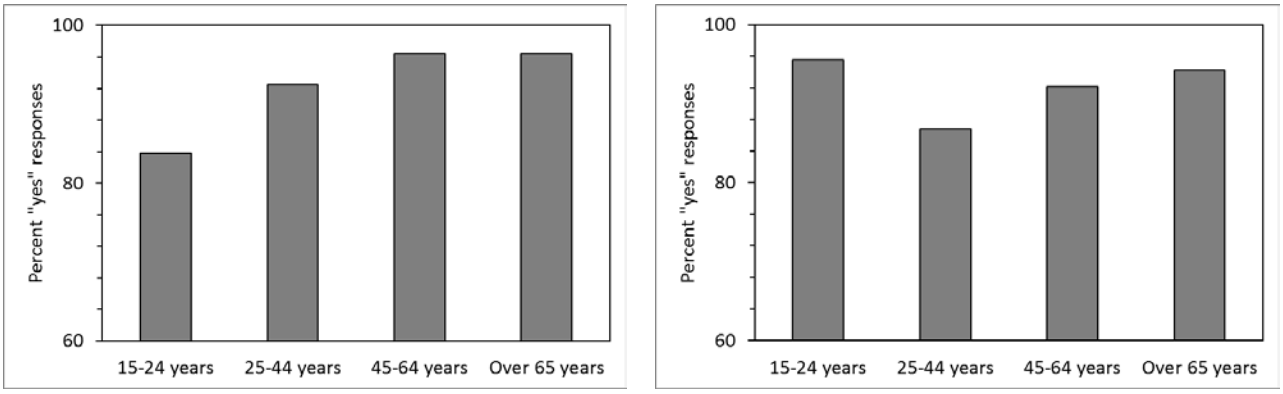
2.4 Results

2.4.1 Public awareness

In the 2016 survey, when respondents were asked whether they had heard of self-driving cars, most of the respondents answered yes (94.5%). The percentage of yes responses was significantly different for men (98.0%) and women (91.2%), (X^2 (1, N = 614) = 13.61, $p < .001$). As shown in the top panel of figure 2.11, the pattern of responses was suggestive of greater awareness of self-driving cars with increasing driver age, but this trend was not statistically reliable ($p > 0.05$). When the survey questions were repeated in 2017, the proportion of respondents answering 'yes' was slightly lower (91.1%) than in the previous sample. The percentages were significantly different for men and women, with 96.1% of men,

and 86.9% of women answering yes (X^2 (1, N = 935) = 24.44, p < .001). The responses did not show any reliable age trend in awareness of self-driving cars as shown in the right panel of figure 2.11.

Figure 2.11 Percent of respondents who had heard of self-driving cars in the 2016 survey (left panel) and the 2017 survey (right panel).



By way of comparison, the respondents were also asked about their knowledge of some other recent transport technologies (electric cars, hybrid cars and electric bikes). In both the 2016 and 2017 samples nearly all the respondents indicated they had heard of electric cars (2016: 98.2% overall, 99.3% of men and 97.2% of women; 2017: 98.7% overall, 99.3% of men and 98.2% of women). Fewer people had heard of hybrid cars (2016: 92.8%; 2017: 93.3%), with a similar slight gender bias for men (2016: 97.6% of men, 88.3% of women; 2017: 98.2% of men and 89.0% of women). Fewer still said they had heard of electric bikes in both 2016 (91.7%, 94.3% of men and 89.3% of women) and 2017 (95.1%, 97.0% of men and 93.4% of women), but this was nearly on a par with the proportion of respondents who had heard of self-driving cars.

2.4.2 Degree of knowledge

The respondents were also asked to rate how knowledgeable they felt about self-driving cars on a seven-point scale ranging from ‘I know nothing about this’ (1) to ‘I know a great deal about this’ (7). Although the responses ran the full range of the scale, in general the respondents’ answers indicated a low self-rating of their knowledge with the median of the men’s ratings of 3 and the median of women’s ratings of 2 in both 2016 and 2017.

Independent sample median tests (Mann Whitney U tests) of the gender difference in these ratings indicated the difference was significant for the 2016 sample (X^2 (1, N = 614) = 37.51, p < .001), and for the 2017 sample (X^2 (1, N = 935) = 45.69, p < .001), as shown in figure 2.12. When the self-ratings of the degree of knowledge were compared across age groups, no clear trends emerged, as shown in figure 2.13. Independent sample median tests did not return any reliable age-related differences in the ratings for the 2016 sample (X^2 (3, N = 614) = 2.48, p = .478) or for the 2017 sample (X^2 (3, N = 935) = 1.93, p =.588).

Figure 2.12 Degree of knowledge of self-driving cars for males and females, in 2016 (top panel) and 2017 (lower panel) samples

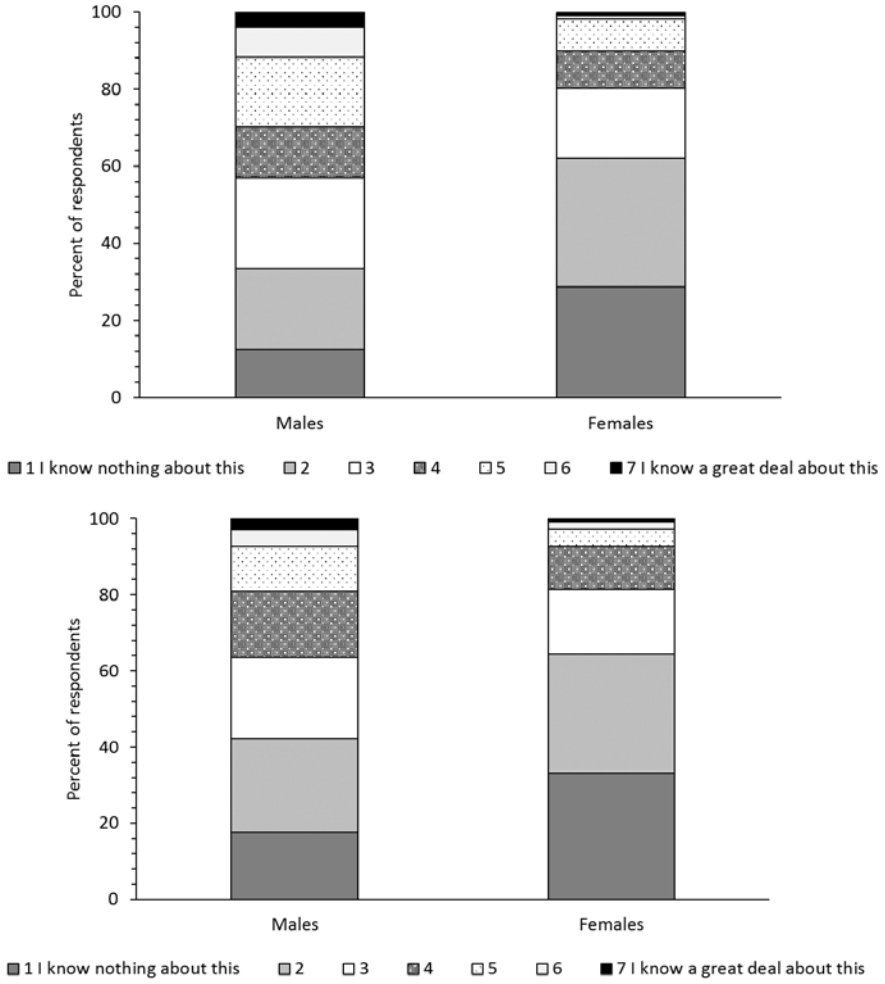
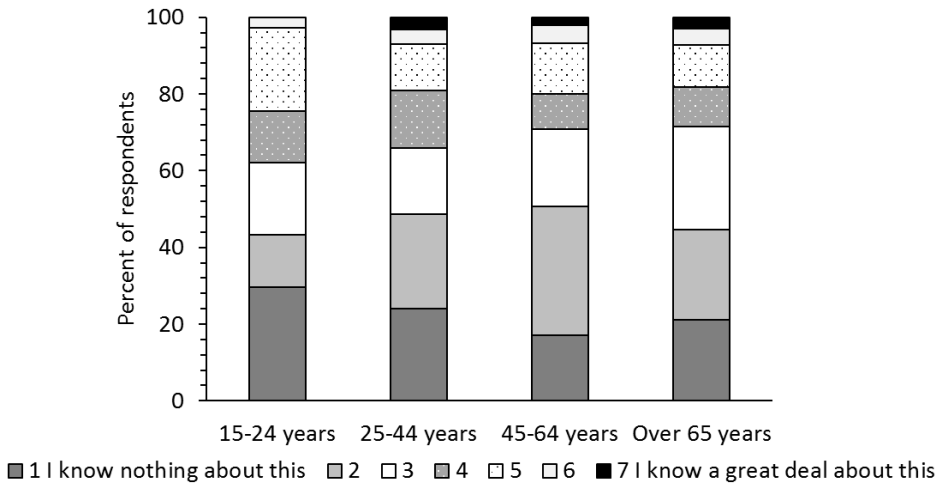
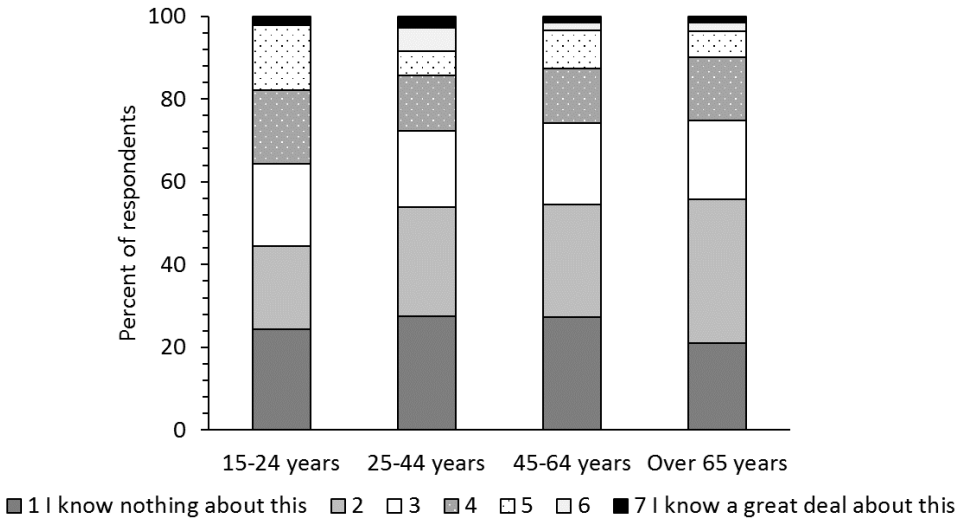


Figure 2.13 Self-rated degree of knowledge about self-driving cars for 2016 (top panel) and 2017 (lower panel)





When asked about their recent experience with self-driving cars, the number of respondents with direct experience in the past month was understandably quite low. In 2016 four respondents (two men and two women), 0.7% of the sample said they had used a self-driving car every day, or almost every day in the past month. In the 2017 sample this number increased to 10 respondents (six men and four women), 1.1% of the sample. Another four respondents in 2016 (three women and one man) said they had used a self-driving car several times a week in the past month, a number that increased to 10 respondents (three men, seven women) in 2017.

In 2016, one respondent (female) used a self-driving car once a week, and two (both women) had used one once or twice in the past month. In 2017, this increased slightly, with three women using a self-driving car once a week, and another three women using one once or twice in the past month. The great majority of respondents in both samples (2016: 98.2%, 2017: 97.2%) indicated they had not used a self-driving car in the past month.

2.4.3 Concerns and obstacles

When the respondents were asked to rate how safe they would feel travelling in a self-driving car (on a seven-point scale, where 1 = extremely unsafe and 7 = extremely safe), a large number indicated they would feel extremely unsafe, 35.3% in 2016 and 33.8% in 2017. In both samples more women than men rated them as being extremely unsafe; in 2016 43.5% of women respondents compared with 26.6% of men, and in 2017, 36.3% of women compared with 30.9% of the men (see figure 2.14). Independent sample median tests indicated this gender difference was significant, both in the 2016 sample (X^2 (1, N = 614) =, 10.67, p = .001) and in the 2017 sample (X^2 (1, N = 935) = 10.25, p = .001). Across both genders, only 18.9% of respondents in the 2016 sample gave a rating in the ‘safe’ range (higher than 4 on the seven-point scale) rising only marginally to 20.3% in the 2017 sample.

As can be seen in figure 2.15, there was a slight tendency for older respondents to rate the safety of travelling in a self-driving car as lower (more unsafe), but this tendency was not statistically reliable (2016: X^2 (3, N = 614) = 0.937, p = .816; 2017: X^2 (3, N = 935) = 16.89, p = .075).

Participants’ knowledge of self-driving cars showed a significant association with safety ratings (2016: X^2 (36, N = 614) = 134.049, p < .001; 2017: X^2 (36, N = 935) = 166.462, p < .001). To explore this further the samples were divided into those reporting ‘no knowledge’ of self-driving cars and those reporting ‘some/more knowledge’. Independent sample median tests revealed that those with no knowledge of self-

driving cars rated safety as significantly lower compared to those with some/more knowledge (2016: X^2 (6, N = 614) = 38.012, $p < .001$; 2017: X^2 (6, N = 935) = 50.768, $p < .001$). For the 2016 sample over half (54.7%) of those reporting no knowledge rated self-driving cars as extremely unsafe compared with a third (30.2%) of those with some/more knowledge. The pattern was similar in 2017 (50.8% compared with 27.8%).

Interestingly, the safety ratings were not different for the respondents who indicated they had driven in a self-driving car in the past month (11 in 2016 and 26 in 2017). Of the respondents in the 2016 sample, 36.4% rated travelling in a self-driving car as extremely unsafe (four respondents), with 30.8% (eight respondents) answering this way in the 2017 sample. In 2016, of the respondents who had used a self-driving car in the past month, only two respondents (18.2%) gave a rating in the safe range (higher than 4 on the seven-point scale), and in 2017 only six (23.1%) gave a rating in the safe range. Independent sample median tests indicated that the ratings of respondents who had used a self-driving car in the past month were not reliably different from the responses of those who had not, either in 2016 (X^2 (1, N = 614) = 0.034, $p = .853$), or in 2017 (X^2 (1, N = 935) = 0.092, $p = .761$).

Figure 2.14 Respondent ratings about how safe they would feel travelling in a self-driving car in the 2016 sample (top panel) and 2017 sample (lower panel)

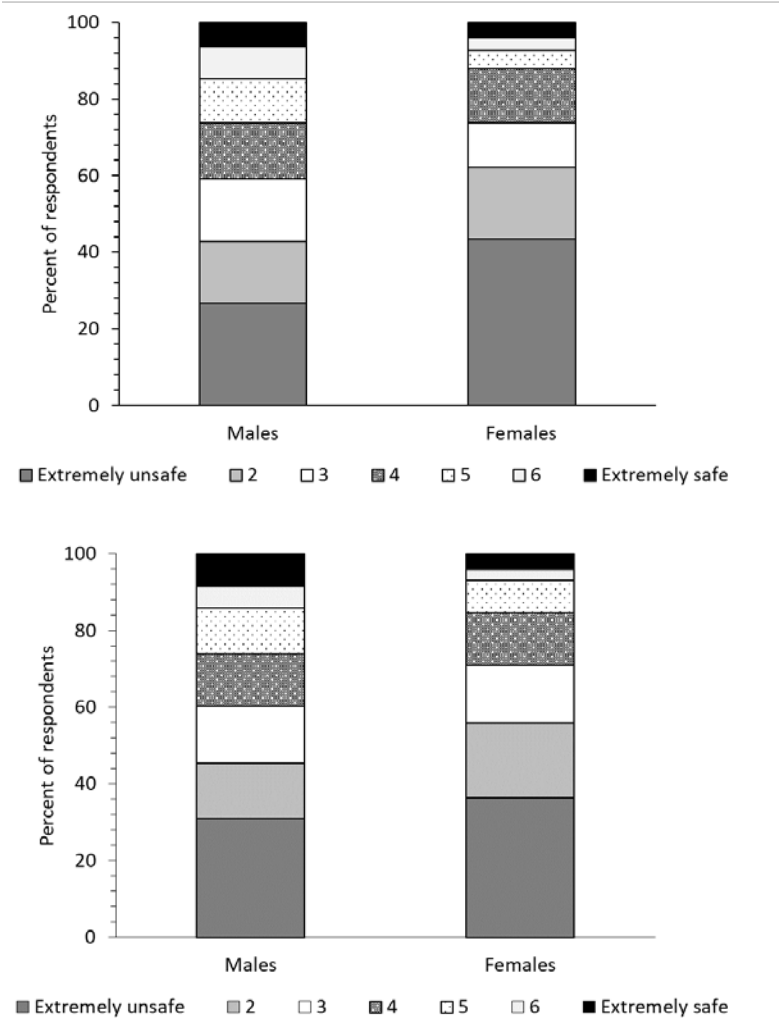
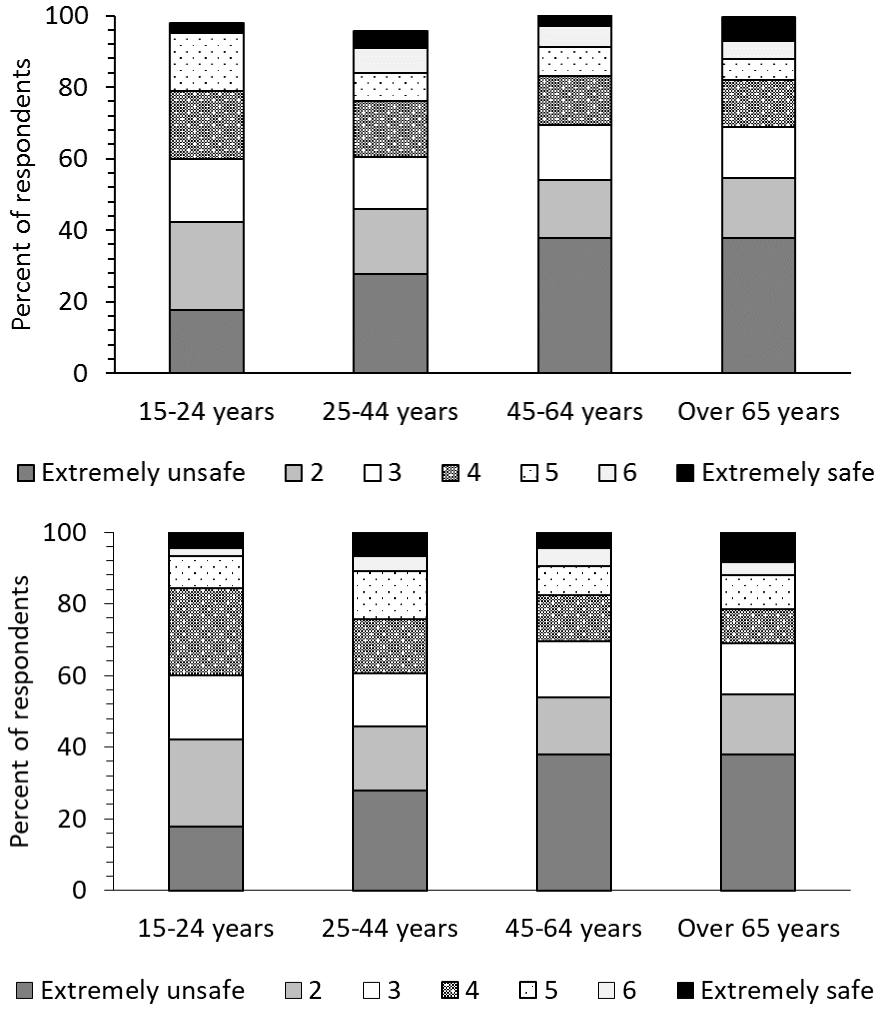


Figure 2.15 Respondent ratings how safe they would feel travelling in a self-driving car separated by age group in the 2016 sample (top panel) and 2017 sample (lower panel)



The respondents were asked what they considered the greatest barrier to using a self-driving car, in an open-ended question (where they provided more than one reason, their first reason mentioned was tallied). The responses are summarised in table 2.3. As shown in the table, trust in the technology was identified as the greatest barrier in 2016 and 2017. The proportion of respondents reporting trust in technology as a primary barrier showed a marked increase (5%) between 2016 and 2017, possibly due to increasing publicity about cybersecurity and hacking. The next most frequently mentioned concerns were safety, lack of control and the cost. Interestingly a reasonable proportion of respondents identified that they liked driving as a barrier to using a self-driving car (over 6% in 2016 and 2017).

Table 2.3 Barriers to using a self-driving car identified by respondents in the 2016 and 2017 surveys

Barriers to use	2016		2017		Overall
	Frequency	Percent	Frequency	Percent	Percent
Trust/confidence in tech/hacking	131	21.34	249	26.63	24.53
Safety	81	13.19	114	12.19	12.59
Lack of control	68	11.07	111	11.87	11.56
Cost	78	12.70	94	10.05	11.10
I like driving	37	6.03	64	6.84	6.52
Lack of knowledge about them	35	5.70	62	6.63	6.26
Fear/anxiety	33	5.37	22	2.35	3.55
Availability	17	2.77	34	3.64	3.29
Don't want to/wouldn't be comfortable	12	1.95	31	3.32	2.78
Unsuitability for New Zealand roads and conditions	21	3.42	21	2.25	2.71
No barrier	14	2.28	12	1.28	1.68
Mix of self-driving and normal cars	6	0.98	13	1.39	1.23
Happy with existing vehicles	10	1.63	6	0.64	1.03
Legal and ethical issues	6	0.98	7	0.75	0.84
My age/too old to learn	7	1.14	5	0.53	0.77
Other reasons	58	9.45	90	9.63	9.55
Total	614		935		

2.5 Summary

The surveys revealed that the majority (>90%) of respondents had heard about self-driving cars, electric cars, hybrid cars and electric bikes; however, knowledge of advanced driver assistance systems was much lower, with less than 23% of the respondents having direct experience of adaptive cruise control, intelligent parking assistance or automatic lane keeping. In general men reported greater levels of knowledge or had more experience of these technologies compared with women. The most commonly endorsed benefit of CAVs was a reduction in crashes, followed by improved fuel economy, decreased traffic congestion and a reduction in emissions. The main reason for wanting to use a CAV was so they could do other things, but increased safety and decreased congestion were also rated as being important. Respondents were most likely to let the car drive itself on the motorway. Self-driving cars were most likely to be used when people were tired, impaired or over the drink drive limit, but only a very small proportion of respondents would use one to transport their children.

Respondents' main concerns were hacking and equipment failure, with women being more worried about CAVs than men. It was an interesting inconsistency that increased safety was identified as one of the greatest potential benefits; a third of respondents reported they would feel extremely unsafe in a self-driving car and only 20% reported they would feel safe. Participants who were knowledgeable about self-driving cars rated their safety as higher, but surprisingly experience of travelling in a self-driving car did not alter safety ratings.

For some at least, there is a clear level of concern about CAVs, and in keeping with this a quarter of the sample reported they would never use a CAV. The greatest barriers to using CAVs were trust, safety, lack of control and cost with a small but significant proportion noting that the simple fact they liked driving was a significant barrier to using CAVs.

Respondents indicated they were generally willing to share and receive data if it was to their benefit (eg to avoid congestion), but were less willing to share data with entities such as insurance companies. The respondents, however, were not willing to pay much for this type of technology; 20% of respondents were not willing to pay any extra, and 30% were willing to pay $1,000 to $5,000. Participants' knowledge of self-driving technology was not related to willingness to pay. Interestingly though participants who had used automatic lane keeping and intelligent parking assistance were willing to pay more for automated driving technology.

3 Attitudes to carsharing and ridesharing

The data presented in this section comes from two sources, the *Readiness for shared mobility survey* (conducted specifically for this project), and the *Transport sharing and you survey* (MoT 2017).

3.1 Readiness for shared mobility survey: Method

3.1.1 Participants

A digital data collection company (Research Now) was contracted to recruit and administer the survey to respondents throughout New Zealand. A series of invitations to take part in the study were sent to Research Now panel members over 16 years of age. As a result of the invitation, 1,735 potential respondents followed the link to the survey and 1,564 (90.1%) indicated they would like to complete the survey. Of these, 1,360 used a car as their main form of transport (one of the eligibility criteria) and after screening to ensure the majority of the questions had been completed we had a final sample of 1,127. The participant characteristics are summarised in table 3.1. As shown in the table, the average age of the participants was 44.4 years (SD=20.4, range 16 to 85 years) with 562 (49.9%) identifying as male, 557 as female (49.4%) and 5 (0.4%) as non-binary. In response to a question on ethnicity 852 (75.6%) identified as New Zealand European, 88 (7.8%) as Māori, 19 as Samoan (1.7%), 5 as Tongan (0.4%), Cook Island Māori 18 (1.6%), Niuean 3 (0.3%), Chinese, 63 (5.6%), Indian 46 (4.1%) and Other 110 (9.8%).

In terms of personal income, the largest proportion of respondents reported a personal income of $20,000 to $40,000 which encompasses the New Zealand median annual income of $34,917 in 2017 (Statistics New Zealand 2018b). With regard to education, 58% of respondents had completed post-secondary education, slightly higher than that of the general population of New Zealand (51%) (Statistics New Zealand 2018b). As shown in the table 3.1, the geographical distribution of participants was broadly similar to that of the general population (Statistics New Zealand 2013). Together this suggests the survey respondents were representative of the New Zealand population.

All but 14 of the respondents held a New Zealand driving licence (mean years held = 23.62 years, SD = 20.11, range 1 to 70 years). The majority of respondents (n=941, 83.5%) took most of car journeys as a driver, with 184 (16.3%) taking the majority of their trips as a passenger. Most of the respondents (n=993, 88.1%) owned a smartphone and 162 (14.4%) had a long-term disability lasting more than six months.

Table 3.1 Demographic characteristics of the sample completing the readiness for shared mobility survey

Characteristics	N=1,127
Age in years (mean, SD; range)	44.36 (20.45); 16-85
Gender (n, %)	
Male	562 (49.9)
Female	557 (49.4)
Non-binary	5 (0.4)
Prefer not to say	3 (0.3)
Ethnicity (n, %)	
NZ European	852 (75.6)
Maori	88 (7.8)
Samoan	19 (1.7)
Tongan	5 (0.4)

Characteristics	N=1,127
Cook Island Maori	18 (1.6)
Niuean	3 (0.3)
Chinese	63 (5.6)
Indian	46 (4.1)
Other	110 (9.8)
Prefer not to say	16 (1.4)
Annual personal income ($) before tax (n, %)	
Loss	1 (0.1)
Zero	34 (3.0)
1–20,000	161 (14.3)
20,001–40,000	250 (22.2)
40,001–60,000	205 (18.2)
60,001–80,000	121 (10.7)
80,001–100,000	77 (6.8)
>100,001	96 (8.5)
Prefer not to answer	182 (16.1)
Highest secondary school qualification (n, %)	
None	76 (6.7)
NCEA Level 1 or equivalent	130 (11.5)
NCEA level 2 or equivalent	143 (12.7)
NCEA level 3 or equivalent	462 (41.0)
Other secondary qualification	273 (24.2)
Prefer not to answer	43 (3.8)
Completed post-secondary qualification (n, %)	654(58.0) [51.0]
Place of residence (n, %), [census pop %]	
Northland	42 (3.7) [3.6]
Auckland	374 (33.2) [33.4]
Waikato	111 (9.8) [9.5]
Bay of Plenty	71 (6.3) [6.3]
Gisborne	8 (0.7) [1.0]
Hawkes Bay	41 (3.6) [3.6]
Taranaki	25 (2.2) [2.6]
Whanganui	23 (2.0)
Manawatū	45 (4.0)
Wairarapa	8 (0.7)
Wellington	126 (11.2) [11.1]
Nelson Bays	26 (2.3) [1.1]
Marlborough	12 (1.1) [1.0]
West Coast	9 (0.8) [0.8]
Canterbury	130 (11.5) [12.7]
Timaru-Oamaru	13 (1.2)
Otago	39 (3.5) [4.8]
Southland	24 (2.1) [2.2]
Residence type (n, %) [census pop %]	
Urban	910 (80.7) [86%]
Rural	217 (19.3)

3.1.2 Procedure and questionnaire design

The study received approval (#18:12) from the School of Psychology Research and Ethics Committee at the University of Waikato. As described above, a digital data collection company, Research Now, notified their panel members by email of the opportunity to participate in the survey. The email contained a web link which potential respondents could use to access the survey. Upon activating the web link the potential respondents were provided with a short overview of the purpose of the research (including definitions of the terms used in the survey), followed by a request to provide consent and complete the eligibility (use of a car as their main form of transport) and quota questions (gender and age). Eligible respondents were directed to the remaining questions in the survey, while ineligible respondents received a message that explained they were not eligible for the current study and thanked them for their interest. On completion of the survey respondents were thanked for taking part.

The full survey can be found in appendix C. In the overview at the start of the survey, the respondents were presented with a description of the different shared transport options mentioned in the survey as follows:

> **App-based ride hailing** encompasses services, such as Uber and Zoomy, where people can arrange and pay for a driver to take them to a particular destination, using an app on their smartphone. This includes traditional taxi services that can be booked and paid for through a smartphone app.
>
> **Ridesharing/carpooling** is where two or more people share the same vehicle to a particular destination, such as work or town. Ridesharing/carpooling may be arranged with someone you know, or through websites or apps, for travel to work, or an event, or even between cities.
>
> **Carsharing** is a type of car rental service where customers can rent and pay for vehicles by the minute or hour, and where vehicles are parked at various locations within a city. Prior to use, individuals must register with a carshare service, and then they can access the carshare vehicles whenever they need them. Examples include Cityhop, Mevo and Yoogo.

The questions in the first part of the survey (transport sharing) were based on those in Ministry of Transport's *Transport sharing and you survey*. Modifications were made to the questions to match the definitions provided above and to exclude questions about bike sharing schemes. Respondents were asked to indicate if they had heard about app-based ride hailing, ridesharing/carpooling and carsharing, whether any of these services were available to them, how knowledgeable they felt about the service (from 1, I know nothing to 5, I know a great deal), had they used any of the services in the last 12 months, and did they intend to use each of the services in the next 12 months (no, yes, but less than know, yes same as now, yes more than now). If respondents indicated they did not intend to use the service in the next 12 months, they were presented with two additional questions: select three barriers (from a list of 8 options) that prevented them from using the service; and select 3 factors (from a list of 8) that would enable them to use the service. Those who indicated they intended to use the service in the next 12 months were asked to select up to three reasons why (from a list of 12 options).

The next section focused on how the respondents' current travel modes. The first question (taken from the ITF 2017) asked how the respondents usually travelled for a variety of different purposes (travel types are listed in table 3.1) including: travel to/from place of work or study; travel to drop off/pick up children at school, daycare or other place; daily shopping; social activities; leisure activities; and personal matters. They were then asked to select which of these trips they made most frequently by car, how long the trip usually took (in one direction), how long it took to get to their destination once they had parked, and how many adults and children made the trip with them.

The third section was a series of questions from ITF (2017) that explored respondents' attitudes towards a shared taxi service compared with their current transport. The respondents were presented with a description of a shared taxi as follows:

> A shared taxi is an on-demand door-to-door service with up to six people sharing the vehicle. Other passengers would be departing from a location close to you and travelling to a similar destination. The vehicle would be a modern minivan of 8 seats rearranged for 6 seats, with easy entry and exit and capacity to carry luggage (including prams and bikes). Shared taxis would be driven by a professional driver and include access to the internet as part of the fee. A shared taxi can be booked in real time via a smartphone app, and rides are confirmed within a minute of request. A shared taxi is cheaper than conventional taxi services or current single pick up taxi services (eg Uber).

They were then asked to think about the trip they most commonly made in their car, and indicate how much time they would need to save to use a shared taxi instead (< 1 minute to > 1 hour, or if they would not use a shared taxi). Respondents were then provided with information about the costs of using a private car as follows (taken from the ITF 2017 survey):

> Car drivers tend to forget the cost of using a private car. For 15,000 km driving per year (on average 60 km per day) the cost is NZ$20 per day (NZ$10 in fuel/energy + NZ$10 purchase price of car + insurance, licensing, warrant of fitness + maintenance). Including tolls and parking costs the total cost of private car use amounts to NZ$25 to NZ$30 per day. For most people the cost of the daily commute (to work or place of study) in a private car is approximately NZ$25.

Respondents were asked how much they would need to save to use a shared taxi rather than the car for their most common trip (< NZ$5 to NZ$30, or if they would not use a shared taxi). For the same journey they were then asked to indicate how much time they would be willing to spend getting to a pick up point for a shared taxi and getting to their final destination from the drop off point (< 1 minute to 30 minutes or I would not use a shared taxi). The next questions asked how long they would be willing to spend on a detour (ie to drop someone else off or pick them up) (< 1 minute to 15 mins or I would not use a shared taxi) and how many people they would be willing to share the taxi with (excluding the driver) (1–6 or I would not be willing to use a shared taxi). They were then asked to indicate the types of trips they would use a shared taxi for if one were available (travel to/from work or place of study, too drop off/pick up children, daily shopping, social activities, leisure activities, personal matters, one off or occasional trips (eg travel to/from the airport) or other trips.

Respondents were asked about the number of cars in their household and the number they would sell if a shared taxi was available. The last two questions about the shared taxi asked respondents to list the barriers and enablers for a shared taxi scheme (open-ended answers). The final section of the survey collected additional demographic information including age (in years), ethnicity, income, presence of a long-term disability, highest secondary school qualification and highest overall qualification, residential district and location (urban/rural), length of time as a New Zealand licensed driver and if they owned a smartphone.

3.1.3 Analysis

We used a similar approach to the analyses as described in the previous chapter. The data from each question was summarised as frequency counts, percentages, means or medians as appropriate. We explored differences in responses to the questions between males and females, age groups and usual role (as a driver and passenger) using chi square tests, Mann Whitney U tests or Wilcoxon signed ranks

tests as appropriate. A series of binary logistic regressions was undertaken to determine if combinations of categorical predictors could predict use of these transport sharing services in the previous 12 months.

For the shared taxi scenarios, as well as summarising the data for each question as described above, we also explored the effect of providing information on the cost of car travel or respondents' willingness to use a shared taxi. For the open-ended questions on barriers and enablers, similar responses were grouped into categories and summarised in tables.

3.2 Results

3.2.1 Current travel modes

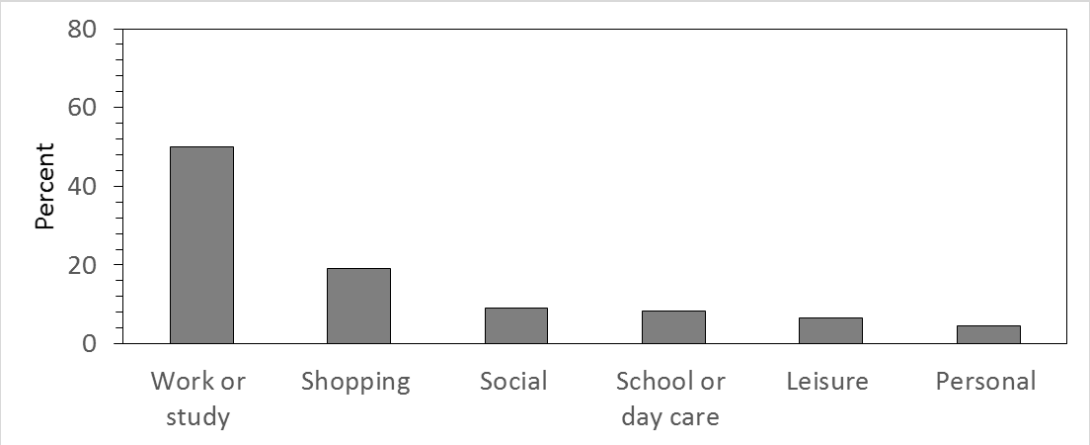
To provide some context to evaluate participant's attitudes towards new transport sharing schemes, we asked respondents to report how they usually travelled to different place or for different trip purposes. The findings are summarised in table 3.2. As shown in the table, personal trips were the most frequent (n=1,123) and trips to school/daycare the least frequent. Driving a private car was by far the most common transport mode (70% of all trips) followed by travelling as a passenger in a car (13%), walking (8%) and taking the bus (3%). Ridesharing/carpooling was used for just over 2% of the total trips and mostly for leisure activities.

Table 3.2 The number (and percentage) of trips by mode for different trip purposes (percentages are of those making that trip type)

	Work or study		School or day care		Shopping		Social		Leisure		Personal		Total trips
	n	%	n	%	n	%	n	%	n	%	n	%	
Car driver	638	68.7	430	71.9	785	71.4	760	68.2	648	64	846	75.3	4,107
Car passenger	72	7.8	53	8.9	152	13.8	206	18.5	132	13	141	12.6	756
Walk	98	10.5	62	10.4	95	8.6	39	3.5	95	9.4	56	5.0	445
Bus	58	6.2	14	2.3	23	2.1	39	3.5	33	3.3	33	2.9	200
Rideshare or carpool	18	1.9	8	1.3	15	1.4	33	3.0	48	4.7	11	1.0	133
Cycle	17	1.8	23	3.8	14	1.3	14	1.3	29	2.9	8	0.7	105
Rail	18	1.9	1	0.2	4	0.4	4	0.4	10	1	4	0.4	41
Taxi	3	0.3	3	0.5	2	0.2	11	1.0	3	0.3	16	1.4	38
Light rail/bus rapid transit	5	0.5	2	0.3	7	0.6	5	0.4	4	0.4	6	0.5	29
Ferry	2	0.2	2	0.3	3	0.3	4	0.4	10	1	2	0.2	23
Total	929		598		1100		1115		1012		1123		5877

We were also interested in which trips were most frequently taken by car in a typical week. Figure 3.1 shows that travel to work or study was the most frequent car trip (50% of respondents), followed by shopping trips (19%) and social activities (9%).

Figure 3.1 The percentage of trips most commonly taken by car in a typical week

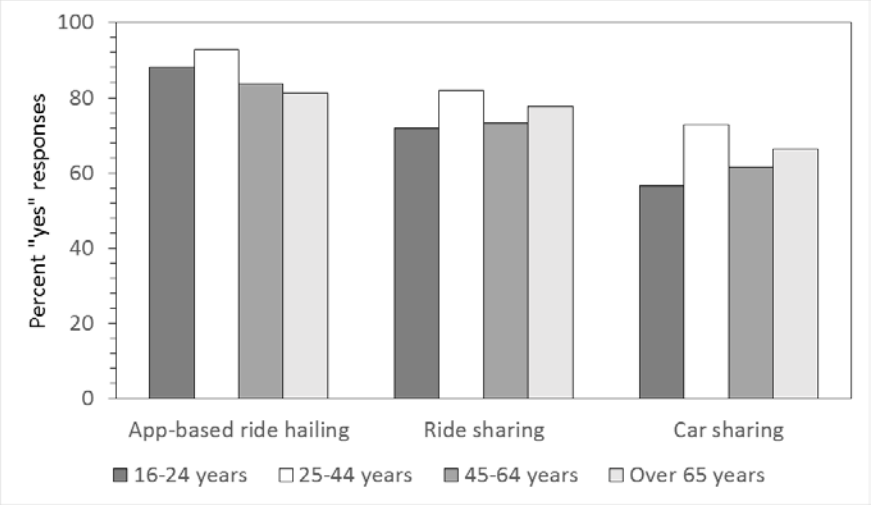


The trips taken most by car were on average 36.51 minutes (SD = 44.96; range = 1-307 minutes). For 46% of the sample it took less than 1 minute to reach their destination once parked, with 90% reaching their destination with 10 minutes of parking. It took 5% of the sample more than 20 minutes to reach their destination after parking. In terms of passengers taking this trip, overall 42% of trips were take alone, 29% with one passenger and 14% with two. Of these, 53.3% included at least one adult and 21.8% included one or more children.

3.2.2 Public awareness

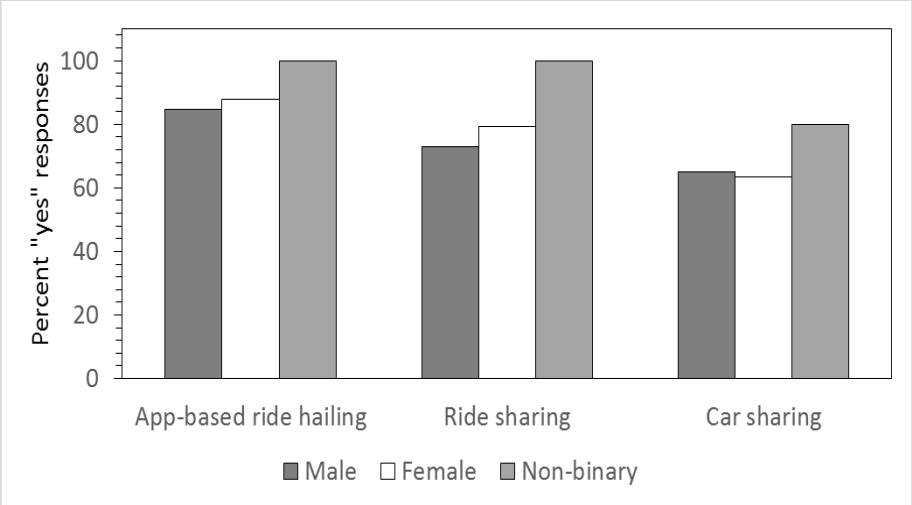
When respondents were asked about various carsharing options, 973 (86.3%) had heard of app-based ride hailing (eg Uber or Zoomy), 858 (76.1%) had heard of ridesharing or carpooling options and 724 (64.2%) had heard about carsharing. There were differences in awareness of these new transport options by age (figure 3.2. As shown in the figure, overall, a greater proportion of those in the 25 to 44 year age group reported having heard of each of the new transport sharing options. Interestingly though the pattern of awareness by age group differed for each of the transport sharing options. For the app-based ride hailing services those aged over 65 years were the least likely to have heard about this transport sharing option (the association between age and awareness was significant, X^2 (3, N=1127) = 17.80, p<.001). In contrast, the youngest age group (16 to 24 years) were least likely to have heard of ridesharing or carsharing (X^2 (3, N=1127) = 9.84, p=.02 and X^2 (3, N=1127) = 17.19, p=.001 respectively).

Figure 3.2 Percentage of respondents by age group reporting that they had heard of each transport sharing option



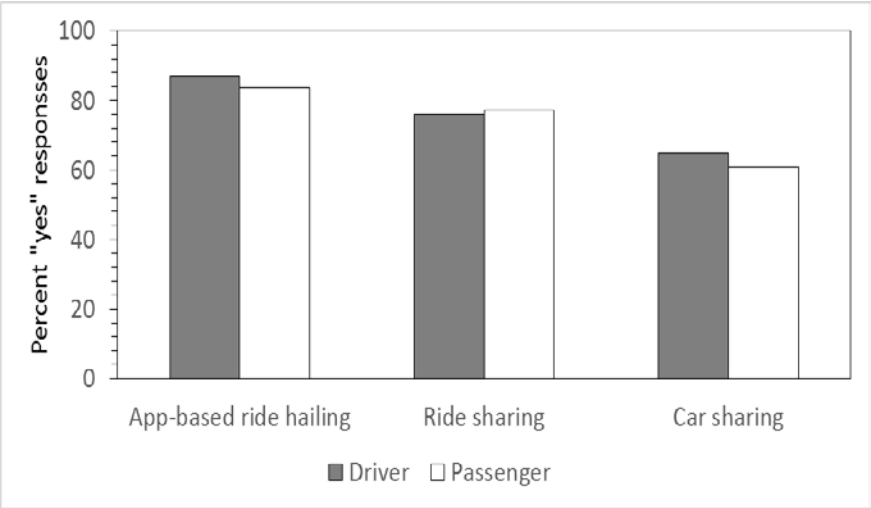
We also examined the association between awareness of transport sharing options and gender (figure 3.3). All respondents who self-identified as non-binary (n=5) had heard of app-based ride hailing and ridesharing options, and four of the five had heard of carsharing. The proportions of male and female respondents reporting awareness of the three transport sharing option were similar; the associations between gender and awareness were not statistically significant (all *p*'s >.5).

Figure 3.3 Percentage of respondents by gender reporting that they had heard of each transport sharing option



We then examined the respondents' role, as driver or passenger, to see whether it was associated with their awareness of transport sharing options (figure 3.4). As shown, a similar proportion of drivers and passengers had heard of the three options (but note that the majority of the sample were drivers n=941, with only 184 reporting that they were mainly passengers when using a car for transport). There was no statistically significant association between role and awareness of the three transport sharing options (all *p*'s >.05).

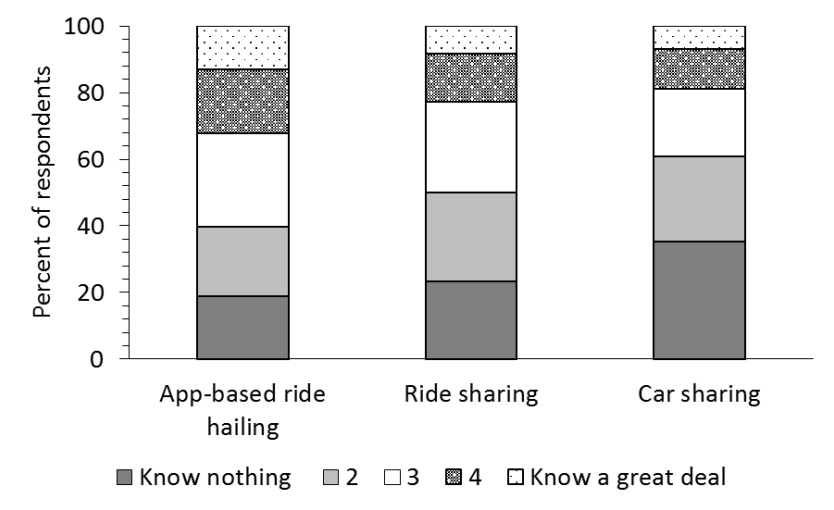
Figure 3.4 Percentage of respondents by gender reporting they had heard of each transport sharing option



3.2.3 Degree of knowledge

We asked respondents how knowledgeable they felt about the three transport sharing options (figure 3.5). As can be seen in the figure, respondents rated their knowledge as greatest for app-based ride hailing and least for carsharing (40% reported they knew nothing or very little about app-based ride hailing, compared with 61% for carsharing).

Figure 3.5 Respondents' ratings of how knowledgeable they felt about each transport sharing option



More detailed analyses showed that knowledge of transport sharing options varied by age (figure 3.6) More specifically, knowledge of app-based ride hailing services decreased with age (figure 3.6a; X^2 (12, N=1127) = 166.57, p<.0001), with 22% of those aged 16 to 24 years reporting they knew nothing or very little, 25% of those aged 25 to 44 years, 49% of those in the 45 to 64 aged group and 63% of those aged over 65 years. Interestingly, the pattern was different for ridesharing/carpooling and carsharing options, with those aged 25 to 44 years reporting the greatest knowledge. For ridesharing, 65% of 25 to 44 year olds rated their knowledge as '3' or higher compared with 55% aged 16 to 24 years, 43% aged 45 to 64 years and 37% of those aged over 65 years (the association between age and knowledge was

statistically significant X^2 (12, N=1127) = 71.03, p<.0001). There was also a significant association between age group and knowledge of carsharing, X^2 (12, N=1127) = 65.64, p<.0001. Over half (57%) of those aged 25 to 44 years rated their knowledge as 3 or higher, compared with 40% of 16 to 24 year olds and 31% of those in the 45 to 64 and over 65 age groups.

Figure 3.6 Respondent ratings of how knowledgeable they felt about a) app-based ride hailing services; b) ridesharing/carpooling options; c) carsharing, by age group

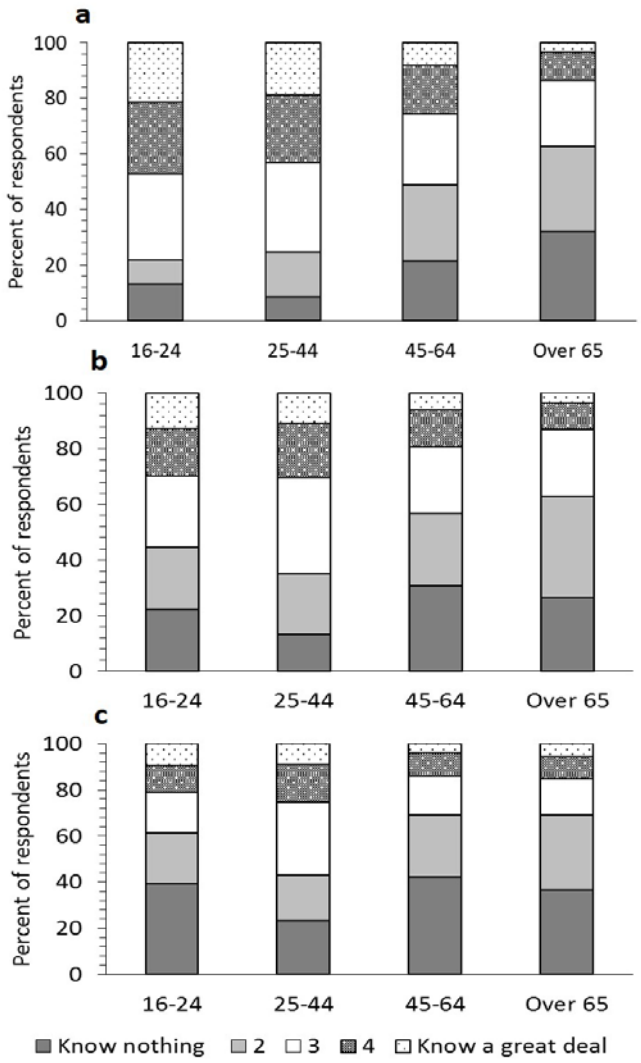
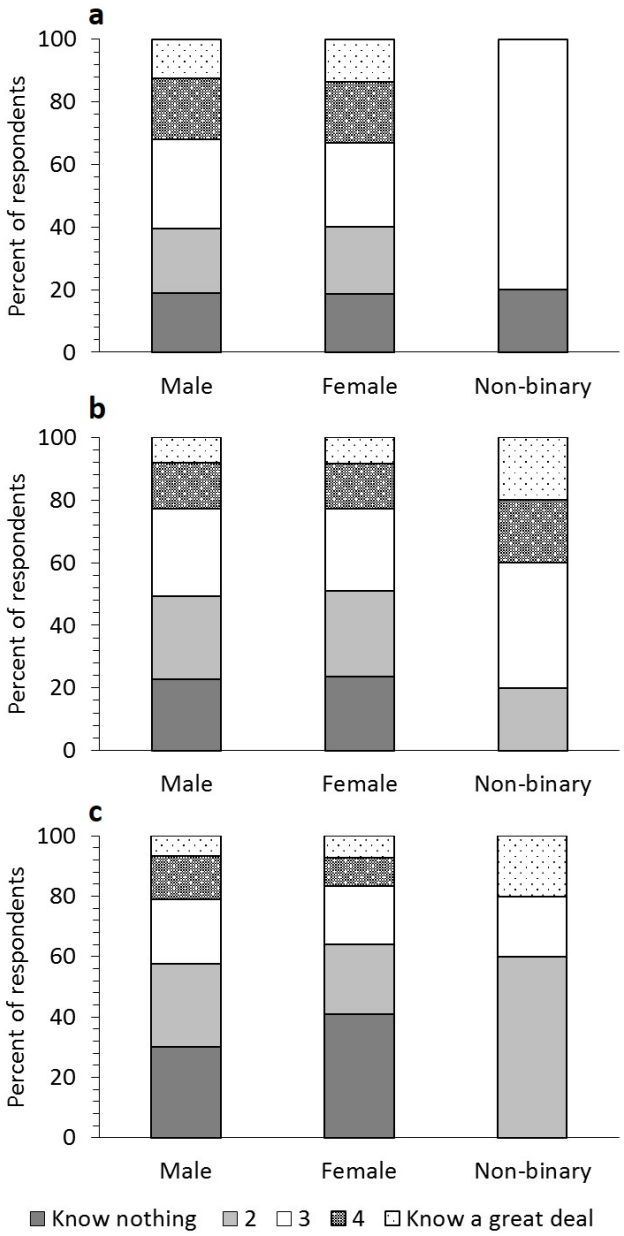


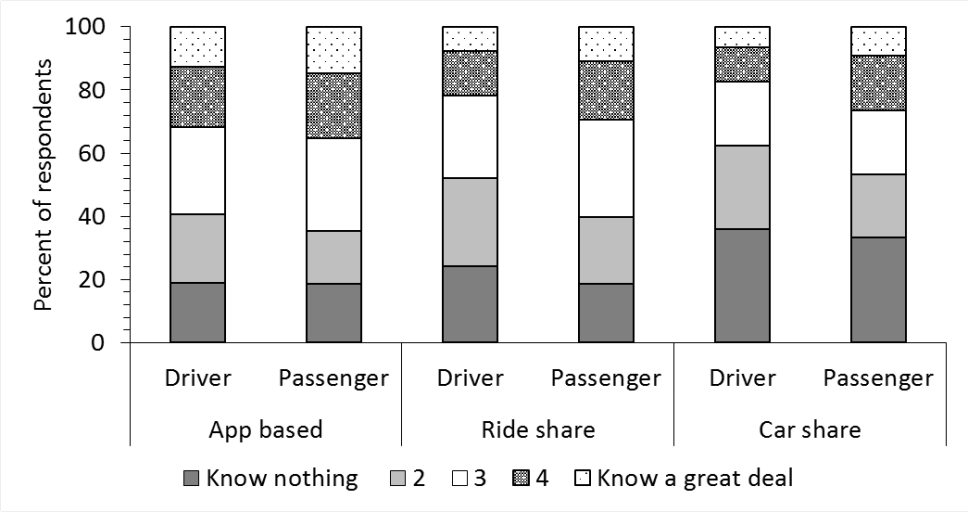
Figure 3.7 presents ratings of the respondents' knowledge by gender. As shown in the figure, knowledge of app-based ride hailing services and ridesharing/carpooling (a and b) was similar regardless of gender. Chi square tests confirmed that the associations between app-based ride hailing services, ridesharing options and gender were not statistically significant (X^2 (12, N=1127) = 11.81, p=.461 and X^2 (12, N=1127) = 8.02, p=.783 respectively). In contrast, there was a significant association between knowledge of carsharing and gender, with approximately 10% more of the female respondents (41%) stating they knew nothing about carsharing compared with male respondents (30%; X^2 (12, N=1127) = 27.3, p=.006).

Figure 3.7 Respondent ratings of how knowledgeable they felt about a) app-based ride hailing services; b) ridesharing/carpooling options; c) carsharing, by gender



The respondents' ratings of their knowledge as a function of their main role (ie driver or passenger) is shown in figure 3.8. Knowledge of app-based ride hailing was similar for drivers and passengers, X^2 (4, N=1,125) = 2.61, p=.626 but passengers were more knowledgeable about ridesharing X^2 (4, N=1,125) = 10.20, p=.037 and carsharing X^2 (4, N=1,125) = 10.09, p=.039 than drivers. For ridesharing 22% of drivers reported knowing a lot about the service (ratings 4 & 5 combined), compared with 29% of passengers. High levels of knowledge of carsharing were reported by 17% of drivers and 27% of passengers.

Figure 3.8 Driver and passenger ratings of how knowledgeable they felt about the transport sharing options



As well as asking respondents directly about their knowledge of transport sharing options, we asked about their use of them over the previous 12 months. Overall, 35% of respondents had used app-based ride hailing, 25% had used ridesharing/carpooling and 21% had used carsharing.

Use of these services differed by age group (figure 3.9) with those aged 25 to 44 years showing the greatest use, closely followed by those aged 16 to 24 years. Use of each transport sharing option in the 45 to 64 year old group was almost 60% lower than that of the 25 to 44 age group. Those aged over 65 years reported the lowest use; interestingly their pattern of use was different from the other age groups with similar numbers reporting use of app-based ride hailing services and carsharing (12%), and lowest use of ridesharing/carpooling. The associations between age and each transport sharing option were statistically significant (app-based ridesharing X^2 (3, N=1,127) = 141.47, p<.001; ridesharing/carpooling X^2 (3, N=1,127) = 108.44, p<.001; carsharing X^2 (3, N=1,127) = 61.10, p<.001).

Figure 3.10 presents use of the previous 12 months by gender. As can be seen in the figure, the pattern of use was similar for males and females (note that comparisons with the non-binary group are difficult as the sample size is small, n=5), and the associated chi square tests did not reveal a statistically significant association (app-based ridesharing X^2 (3, N=1,127) = 4.72, p=.194; ridesharing/carpooling X^2 (3, N=1,127) = 1.81, p=.613; carsharing X^2 (3, N=1,127) = 2.23, p=.527).

Prior use of ridesharing/carpooling and carsharing options differed by the respondent's role (figure 3.11) with a greater proportion of passengers (35% and 30% respectively) than drivers (23% and 19% respectively) using these transport sharing options (ridesharing/carpooling X^2 (1, N=1,125) = 12.33, p<.001; carsharing X^2 (1, N=1,125) = 10.30, p<.001). In contrast, a similar proportion of drivers and passengers had used app-based ride hailing services in the previous 12 months (X^2 (1, N=1,125) = 10.30, p<.001).

Figure 3.9 Use of each transport sharing option by age group over the last 12 months

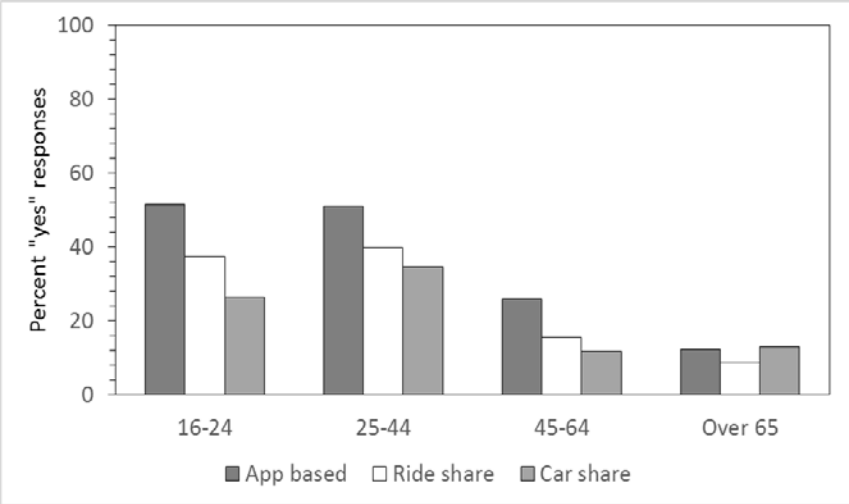


Figure 3.10 Use of each transport sharing option by gender over the last 12 months

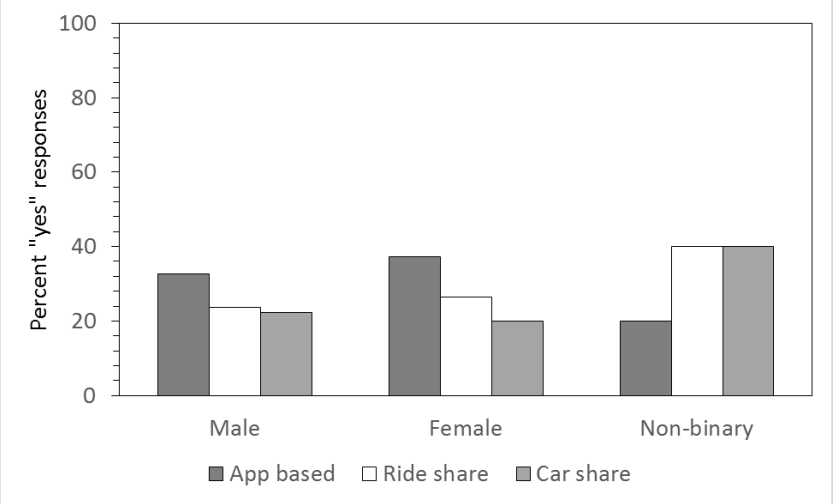
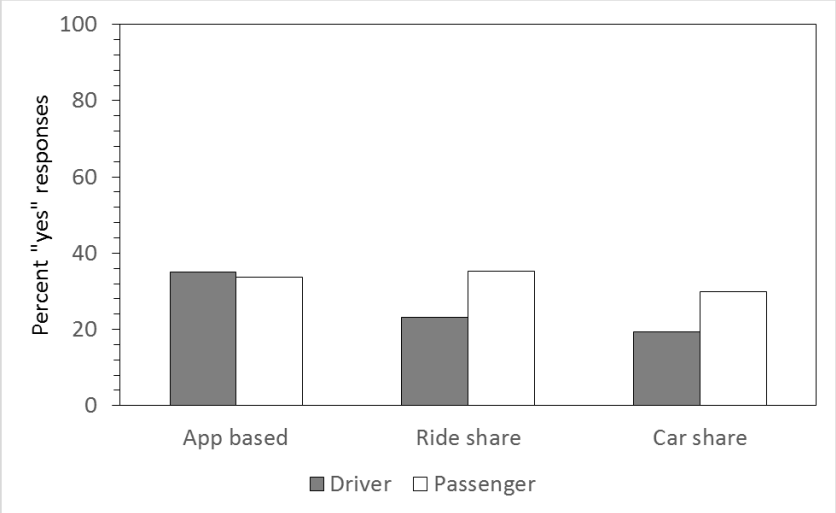
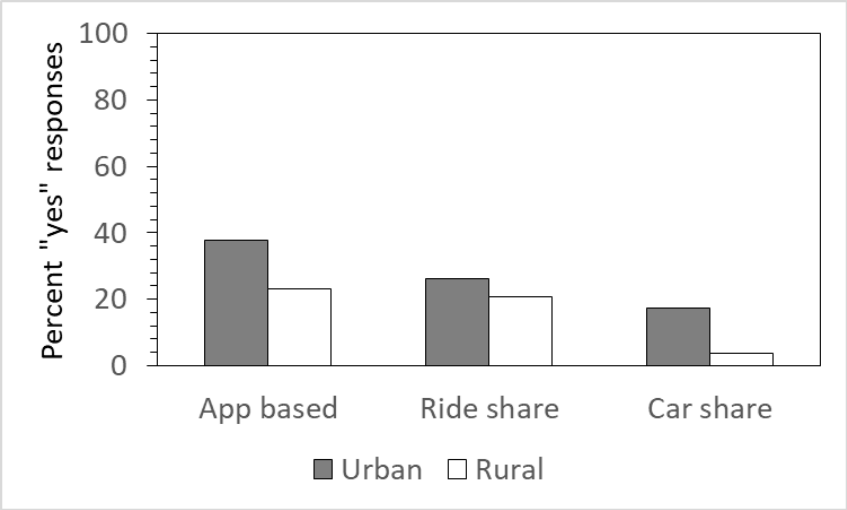


Figure 3.11 Use of each transport sharing option by drivers and passengers over the last 12 months



One other factor that may affect the use of transport sharing options is whether people live in urban or rural areas. Figure 3.12 shows the use of each transport option in the previous 12 months by residential location. As shown in the figure, a greater proportion of those living in an urban area had used the new transport sharing options, compared with those in rural locations. However, the only statistically significant association between residential location and use was for app-based ride hailing services (X^2 (1, N=1,127) = 16.56, p<.001; ridesharing/carpooling X^2 (1, N=1,127) = 2.73, p=.10; X^2 (1, N=1,127) = 0.14, p=.71).

Figure 3.12 Percentage of respondents using each transport option by residential type (urban/rural)



To determine if combinations of categorical predictors were able to explain the use of these new transport options in the previous 12 months, a series of binary logistic regression analyses was undertaken. Initially seven models were specified (age, gender and location, plus the interaction terms) for each outcome variable (app-based ride hailing services, ridesharing/carpooling and carsharing) and the findings were examined to determine which predictors provided significant explanatory power. The analyses were then re-run containing only the variables that made a significant contribution to the model (as suggested by Field 2018).

The final regression model predicting use of app-based ride hailing services in the previous 12 months is shown in table 3.3. The overall model was significant, X^2 (4) = 167.37, p<.001, classified 69% of the cases correctly and accounted for 19% of the variance (Nagelkerke R^2). As shown in the table, the odds of using an app-based ride hailing service in the previous 12 months were highest in the youngest age group (OR=8.01 compared with those over 65 years), and decreased with age (OR = 7.38 for 25 to 44 years and OR = 2.57 for 45 to 64 years). Those living in an urban location were 2.5 times as likely to have used an app-based ride hailing service in the previous 12 months.

Use of ridesharing/carpooling in the previous 12 months was predicted by age group and gender (table 3.4; X^2 (7, N-1,119) = 127.07, p<.001). The final model accounted for 16% of the variance (Nagelkerke R^2) and classified 75% of cases correctly overall (but classification accuracy was poor for those who had used ridesharing in the last year). As shown in the table, the odds of using ridesharing were higher for those in the younger age groups (eg OR = 3.84 for 16 to 24 year olds compared with those aged over 65 years). Overall, males were less likely than females to have used ridesharing in the previous 12 months (OR = 0.27), but this differed by age. Compared with females aged over 65 years, males were significantly more likely to have used ridesharing in the previous 12 months in the two youngest age

groups (16 to 24 years OR= 3.82; 25 to 44 years OR = 4.51); in the oldest age group (the reference group) females were more likely to have used ridesharing than males (13.2% versus 4%).

The regression model predicting use of carsharing in the previous 12 months was also statistically significant X^2 (12, N = 1,119) = 87.26, p<.001, explaining 11% of the variance. Age group, gender and location were significant predictors of prior carsharing (table 3.5), with an overall classification accuracy of 78.9%, but as with ridesharing, accuracy was poor (0%) for those who had used carsharing in the last year. As shown in the table, age group and gender were significant predictors. Those aged 25 to 44 were 1.9 times more likely to have carshared in the last year compared with those aged over 65. In addition, males in the two youngest age groups were more likely to have used carsharing in the previous 12 months compared with the reference groups (16 to 24 years OR= 4.04; 25 to 44 years OR = 4.22).

Table 3.3 Final logistic regression model predicting use of app-based ride hailing services in the previous 12 months

					95% CI for odds ratio		
	b	SEB	Wald	p	Lower	Odds ratio	Upper
Constant	-.513	0.18	104.45				
Age group (vs 65+ years)			125.013	<.001			
16–24 years	2.08	.22	91.17	<.001	5.22	8.01	12.26
25–44 years	2.00	.22	83.87	<.001	4.81	7.38	11.33
45–64 years	0.94	.23	17.30	<.001	1.65	2.57	1.64
Location (urban)	0.73	.19	15.45	<.001	2.08	1.44	2.99

Table 3.4 Final logistic regression model predicting use of ridesharing/ carpooling in the previous 12 months

					95% CI for odds ratio		
	B	SEB	Wald	p	Lower	Odds ratio	Upper
Constant	-1.88	.25	55.22				
Age group (vs 65+ years)							
16–24 years	1.34	.31	19.46	<.001	2.11	3.84	6.97
25–44 years	1.37	.31	19.68	<.001	2.14	3.92	7.16
45–64 years	0.26	.34	0.58	0.45	0.66	1.30	2.55
Gender (male vs female)	-1.30	.49	7.09	.008	0.11	0.27	0.71
Gender (vs female) x age (vs 65+)			7.92	.048			
16–24 years	1.34	0.55	6.00	.014	1.31	3.82	11.14
25–44 years	1.51	0.55	7.59	.006	1.54	4.51	13.20
45–64 years	1.12	0.59	3.59	.058	0.96	3.05	9.70

Table 3.5 Final logistic regression model predicting carsharing in the previous 12 months

					95% CI for odds ratio		
	B	SEB	Wald	p	Lower	Odds ratio	Upper
Constant	-1.54	.23	46.91				
Age group (vs 65+ years)			14.65	.002			
16–24 years	0.28	.30	0.90	.344	0.74	1.33	2.39
25–44 years	0.63	.29	4.69	.030	1.06	1.89	3.34
45–64 years	-0.60	.36	2.76	.097	0.27	0.55	1.11
Gender (male vs female)	-0.90	.38	5.76	.016	0.19	0.41	0.85
Gender (vs female) x age (vs 65+)			11.57	.009			
16–24 years	1.40	0.46	9.07	.003	1.63	4.04	10.03
25–44 years	1.44	0.46	10.00	.002	1.73	4.22	10.31
45–64 years	1.00	0.54	3.48	.062	0.95	2.72	7.77

3.2.4 Concerns and obstacles

Respondents were asked about availability of each of the new transport options. Overall, app-based ride hailing services were available to 53% (n=594) of the sample (17.3%, n = 195, did not know); ridesharing/ carpooling was available to 34.9% (n=393) of the sample (31.5% did not know); and only 27.5% (n=310) of respondents indicated that carsharing was available (39.9%, n = 450 did not know). Respondent reports of the availability of each of the transport sharing options differed by age group (figure 3.13); the older age groups were significantly less likely to report any of the three transport options were available to them (app-based ride hailing X^2 (6, N = 1,127) = 120.31, p<.001; ridesharing/carpooling X^2 (6, N = 1,127) = 138.75, p<.001; carsharing X^2 (6, N = 1,127) = 105.64, p<.001).

Figure 3.13 Respondent responses regarding the availability of a) app-based ride hailing services; b) ridesharing/carpooling options; c) carsharing, by age group

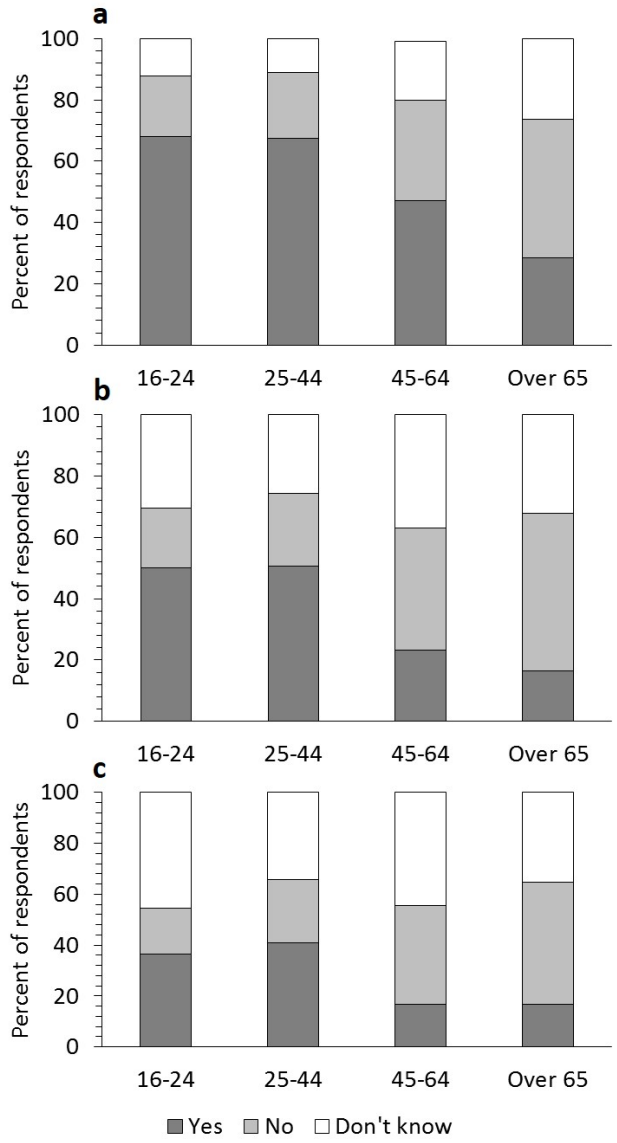
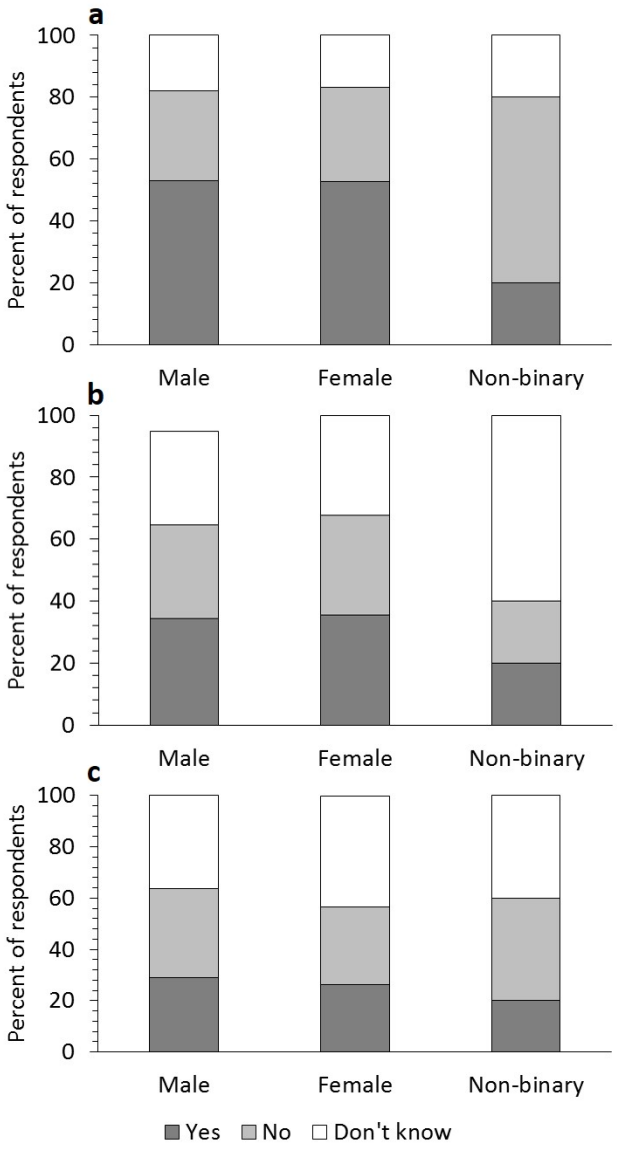


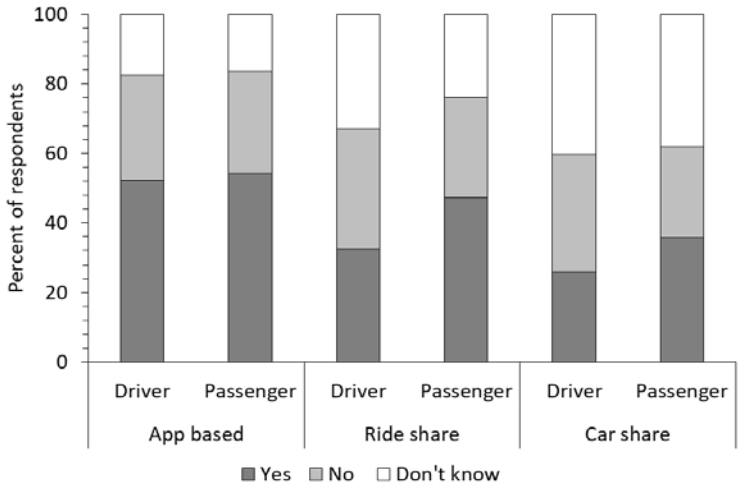
Figure 3.14 presents respondents' reports of the availability of new transport sharing options by gender. As shown in the figure, a) availability of app-based ride hailing, b) ridesharing/carpooling and c) carsharing, was similar regardless of gender (note that only a small number (five) of respondents identified as non-binary). Chi square tests confirmed that the association between availability of app-based ride hailing service, ridesharing options and carsharing was not statistically significant, X^2 (6, N = 1,127) = 4.42, p=.620; X^2 (6, N = 1,127) = 5.24, p=.51 ; and X^2 (6, N = 1,127) = 7.78, p=.23, respectively.

Figure 3.14 The availability of a) app-based ride hailing services; b) ridesharing/carpooling options; c) carsharing, by gender



The respondents' answers regarding the availability of the transport sharing options differed by their usual role (driver or passenger) as is shown in figure 3.15. Reports of the availability of app-based ride hailing services were similar for drivers and passengers, X^2 (2, N = 1,125) = 0.29, p=.686; however, passengers reported significantly greater availability of ridesharing/carpooling (47%) compared with drivers (32.5%) X^2 (2, N = 1,125) = 15.10, p=.001) and carsharing options (passengers 35.9% vs 25.9% of driver, X^2 (2, N = 1,122) = 8.52, p=.014).

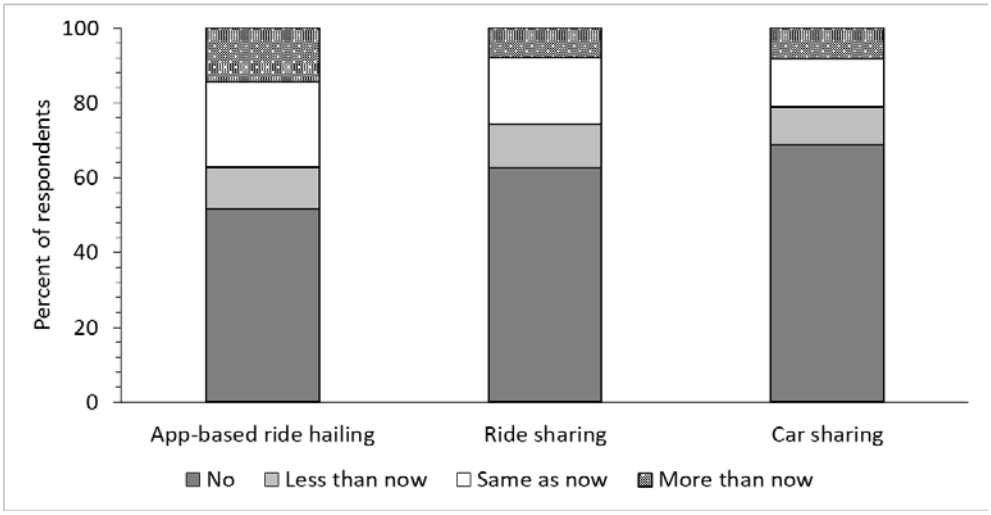
Figure 3.15 The availability of app-based ride hailing services, ridesharing/carpooling options and carsharing for drivers and passengers



3.2.5 Likely use and trip type

Respondents were also asked about their intention to use each of the transport sharing options in the next 12 months (figure 3.16). Over half the respondents reported they would not use any of the three transport sharing options in the next 12 months (app-based ride hailing 51.7%, ridesharing 62.6%, and carsharing 68.7%) and approximately 11% reported they would use each of the transport options less than they do currently. Almost 40% of respondents anticipated their use of app-based ride hailing services in the next 12 months to be the same or greater than currently; the numbers were somewhat lower for ridesharing (25.8%) and carsharing (21.1%).

Figure 3.16 Anticipated use of the new transport sharing options in the next 12 months



We also examined intended use by age group (figure 3.17). As can be seen in the figure, the proportion of respondents reporting they would not use one of the transport sharing options increased with age. For all new transport sharing options, use over the next 12 months at the current level or more was greatest for those aged 25 to 44 years, followed by the 16 to 24 group. Chi square tests confirmed that the association between use in the next 12 months and age group was statistically significant for each of the

transport sharing options: app-based ride hailing, X^2 (9, N = 1,127) = 210.93, p<.0001; rideshare/carpooling , X^2 (9, N = 1,127) = 162.37, p<.0001; carsharing X^2 (9, N = 1,127) = 105.27, p<.0001. Figure 3.18 presents use over the next 12 months by gender. As shown in the figure, the pattern of future use was similar for males and females for each of the transport sharing options; the chi square indicated the associations between future use and gender were not statistically significant (app-based ride hailing X^2 (9, N = 1,127) = 8.80, p=.456; rideshare/carpooling X^2 (9, N = 1,127) = 5.27, p=.810; and carpooling X^2 (9, N = 1,127) = 5.92, p=.748).

Figure 3.17 Intended use over the next 12 months by age group for a) app-based ride hailing; b) rideshare/carpooling; c) carsharing

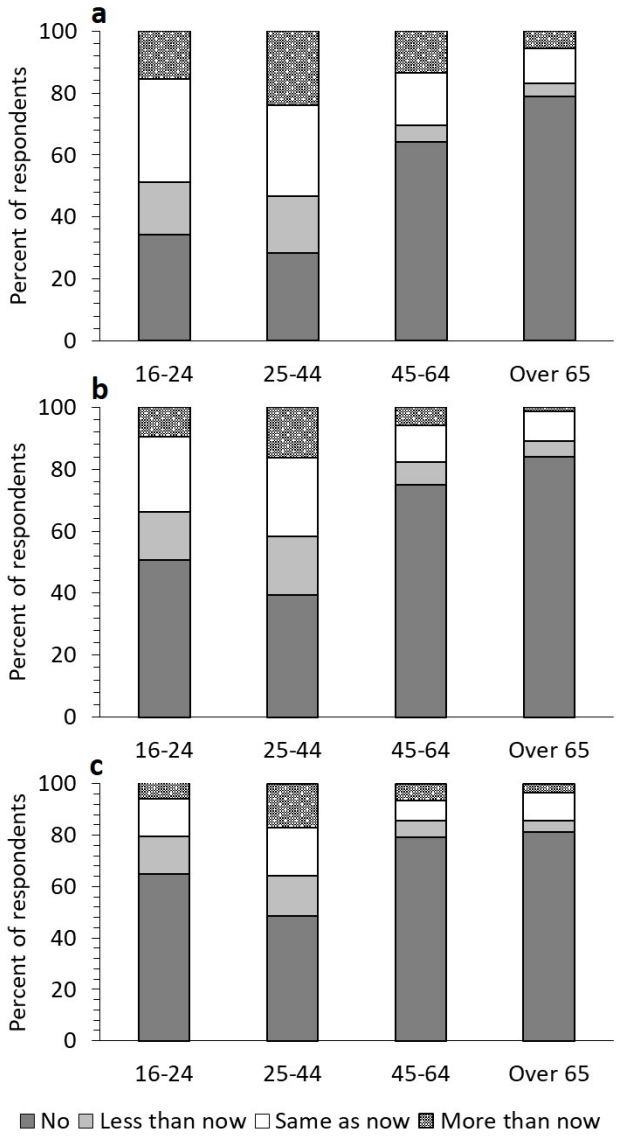
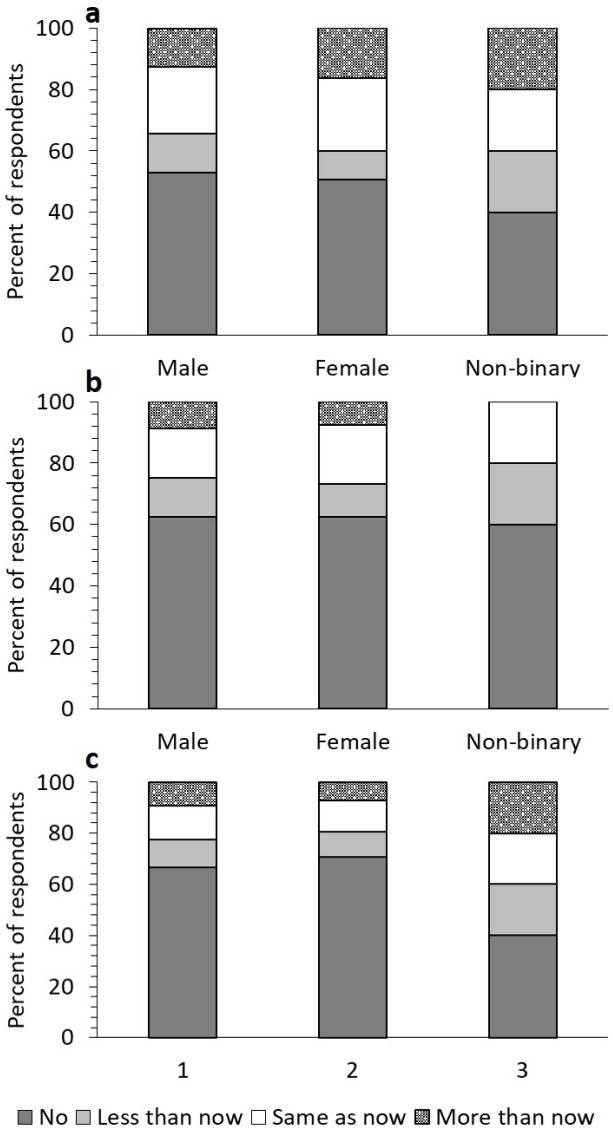
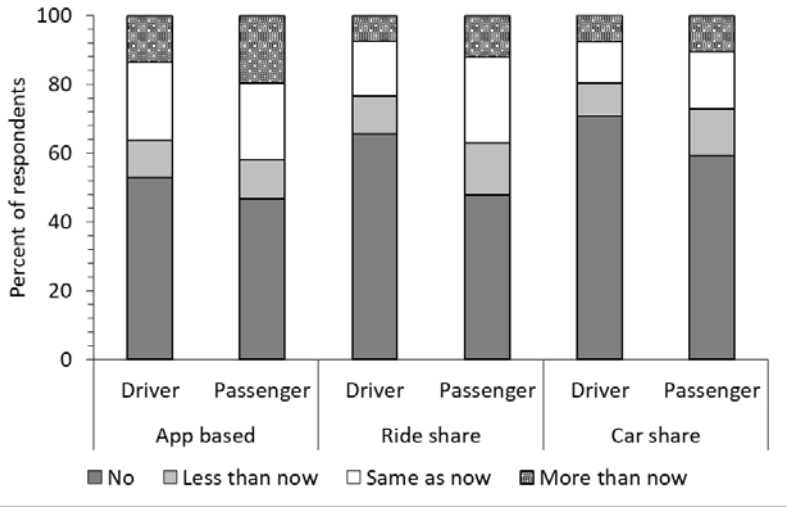


Figure 3.18 Intended use over the next 12 months for a) app-based ride hailing; b) rideshare/carpooling; c) carsharing, by gender



The intended use of app-based ride hailing over the next 12 months was similar for drivers and passengers (figure 3.19; X^2 (3, N = 1,125) = 5.052, p=.168), although a greater percentage of passengers reported an intention to use this service more than they currently did compared with drivers (19.6% of passengers vs 13.5% of drivers). In contrast, the pattern of future use between drivers and passengers for rideshare/carpooling and carsharing showed a different pattern. In both cases, passengers were more likely to use each of these transport sharing options in the next 12 months compared with drivers. Chi square analyses confirmed the associations between future use of both rideshare/carpooling (X^2 (3, N = 1,125) = 21.06, p<.0001) and carsharing (X^2 (3, N = 1,125) = 9.42, p=.024) and usual role (as driver or passenger) were statistically significant.

Figure 3.19 Intended use over the next 12 months for app-based ride hailing, rideshare/carpooling and carsharing for drivers and passengers



We also examined the association between knowledge about each transport sharing option and intended use. There was a significant association between knowledge and intended use of app-based ride hailing (X^2 (1, N = 1,127) = 136.79, p < =.001); only 12% of those who knew nothing about the service intended to use it, compared with 57% of those who knew about the service.

The findings were similar for ridesharing (X^2 (1, N = 1,127) = 89.99, p < =.001) and carsharing (X^2 (1, N = 1,127) = 146.02, p < =.001). Of those who knew nothing about the service, 13% were planning to use ridesharing and 9% to use carsharing. Of those who knew about the service, 45% intended to use ridesharing and 44% carsharing in the next 12 months.

3.2.6 Barriers and enablers

Respondents who were not intending to use the transport options were asked to identify the top three barriers that would prevent them from using each of the services. As shown in table 3.6, owning a car was the most commonly identified first and second barrier to using app-based ride hailing services; the third most common barrier identified was expense. Overall car ownership was the most frequently endorsed barrier, followed by lack of availability, safety and cost. The free text responses to those selecting the 'other' option included the inconvenience of using the services; other transport options such as public transport and own transportation such as walking; a lack of interest in using the services; personal preference/appraisal of the services; using their cars for more than just the purpose of transportation; not travelling often; needs based; and availability/inconvenience of these services when living in rural areas. One respondent commented that these services were often not suitable for the disabled.

Table 3.6 The frequency (and percentage) for each option identified as one of the three barriers to future use of app-based ride hailing services (n=583). Data is presented by the rankings for barrier 1

	Barrier 1		Barrier 2		Barrier 3		Total	Rank
	n	%	n	%	n	%	n	
I own a car	279	47.9*	127	21.8*	80	13.7	486	1
These services aren't available in my area	161	27.6	55	9.4	48	8.2	264	2
I wouldn't feel safe	41	7.0	95	16.	81	13.9	217	3
I don't own a smartphone	31	5.3	51	8.7	24	4.1	106	7
I don't know how to access/use these services	26	4.5	79	13.6	77	13.2	182	5
These services don't meet my need	19	3.3	66	11.3	59	10.1	144	6
These services are more expensive than other transport options	16	2.7	77	13.2	109	18.7*	202	4
Other	10	1.7	11	1.9	41	7.0	62	8

Availability was the most highly ranked first enabler for using app-based ride hailing services (table 3.7). The second and third highest ranking enablers were price. When looking at the total number of endorsements for each statement, price was most commonly endorsed (ie cheaper price would enable use), followed by availability, safety and better information on how to access the service. The 'Other' responses included inconvenience to use the services rather than using their personal cars, a lack of interest or intent to use these services.

Table 3.7 The frequency (and percentage) for each option identified as one of the three enablers of future use of app-based ride hailing services (n=583). Data is presented by the rankings for enabler 1

	Enabler 1		Enabler 2		Enabler 3		Total	Rank
	n	%	n	%	n	%	n	
If these services were available in my area	166	28.5*	49	8.4	62	10.6	277	2
If these services were cheaper than other transport options	122	20.9	140	24.0*	112	19.2*	374	1
Finding out more about the safety of these services	85	14.6	93	16.0	74	12.7	252	3
Learning how to access/use these services	64	11.0	106	18.2	81	13.9	251	4
Having a smartphone	60	10.3	39	6.7	22	3.8	121	7
If these services could meet my need	36	6.2	52	8.9	39	6.7	127	6
Other	26	4.5	4	0.7	22	3.8	52	8
Seeing other people around me using these services	24	4.1	49	8.4	91	15.6	164	5

The barriers and enablers for those not planning to use ridesharing/carpooling services over the next 12 months are summarised in tables 3.8 and 3.9. Owning a car was the highest ranked item for the first two

barriers, while not wanting to share a car with strangers was the highest ranked third barrier. When looking at overall endorsement rates, car ownership was endorsed most often, followed by a lack of awareness of ridesharing/ carpooling options and not wanting to share a car with strangers. The 'other' responses fit within two broad categories, work hours making it difficult to rideshare, and personal preference with their needs not fitting with this type of transport sharing option.

Table 3.8 The frequency (and percentage) for each option identified as one of the three barriers to future use of ridesharing/carpooling (n=705). Data is presented by the rankings for barrier 1

	Barrier 1		Barrier 2		Barrier 3		Total	Rank
	n	%	n	%	n	%		
I own a car	254	36.0*	112	15.9*	73	10.4	439	1
I'm unaware of ridesharing/carpooling options in my area	237	33.6	71	10.1	60	8.5	368	2
I don't want to share a car with strangers	48	6.8	58	8.2	113	16.0*	219	3
I wouldn't feel safe	33	4.7	86	12.2	45	6.4	164	6
Losing convenience	28	4.0	74	10.5	86	12.2	188	4
Losing freedom	26	3.7	58	8.2	88	12.5	172	5
Negotiating terms of use with others using the vehicle	24	3.4	57	8.1	51	7.2	132	8
I don't know how to access/use these options	22	3.1	87	12.3	38	5.4	147	7
Other	14	2.0	1	0.1	9	1.3	24	11
Reduced ability to get somewhere in an emergency	11	1.6	45	6.4	64	9.1	120	9
Insurance concerns	8	1.1	34	4.8	49	7.0	91	10

The first most highly ranked enabler for ridesharing and carpooling was availability, the second was insurance, and the third was fair payment (table 3.9). When looking at the total number of endorsements for each statement, availability was the most frequently endorsed, followed by more information about safety and a fair payment system. The responses to this question appear more evenly dispersed compared with the previous questions, perhaps reflecting the respondents' general lack of knowledge of these services. The 'Other' comments focused on not wanting to use the services, lack of interest, and a perceived lack of freedom associated with the use of this type of service.

Table 3.9 The frequency (and percentage) for each option identified as one of the three enablers of ridesharing/carpooling (n=705). Data is presented by the rankings for enablers

	Enabler 1		Enabler 2		Enabler 3		Total	Rank
	n	%	n	%	n	%	n	
Having ridesharing/carpooling options available in my area	230	32.6*	41	5.8	51	7.2	322	1
Finding out more about the safety of these services	113	16.0	93	13.2	47	6.7	253	2=
Ensuring insurance was covered in the event of an accident	64	9.1	109	15.5*	62	8.8	235	4
Ensuring everyone pays fairly for how much they use the vehicle	57	8.1	95	13.5	101	14.3*	253	2=
Having a firm agreement about use	47	6.7	92	13.0	81	11.5	220	6
Knowing how to find other people who want to rideshare	47	6.7	95	13.5	87	12.3	229	5
Other	44	6.2	1	0.1	9	1.3	54	11
Make ridesharing/carpooling a part of community infrastructure	40	5.7	33	4.7	52	7.4	125	8
Having accessible booking system in place	25	3.5	45	6.4	72	10.2	142	7
Having access to online ridesharing groups or apps that help people connect (eg Uber Commute)	24	3.4	28	4.0	32	4.5	84	9
Having access to a variety of car types for different purposes	14	2	15	2.1	34	4.8	63	10

Respondents who had indicated they would not use carsharing in the next 12 months (n=774) ranked car ownership as the first barrier (table 3.10). Loss of convenience was most commonly ranked as the second barrier and loss of freedom as the third. Looking at the total endorsements for each item, car ownership was selected most frequently, followed by availability, loss of convenience and freedom. The most frequent other comments focused on work schedules and that they were just not interested in using carsharing services.

Table 3.10 The frequency (and percentage) for each option identified as one of the three barriers to future use of carsharing (n=774). Data is presented by the rankings for barrier 1

	Barrier 1		Barrier 2		Barrier 3		Total	Rank
	n	%	n	%	n	%		
I own a car	299	38.6*	117	15.1	103	13.3	519	1
I'm not aware of carsharing in my area	284	36.7	85	11.0	79	10.2	448	2
Losing convenience	45	5.8	157	20.3*	93	12.0	295	3
I don't know how to access/use these services	39	5.0	115	14.9	45	5.8	199	5
Losing freedom	38	4.9	108	14.0	141	18.2*	287	4
Reduced ability to get somewhere in an emergency	27	3.5	57	7.4	112	14.5	196	6
Other	18	2.3	3	0.4	7	0.9	28	10
Insurance concerns	13	1.7	62	8.0	78	10.1	153	7
These services are more expensive than other transport options	6	0.8	29	3.7	46	5.9	81	8
Types of vehicles available don't suit my needs	5	0.6	13	1.7	20	2.6	38	9

The most commonly chosen first enabler was availability; how to access and use the service was the most frequently endorsed second enabler and an accessible booking system was the third (table 3.11). Overall, availability was most frequently selected, followed by cost, a convenient booking system and insurance. In the other comments, many respondents indicated they would not use the service, or were not interested in it and they preferred to use their own car. Some respondents indicated they might consider using a carsharing service if it was more convenient and safer.

Table 3.11 The frequency (and percentage) for each option identified as one of the three enablers of ridesharing/carpooling (n=774). Data is presented by the rankings for enabler 1

	Enabler 1		Enabler 2		Enabler 3		Total	Rank
	n	%	n	%	n	%	n	
Having the service available in my area	303	43*	83	10.7	90	11.6	476	1
If carsharing fees were less than car ownership costs	108	15.3	130	16.8	136	17.6	374	2
Having insurance covered in the event of an accident	90	12.8	119	15.4	98	12.7	307	4
Learning how to access/use these services	83	11.8	148	19.1*	66	8.5	297	5
Having an accessible booking system	54	7.7	115	14.9	146	18.9*	315	3
Other	40	5.7	2	0.3	18	2.3	60	7
Access to a variety of car types for different purposes	27	3.8	47	6.1	67	8.7	141	6

Respondents who indicated they intended to use the new transport sharing options in the next 12 months were asked to rank the top three reasons why they would use the service. The summary for those using app-based ride hailing services is presented in table 3.12. Convenience was the most commonly endorsed first, second and third reason. When looking at the total number of endorsements, convenience was selected most frequently, followed by availability and price. The other responses included use of service when drinking, price and use of service when travelling (rather than every day).

Table 3.12 The frequency (and percentage) for each option identified as one of the top three reasons for using app-based ride hailing services (n=572). Data is presented by the rankings for reason 1

	Reason 1		Reason 2		Reason 3		Total	Rank
	n	%	n	%	n	%	n	
It is convenient	178	31.1*	127	22.2*	87	15.2*	392	1
These services are available in my area	149	26.0	51	8.9	57	10.0	257	2
These services are cheaper than other transport options	82	14.3	77	13.5	81	14.2	240	3
I feel safe using these services	30	5.2	58	10.1	45	7.9	133	6
I don't own a car	27	4.7	38	6.6	7	1.2	72	7
There is an accessible booking system	27	4.7	76	13.3	72	12.6	175	4
I know how to access/use these services	22	3.8	52	9.1	82	14.3	156	5
Other	19	3.3	6	1.0	8	1.4	33	10
Sustainability / reducing carbon footprint	14	2.4	15	2.6	42	7.3	71	8
These services meet my needs	13	2.3	29	5.1	28	4.9	70	9
I have a health condition that prevents me from driving	6	1.0	5	0.9	12	2.1	23	12
My workplace requires me to use this service for business trips	5	0.9	11	1.9	10	1.7	26	11

The primary and secondary reason for using ridesharing/carpooling was convenience, and the third most commonly chosen third reason was cheaper price (table 3.13). As with the app-based ride hailing services, convenience, cheap price and availability were the most frequently endorsed items overall. A relatively small proportion of respondents (<3.5%) selected other reasons, including carpooling with family and friends, to cut costs and because it was fun to travel as a group.

Table 3.13 The frequency (and percentage) for each option identified as one of the top three reasons for using ridesharing/carpooling services (n=452). Data is presented by the rankings for reason 1

	Reason 1		Reason 2		Reason 3		Total	Rank
	n	%	n	%	n	%	n	
It is convenient	142	31.4*	78	17.3*	59	13.1	279	1
These services are available in my area	86	19	27	6.0	31	6.9	144	3
I don't own a car	41	9.1	28	6.2	3	0.7	72	8

	Reason 1		Reason 2		Reason 3		Total	Rank
These services are cheaper than other transport options	40	8.8	78	17.3*	66	14.6*	184	2
Sustainability/reducing carbon footprint	36	8	38	8.4	58	12.8	132	4=
I feel safe using these services	35	7.7	53	11.7	44	9.7	132	4=
I know how to access/use these services	26	5.8	49	10.8	45	10.0	120	6
Other	16	3.5	4	0.9	11	2.4	31	10=
There is an accessible booking system	11	2.4	25	5.5	27	6.0	63	9
These services meet my needs	10	2.2	32	7.1	34	7.5	76	7
My workplace requires me to use this service for business trips	5	1.1	7	1.5	19	4.2	31	10=
I have a health condition that prevents me from driving	4	0.9	6	1.3	12	2.7	22	12

The most common reasons for carsharing are presented in table 3.14. As shown in the table, the most commonly selected reasons for carsharing were the same as for the previous transport sharing options: convenience, cheaper price and availability. Other reasons included carsharing informally within the local community of people heading to the same place, and to help others.

Table 3.14 The frequency (and percentage) for each option identified as one of the top three reasons for using a carsharing services (n=388). Data is presented by the rankings for reason 1

	Reason 1		Reason 2		Reason 3		Total	Rank
	n	%	n	%	n	%	n	
It is convenient	110	28.4*	66	17.0*	49	12.6	225	1
These services are available in my area	90	23.2	18	4.6	26	6.7	134	3
These services are cheaper than other transport options	31	8	53	13.7	61	15.7*	145	2
Sustainability/reducing carbon footprint	28	7.2	27	7.0	44	11.3	99	5
I don't own a car	27	7	22	5.7	8	2.1	57	9
Other	26	6.7	1	0.3	7	1.8	34	10
I feel safe using these services	22	5.7	61	15.7	33	8.5	116	4
I know how to access/use these services	18	4.6	46	11.9	33	8.5	97	6
There is an accessible booking system	12	3.1	21	5.4	32	8.2	65	7
These services meet my needs	11	2.8	28	7.2	25	6.4	64	8
I have a health condition that prevents me from driving	7	1.8	5	1.3	8	2.1	20	12
My workplace requires me to use this service for business trips	6	1.5	6	1.5	20	5.2	32	11

3.2.7 Willingness to pay and mode shifts

Respondents were then asked a series of questions about the savings they would need to make to shift to a shared taxi for the trip they typically took by car (described in the section 3.2.1).When asked how much time they would need to save to use a shared taxi service, 55.2% (n=622) would not use a shared taxi; however, when provided with information about the cost of the daily commute in a private car and asked how much they would need to save to use a shared taxi, this figure dropped to 526 (46.7% of the total sample). The demographic characteristics of those reporting they would or would not use a shared taxi in for each of these questions is shown in table 3.15. There was a significant association between gender and use of a shared taxi for the time-saving question (X^2 (1, N = 1,119) = 5.16, p=.023), with a greater proportion of females indicating that they would not use the service. The association between age and use was also statistically significant (X^2 (3, N = 1,119) = 60.52, p<.0001). The proportion of users aged 25 to 44 years (34.2%) was significantly higher compared with the non-users (16.2%), while the opposite pattern was observed for the two older age groups.

For the cost based question, the proportion of males and females reporting they would consider using a shared taxi was similar; a chi square test found no significant association between gender and use based on cost (X^2 (1, N = 1,119) = 1.08, p=.30). In terms of age, for the two youngest groups (16 to 24 and 25 to 44 years) the proportion of those willing to shift to a shared taxi was significantly higher compared with those who would not. In contrast, the opposite was the case for the two older age groups; the proportion reporting they would not use a shared taxi was significantly higher compared with those who would (X^2 (3, N = 1,119) = 59.18, p=<.0001).

Table 3.15 Demographic characteristics of those reporting they would or wouldn't shift to a shared taxi based on time or cost savings. Data is presented as n and the percentage of non-users or users

	Non-user time saving (n=622)	User time saving (n= 505)	Non-user cost (n=526)	User cost (n=594)
Gender[a]				
Male (n,%)	292 (47.2)	270 (54.0)	255 (48.6)	307 (51.7)
Female (n,%)	327 (52.8)	230 (46.0)	270 (51.4)	287 (48.3)
Age group				
16–24 years (n,%)	149 (24.1)	132 (26.4)	117 (22.3)	164 (27.6)*
25–44 years (n,%)	100 (16.2)	171 (34.2)*	82 (15.6)	189 (31.8)*
45–64 years (n,%)	185(29.9)	96 (19.2)*	158 (30.1)	123 (20.7)*
> 64 years (n,%)	185 (29.9)	101 (20.2)*	168 (32.0)	118 (19.9)*

[a] data from respondents of non-binary gender has been excluded from these analyses due to the small sample size. * p<.05 compared to non-user.

As noted above, fewer respondents reported they would not use a shared taxi once they had been provided with the costs of car ownership. The next set of analyses focus on the respondents whose responses changed between the two questions in order to provide insights into who might be most likely to shift their thinking about shared taxi schemes. A total of 152 respondents changed their answer regarding whether or not they would use a shared taxi, of these 29 had indicated they would consider using a shared taxi in response to question 1, but after receiving information about the cost of car journeys, they indicated they would not consider a shared taxi. The remaining 123 respondents indicated they would not use a shared taxi in response to the question on time saving, but they would when provided with information about cost saving. The demographic characteristics of these two groups of respondents are shown in table 3.16. A

higher proportion of females compared with males were willing to consider a shared taxi after receiving information about the cost of car ownership/use (ie they showed a positive shift). With regard to age, those aged 25 to 44 years were least likely to positively shift their response (19.2%) compared with the other age groups. Interestingly, the oldest drivers were the most likely to report they would not consider using a shared taxi after receiving the cost-related information, a negative shift.

Table 3.16 Demographics of the respondents showing a positive or negative shift to using a shared taxi

	Negative shift n=29	Positive shift n=123
Gender[a]		
Male (n,%)	17 (58.6)	54 (43.9)
Female (n,%)	12 (41.4)	69 (56.1)
Age group		
16–24 years (n,%)	2 (6.9)	35 (28.0)
25–44 years (n,%)	6 (20.7)	24 (19.2)
45–64 years (n,%)	8 (27.6)	36 (28.8)
> 64 years (n,%)	13 (44.8)	30 (24.0)

Shifting the focus back to those who reported they would consider using a shared taxi, 20.7% of respondents would shift to a shared taxi from their car for savings of up to five minutes, and an additional 11.9% would shift if the time saved was 6 to 10 mins, 7.4% for savings of 11 to 20 mins, 3.5% for 21 to 30 mins, and 1.8% for time savings of over 30 mins. In terms of cost savings for those willing to use a shared taxi (n= 601), 15% (n=90) would be willing to use a shared taxi for a saving of up to $5, another 259 people (43.1%) would use a shared taxi for savings of $6 to $10, a further 90 (15%) to save $11 to $15, another 89 (14.7%) to save $16 to $20, 27 (4.5%) to save $21 to $25 and another 46 (7.7%) to save $26 to $30.

The subsequent questions asked how much time people would be willing to spend on various aspects of their journey if they used a shared taxi. This included getting to the pick-up point, getting to a final destination, waiting for a ride and time collecting someone else. This data is summarised in table 3.17 in five minute time bins. On average, respondents were willing to spend about three minutes (*M*= 2.95, *SD* = 4.38) getting to a shared taxi pick up point.

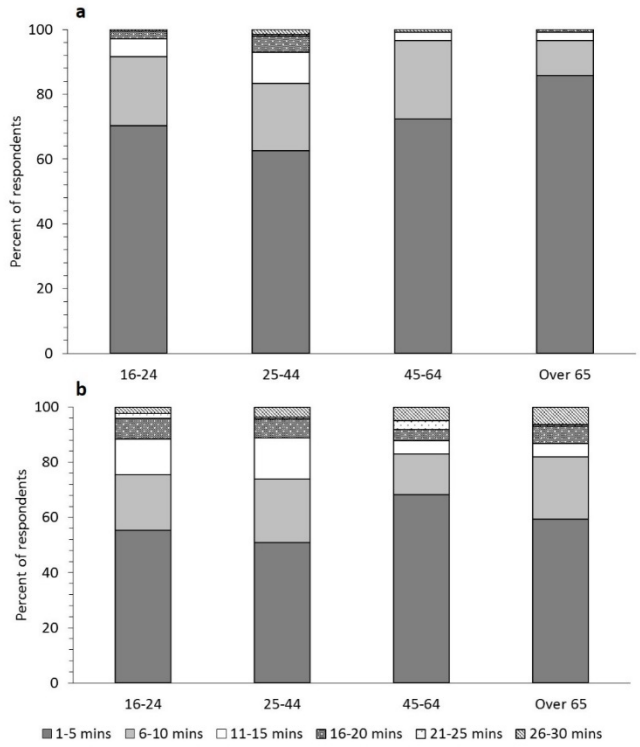
Table 3.17 The time respondents are willing to spend on various aspects of a journey (in five minute time bins) if a shared taxi was available (note the maximum time for waiting and detour was 15 minutes)

	Home to pick up point[a]		Destination from drop off[b]		Waiting time[c]		Detour time[d]	
	n	%	n	%	n	%	n	%
1–5 minutes	423	71.3	350	57.4	383	59.5	390	61.8
6–10 minutes	117	19.7	125	20.5	196	30.4	188	29.8
11–15 minutes	33	5.6	62	10.2	65	10.1	53	8.4
16–20 minutes	14	2.4	39	6.4	-	-	-	-
21–25 minutes	1	0.2	9	1.5	-	-	-	-
26–30 minutes	5	0.8	25	4.1	-	-	-	-
	593		610		644		631	

Note: Number not willing to use a shared taxi [a] = 534, [b] = 517, [c] = 483, [d] = 496

Figure 3.20 shows the length of time respondents in each age group were willing to spend i) getting to a shared taxi pick up point (panel a) and ii) getting to their destination from the drop off point. There was a significant association between age and time to pick up point (X^2 (15, N = 593) = 34.68, p=.003), with a greater proportion of the over 65 age group willing to spend one to five minutes and fewer willing to spend 6 to10 minutes getting to the pickup point compared with all other age groups. Interestingly the two youngest age groups were willing to spend longer getting to a drop off point. The findings for the time people were willing to spend getting to their destination from the drop off point were similar; there was a significant association between age and time to destination (X^2 (15, N = 610) = 28.46, p=.019), with the younger age groups willing to spend more time getting to their final destination (although at least 50% of each age group chose one to five minutes).

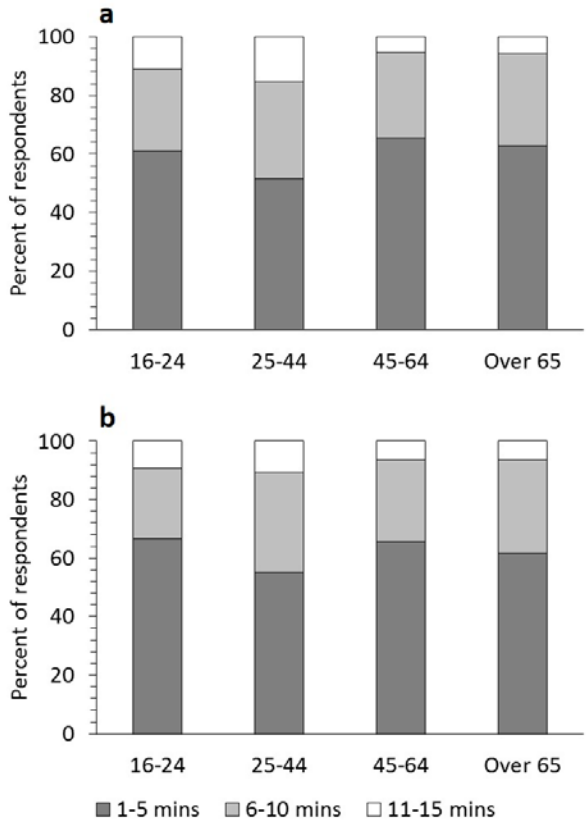
Figure 3.20 The time respondents are by age group a) willing to spend getting to a pick up point and b) getting to their final destination from the drop off point from a shared taxi



Respondents were also asked how long they would be willing to wait for a ride in a shared taxi and how long they would be willing to spend on a detour to collect other passengers (figure 3.21). There was a significant association between age group and time to wait (X^2 (6, N = 644) = 15.08, p=.020), with more of the 25 to 44 year olds willing to wait for longer. There was no significant association between age group and time spent on a detour (X^2 (6, N = 631) = 8.53, p=.202)

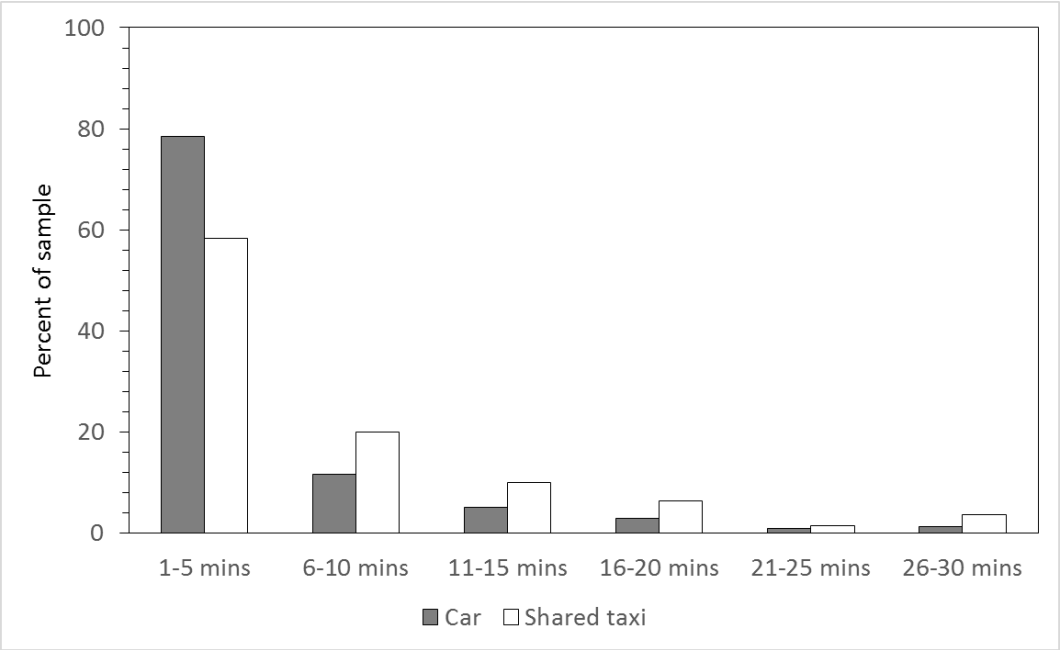
A set of similar analyses was conducted to examine the association between gender and waiting/journey times. There were no significant associations between gender and any of these variables: time to pick up point X^2 (5, N = 585) = 5.19, p=.393; time to destination from drop off point X^2 (5, N = 603) = 7.25, p=.203; time on a detour X^2 (2, N = 624) = 1.82, p =.403; or waiting time X^2 (2, N = 637) = 049, p=.976 (data not shown).

Figure 3.21 The time respondents by age group are: a) willing to wait for a ride; and b) take a detour in a shared taxi



In the first part of the survey we asked respondents about their typical journeys including how long it took for them to get to their destination after parking. Figure 3.22 shows how long it takes for respondents to get to their destination after parking their car (ie their current transport) and how much time they would be willing to spend getting to their destination from a shared taxi drop off point (we only used data from respondents with a car transfer time of less than 30 minutes, as the maximum time to get to a destination from drop off in the shared taxi scenario was 30 minutes). As shown in the figure, the majority of the sample had parking to destination times of under five minutes using their car. Interestingly though, respondents appeared willing to spend longer getting to their destination from a shared taxi drop off compared with their current journey. A Wilcoxon signed ranks test comparing the median time to destination for journeys by car and shared taxi was significant (Z=-10.863, p = <.001, N=598), with the time for car journeys shorter than for a shared taxi (median car = two minutes, median taxi = five minutes).

Figure 3.22 Time taken to get to final destination from parking or drop-off when using a car or shared taxi



The next questions focused on how many other people respondents would be willing to share a taxi with (524 said they would not use a shared taxi). Of those who would use a shared taxi, the mean number of passengers they were willing to share with was 3.70 (SD = 1.51). The same respondents share their car trip with 1.35 (SD 1.74) passengers on average, suggesting that sharing with other passengers was not a significant barrier to using a shared taxi. The number of passengers respondents would be willing to share with based on age group is shown in figure 3.23. A chi square test indicated a significant association between age group and number of passengers, X^2 (5, N = 603) = 54.87, p<.0001. A greater proportion of the younger groups indicated they would be willing to share with one or two other passengers, whereas the older age groups were willing to share with more people. Figure 3.24 shows the number of passengers respondents would be willing to share with by gender. As shown in the figure the data for males and females looks very similar. Supporting this, a chi square testing the association between the number of passengers and gender was not statistically significant (X^2 (5, N = 596) = 3.87, p =.568).

Figure 3.23 The number of passengers the respondents would be willing to share a taxi with by age group

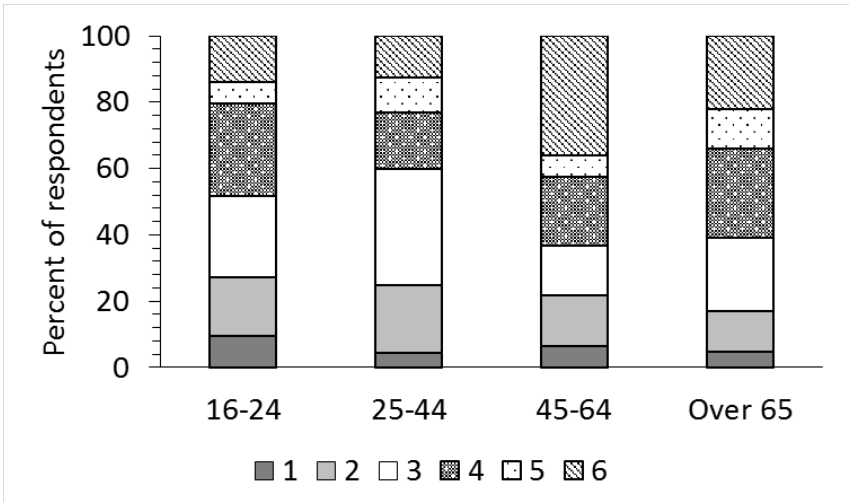
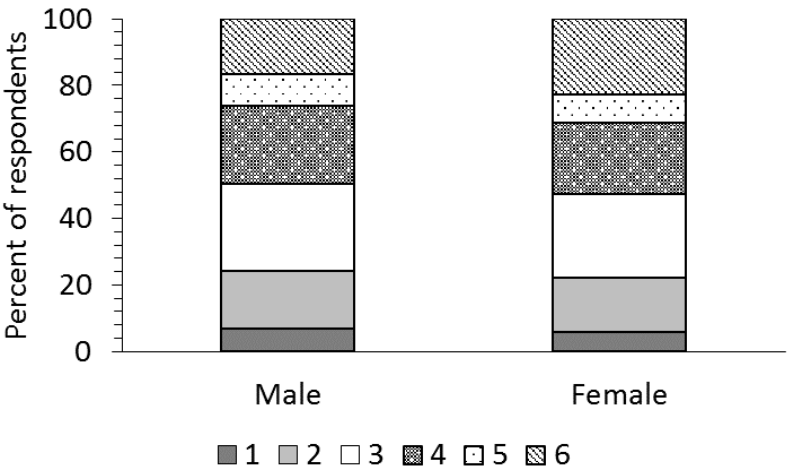
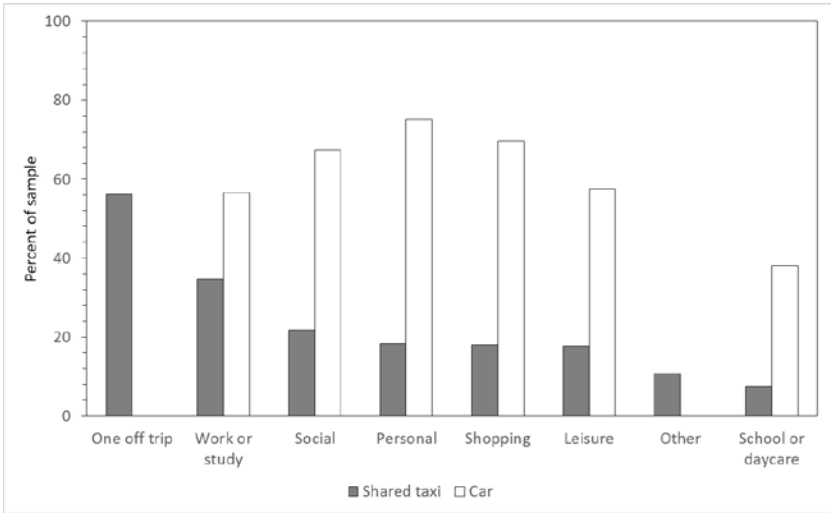


Figure 3.24 The number of passengers the respondents would be willing to share a taxi with, by gender



The next question asked what types of trips the respondents would use the shared taxi for. This data was compared with the trips typically taken by car as shown in figure 3.25. The largest proportion of the sample indicated they would use a shared taxi one-off trips and daily/ routine trips to work, but fewer would use it for family-related or social events. In terms of 'other' responses, the most common answer was they would never use a shared taxi, or that they wouldn't be available where they live (due to cell phone reception issues/rural living). Of those who would use a shared taxi, the most commonly cited 'other' trips were using a shared taxi for an airport transfer (rather like the shuttles that already operate) and, when they had been out drinking and might be over the legal alcohol limit.

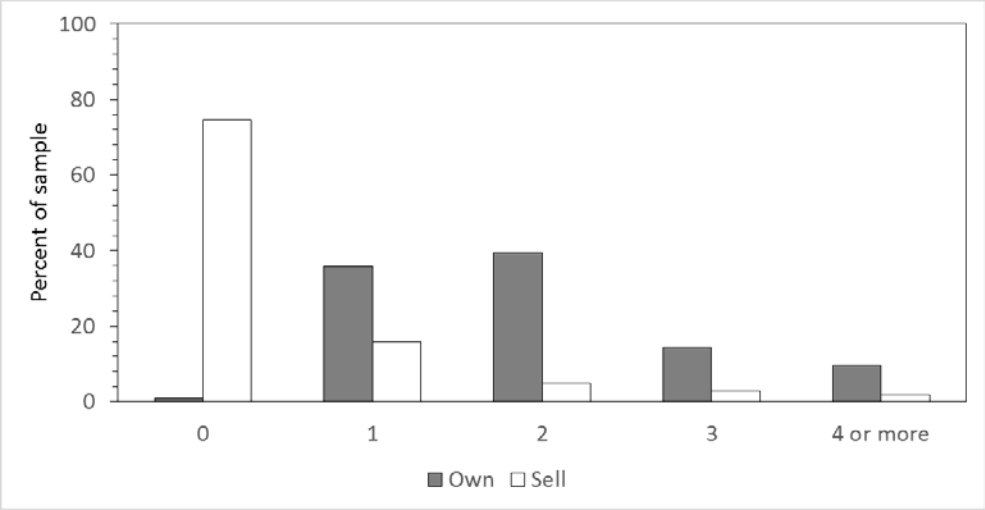
Figure 3.25 The percentage of the sample reporting the types of trips they would take by shared taxi compared with those typically taken by car (as a driver). (Data is not available for car trips for 'other' purposes or 'one-off' trips)



The following questions asked about current car ownership and how many cars would be sold if a shared taxi was available. The percentage of the sample and the number of cars they own and would sell if a shared taxi was available is shown in figure 3.26. As can be seen, the majority of respondents would not sell a car even if a shared taxi was available. As a conservative estimate the sample owns 2,248 cars in total (if we count those who selected '5 or more' as owning five cars). Overall the sample reported that

they would be willing to sell 466 cars (20.7% of the total). Interestingly though, for those with one car 90% of the sample would not sell their only car.

Figure 3.26 The number of cars owned and the number of cars that would be sold if shared taxis were available.



The final two questions asked the respondents to list barriers and enablers for them to use a shared taxi. The findings are summarised in table 3.18. The most commonly reported barrier was time (ie it would take too long), convenience ('needs to be more convenient that using my own car'), and cost. Other comments included concerns about lack of flexibility, freedom, safety, privacy, and that it would be unsuitable for children or those with mobility issues. In terms of enablers, being cheaper than current transport was the most commonly reported, followed by 'would never use it' (ie no enablers).

Table 3.18 Barriers and enablers to using a shared taxi for the current most frequently taken trip by car

Barriers to use	Frequency	Percent	Enablers to use	Frequency	Percent
Takes too long	136	13.45	Cheaper than current transport	250	24.83
Inconvenient	120	11.87	Would never use (ie no enablers)	237	23.54
Cost	93	9.20	Other	93	9.24
Other	87	8.61	Don't know	74	7.35
No barriers	76	7.52	If no other transport	54	5.36
Sharing with strangers	75	7.42	Faster than current transport	52	5.16
Freedom/flexibility/ independence	61	6.03	Accessible and easy to use	46	4.57
Not interested at all	58	5.74	One-off trips (eg airport)	40	3.97
Doesn't fit needs	45	4.45	Readily available	34	3.38
Location (home and destination)	44	4.35	Convenient	34	3.38
Prefer own car	43	4.25	Use with friends	27	2.68
Availability	40	3.96	Door to door service	17	1.69

Barriers to use	Frequency	Percent	Enablers to use	Frequency	Percent
Safety	39	3.86	Safety monitoring	14	1.39
Don't know	34	3.36	Need more information about the service	13	1.29
Suitability (children)	18	1.78	Good reliability	9	0.89
Accessibility	16	1.58	High degree of flexibility	7	0.70
Promptness	10	0.99	Fitted car seats	6	0.60
Reliability	10	0.99			
Not suitable for emergency	6	0.59			
Total	1,011			1,007	

3.3 Transport sharing and you (Ministry of Transport 2017/ 2018): Method

3.3.1 Participants

A subset of the HTS panel who had agreed to be contacted about other transport-related surveys were invited to take part. A total of 3,400 panel members received an invitation via text message and/or email to complete the survey. Of these, 639 people completed the survey (19% response rate). The demographic characteristics of the final sample are summarised in table 3.19, where it can be seen the mean age of the respondents was 51.22 years, and over half of the sample were female (55.6%). The majority of the respondents identified as New Zealand European, were employed and lived in large urban centres.

Table 3.19 The demographic characteristics of the *Transport sharing and you* respondents.

Characteristics	N=639
Age in years (mean, SD; range)	51.22 (15.84, 15-86)
Gender (n, %)	
Male	284 (44.4
Female	355 (55.6)
Ethnicity (n, %)	
NZ European	489 (76.5)
Maori	45 (7.0)
Samoan	9 (1.4)
Tongan	2 (0.2)
Cook Island Maori	3 (0.5)
Niuean	1 (0.2)
Chinese	14 (2.2)
Indian	16 (2.5)
Other	84 (13.1)
Annual personal income ($) before tax (n, %)	
Loss	0
Zero	32 (5.0)
1–20,000	75 (11.7)
20,001–40,000	109 (17.1)

Characteristics	N=639
40,001–60,000	83 (13.0)
60,001–70,000	41 (6.4)
70,001–100,000	64 (10.0)
>100,001	44 (6.9)
Prefer not to answer	122 (19.1)
Employment (n, %)	
Yes	375 (58.7)
No	262 (41.0)
Studying	56 (8.8)
Place of residence (n, %)	
Northland	25 (3.9)
Auckland	93 (14.6)
Waikato	69 (10.8)
Bay of Plenty	56 (8.8)
Gisborne	18 (2.8)
Hawkes Bay	32 (5.0)
Taranaki	20 (3.1)
Manawatū – Whanganui	32 (5.0)
Wellington	59 (13.9)
Nelson – Marlborough	38 (5.9)
West Coast	6 (0.9)
Canterbury	101 (15.8)
Otago	43 (6.7)
Southland	17 (2.7)
Residence type (n, %)	
Urban	500 (78.3)
Rural	139 (21.8)

3.3.2 Procedure and questionnaire design

As described above, a subset of the HTS panel received texts and/or emails inviting them to complete the survey. The questions were initially developed as part of a wider question bank for tracking changes in transport-related attitudes over time by Wooliscroft et al, University of Otago (under contract to the Ministry of Transport) in 2016. Further information can be found on the Ministry of Transport website www.transport.govt.nz/mot-resources/household-travel-survey/panels/

A copy of the survey can be found in appendix D. On the first page, respondents were asked to read about the transport sharing options discussed in the survey. The following definitions were provided (note these differ from the ridesharing survey described previously):

> **App-based ride services** are taxi-like services where people can arrange and pay for transport to a particular destination using their smartphone. Examples include Uber or Zoomy.
>
> **Carsharing/carpooling** is where two or more people share the same vehicle to a particular destination, such as work or town. Carsharing may be arranged with someone you know, or through technology, such as Facebook pages or apps, to arrange carsharing to work, or an event, or even between cities.

Car clubs are services where customers have access to vehicles when they need them without owning or paying ownership costs for those vehicles. Prior to use, individuals must register to a car club, which has a range of vehicles parked at various locations within a city. Examples include CityHop and Mevo.

Bike sharing schemes are services where customers have access to a bicycle for a short period of time. Bikes can be picked up and dropped off at various locations within a city.

The first question asked if respondents had heard about each of the transport sharing options listed above (yes/no). The respondents were then asked if each of the services was available to them (yes/no/don't know), to rate how knowledgeable they felt about each service (1, I know nothing, to 5 I know a great deal) and how attractive they found each service (1, not attractive whatsoever to 5, extremely attractive). They were then asked to indicate if they had used any of the services in the last 12 months (yes/no) and if they had to indicate how many days they had used the service in the last four weeks (not in the last four weeks, 1 to 4 days, 5 to 9 days, 10 to 19 days, 20+ days). Next they were asked if they intended to use each of the services in the next 12 months (no, yes but less than now, yes the same as now, yes more than now). Respondents who indicated they would not use app-based ride services, carsharing/carpooling or car clubs in the next 12 months were asked to rank the top three barriers and enablers from a list of statements (these differed depending on the service). Those who indicated they would not use a bike sharing scheme were asked to list the barriers to using a bike share scheme and the factors that would enable them to use it (free text). Respondents saw a screen displaying a message thanking them for participating, reassuring them their answers had been saved and they could close the web page.

3.3.3 Analysis

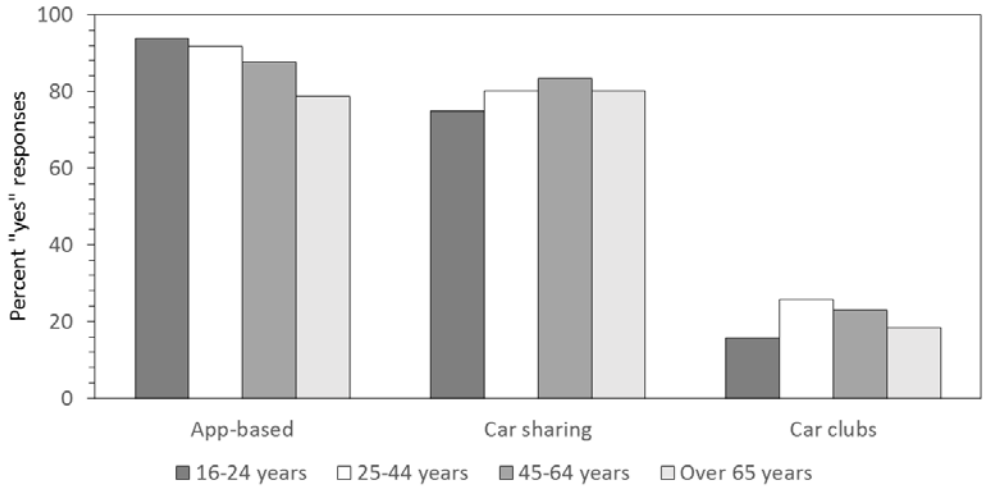
The analyses were conducted in a similar way to the previous surveys; responses to each question were summarised as frequency counts and percentages for the sample overall, and by gender and age group (16 to 24 years, 25 to 44 years, 45 to 64 years, over 65 years). Given the focus of the current project the analyses excluded bike sharing schemes. Chi square tests were used for significant associations between gender and age group for the relevant survey questions. Mann Whitney U tests or Kruskal Wallis tests were used to compare ratings of knowledge and safety by gender and age group.

3.4 Results

3.4.1 Public awareness

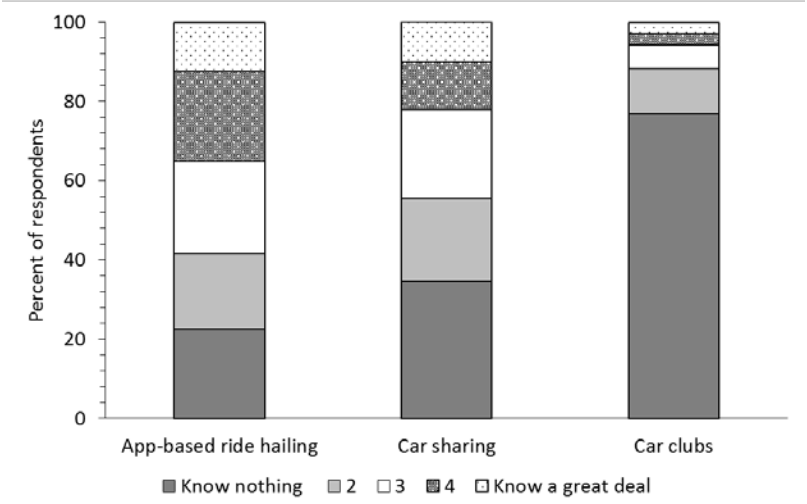
When the respondents were asked about the carsharing options, 87.2% had heard of app-based ride hailing services, 81.4% had heard of carsharing/carpooling, and 22.4% had heard of car clubs. Awareness of the carsharing option differed by age (figure 3.27) for app-based ride hailing (X^2 (3, N = 639) = 14.06, p = .003), with the oldest age least likely to have heard of this option. There was no significant association between age and awareness for carsharing/pooling (X^2 (3, N = 639) = 1.93, p =.587) or car clubs (X^2 (3, N = 639) = 3.33, p =.344). We also explored awareness of each of the transport sharing options by gender; analyses revealed no significant association between gender and awareness (all X^2 <1.6 all p's >.05)

Figure 3.27 The percentage of respondents by age group who had heard of each transport sharing option



Respondents' ratings of their knowledge of each of the transport sharing options are summarised in figure 3.28. As shown in the figure, respondents rated their knowledge as greatest for app-based ride hailing (12.5% indicated they knew a great deal) and least for car clubs (2.8% knew a great deal). There was a significant difference in knowledge ratings across the age groups for the app-based ride hailing services (H (3, N=639) = 33.58, $p < .001$) with the younger groups having the higher median ratings compared with the oldest group (median knowledge ratings = 3 (16 to 24 years), 4 (25 to 44 years), 3 (45 to 64 years) and 2 (over 65 years). There were no significant differences for ratings of knowledge of carsharing/carpooling or car clubs across the age groups (both H's < 1.6, both p's >.6). We also compared ratings of knowledge by gender. There were no significant differences in knowledge ratings between males and females for any of the three transport sharing options (all p's >.05).

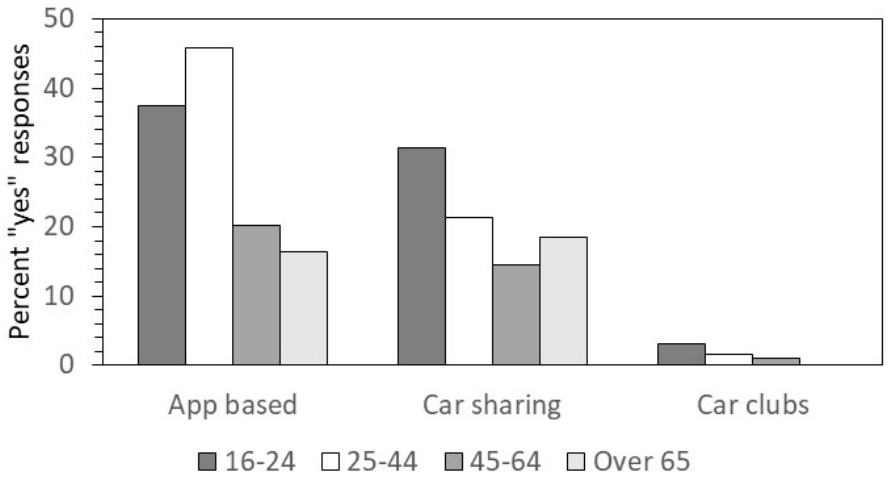
Figure 3.28 Respondents' knowledge ratings for each of the transport sharing options



Respondents were also asked if they had used any of the transport services over the last 12 months, and if they intended to use the service in the next 12 months. Overall, 176 respondents (27.5%) of the sample had used app-based ride hailing in the last 12 months, 116 (18.2%) had used carsharing/carpooling and only 7 (1.1%) had used car club. There was a significant association between age group and use of app-

based ride hailing services (X^2 (3, N = 639) = 49.14, p = <.001). As shown in figure 3.29, the younger respondents were more likely to use app-based ridesharing as compared to the older age groups. There was no statistically significant association between use of carsharing/carpooling or car clubs and age (X^2 (3, N = 639) = 7.59, p = .06 and X^2 (3, N = 639) = 3.33, p = .343 respectively). With regards to gender differences and use of each of the transport sharing options, there were no significant differences between male (28.5%) and female (26.8%) use of app-based ride hailing in the last 12 months (X^2 (1, N = 639) = 0.25, p = .621) or car clubs (males = 1.1%, females = 1.1%; X^2 (1, N = 639) = .01, p = .932). In contrast, a significantly greater proportion of females (23.1%) compared with males (12.0%) had used carsharing/carpooling in the last 12 months (X^2 (1, N = 639) = 13.15, p = <.001).

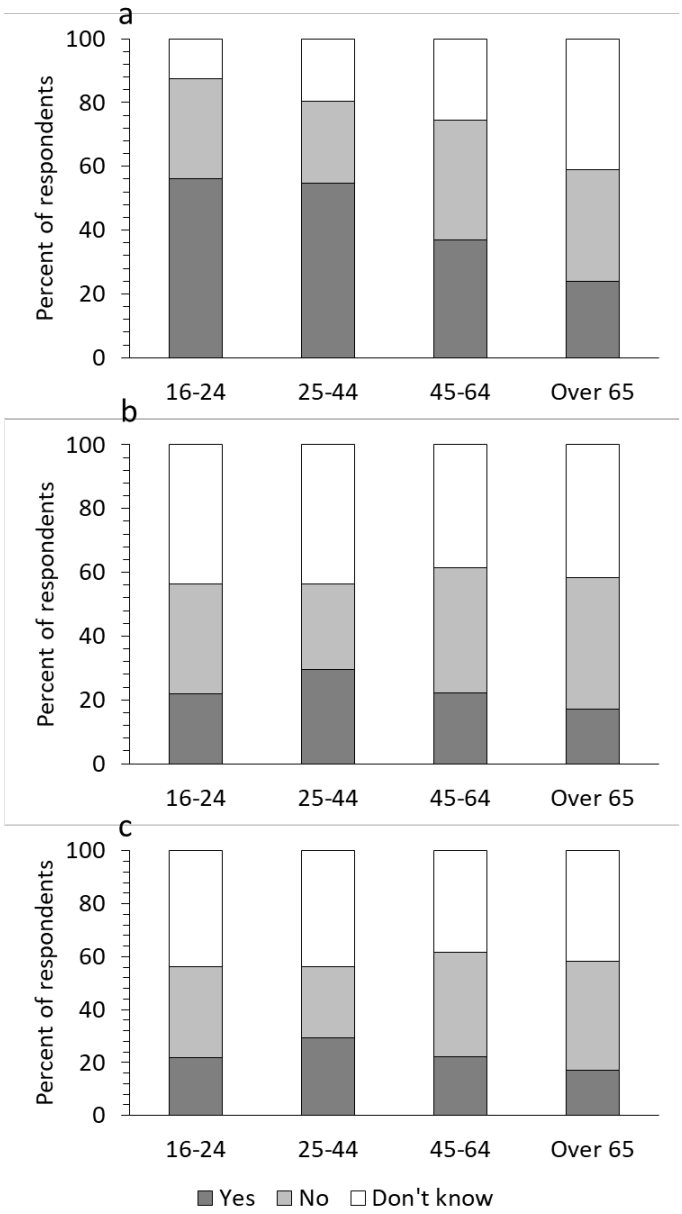
Figure 3.29 The percentage of respondents by age group who had used each of the transport sharing options in the previous 12 months



3.4.2 Concerns and obstacles

Respondents were asked about the availability of each of the transport options. App-based ride hailing services were available to 40.1% (n= 256), 26.8% (n= 171) did not know if it was available. Carsharing/carpooling was available to 148 respondents (23.2%), with 41% of the sample (n=262) reporting they did not know if it was available. Only a small proportion of the sample (3.8%, n = 24) reported that car clubs were available in their area; the majority (58.5%, n = 374) reported they did not know if this service was available. There were significant associations between responses to the availability of app-based ride hailing services and carsharing/carpooling and age group as shown in figure 3.30 (X^2 (6, N = 639) = 43.88, p = <.001 and X^2 (6, N = 639) = 12.65, p = =.049 respectively). As can be seen in the figure, the proportion of respondents who indicated that app-based ride hailing was available decreased with age. For carsharing/carpooling the 25 to 44 age group were most likely to indicate this service was available. The association between responses about the availability of car clubs and age was not significant (X^2 (6, N = 639) = 10.32, p = .112). There were no statistically significant associations between responses to the availability of the transport sharing options and gender (app-based ride hailing: Yes responses M= 31.2%, F = 39.2%, X^2 (2, N = 639) = 0.29, p = 856; carsharing/carpooling: Yes responses M = 21.5%, F = 24.5%, X^2 (2, N = 639) = 2.00, p = .367; car clubs: Yes responses M = 3.9%, F = 3.7%, X^2 (2, N = 639) = 1.80, p = .407.

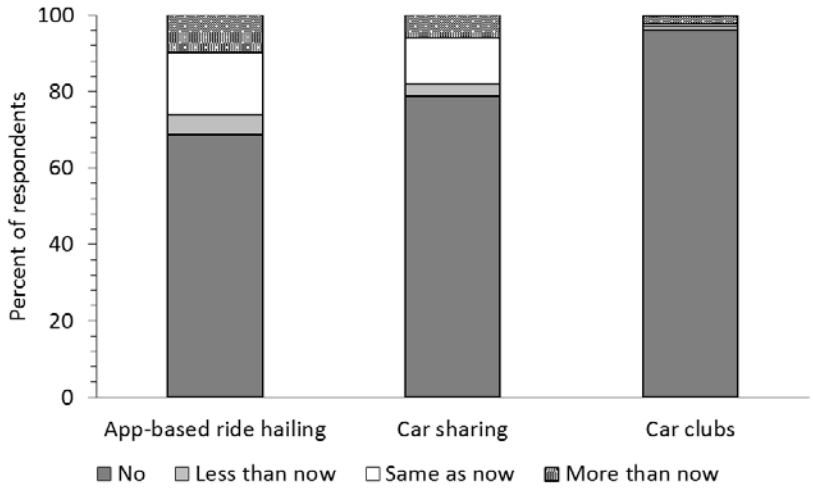
Figure 3.30 Respondents' reports of the availability of: a) app-based ride hailing; b) carsharing/carpooling; and c) car clubs, by age group



3.4.3 Likely use

As in the previous survey, respondents were asked about their intention to use each of the transport sharing options in the next 12 months. As shown in figure 3.30, the majority of respondents did not intend to use any of these services in the next 12 months. For those who were going to use app-based ridesharing and carsharing/carpooling most reported their level of use would be similar to now, with a relatively small proportion indicating their use would increase (9.9% for app-based ride hailing and 5.9% for carsharing).

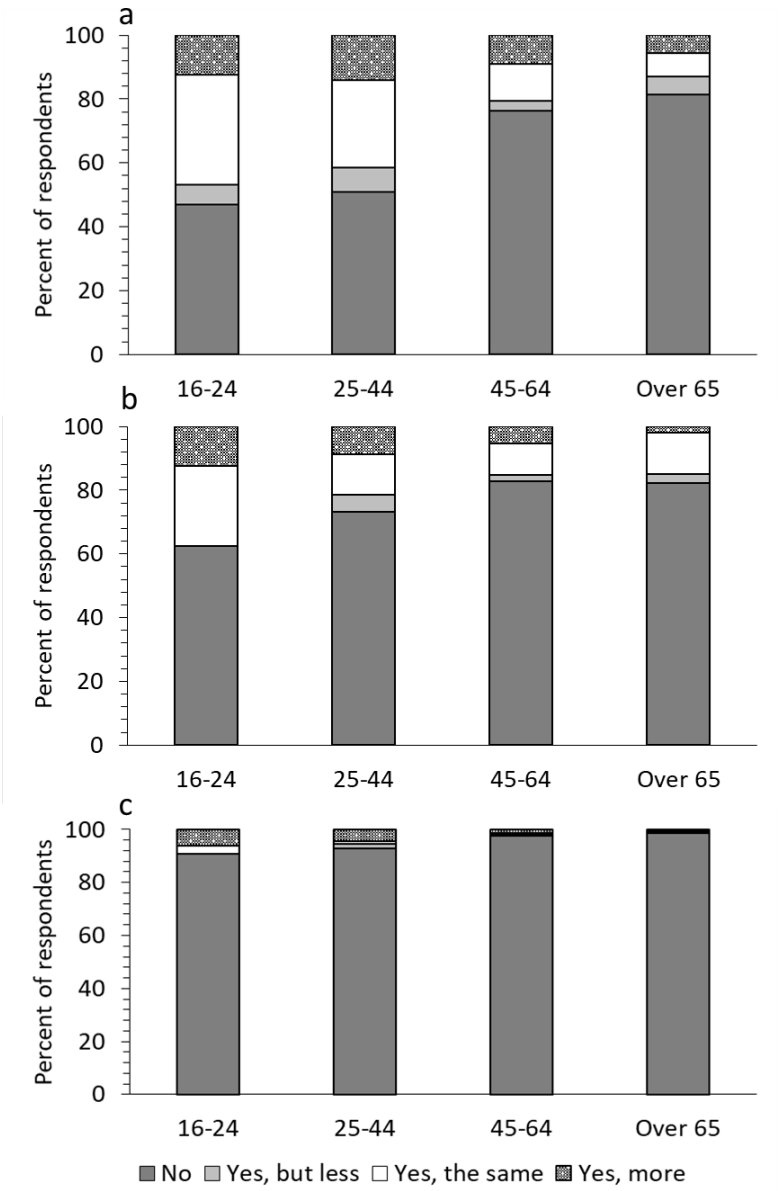
Figure 3.31 Anticipated use of each of the transport sharing options in the next 12 months



We also examined the association between anticipated use of transport sharing options and age. The association was statistically significant for app-based ridesharing (X^2 (9, N = 639) = 58.51, p = <.001) and carsharing/carpooling (X^2 (9, N = 639) = 22.10, p =.009) but not for car clubs (X^2 (9, N = 639) = 14.97, p = .092), see figure 3.32. For app-based ride hailing the two older groups were more likely to report they would not use this service in the next 12 months compared with the two younger groups. Those aged 16 to 24 years were most likely to indicate they would use carsharing/carpooling in the next 12 months. The associations between gender and anticipated use were not statistically significant: app-based ride hailing (X^2 (3, N = 639) = 2.63, p =.453), carsharing/carpooling (X^2 (3, N = 639) = 4.37, p =.224) and car clubs (X^2 (3, N = 639) = 2.32, p =.509).

Knowledge about the service was associated with planned use over the next 12 months for each of the services (app-based ride hailing X^2 (1, N = 639) = 66.94, p < .001; carsharing X^2 (1, N = 639) = 34.60, p < .001; car clubs X^2 (1, N = 639) = 6.35, p < .001). Of those who knew nothing about the service, 3.5% intended to use app-based ride hailing, 8.1% carsharing/carpooling and 2.9% car clubs. For those who had some knowledge of each of the services, 39.4% intended to use app-based ride hailing, 28.1% carsharing/carpooling and 7.4% intended to use car clubs.

Figure 3.32 Anticipated use of: a) app-based ride hailing; b) carsharing/carpooling: and c) car clubs, by age group



3.4.4 Barriers and enablers

The respondents who indicated they did not intend to use the transport sharing options in the next 12 months were asked to rank the top three barriers that prevent them from using the services and three factors that would enable them to use the new transport options. This data is summarised in tables 3.20 to 3.22. The data shown is the total number of times each factor was selected as a barrier or enabler (ie ranked in the top three). For app-based ride hailing services (table 3.20), the greatest barrier was car ownership, followed by availability and uncertainty about how to use the service. The three main factors that would enable people to use the service were price, availability and knowing how to use the service. The 'other' barriers included concerns about the Uber business model, current transport via bike, public transport or on foot, have a company car for work, need a van for work and the flexibility/suitability of app-

based ridesharing to meet transport needs (eg for disabled passengers, children, carrying work tools). 'Other' enablers included not having a car, if there was a professional New Zealand-based service with a more ethical business model, and no need for this type of service.

Table 3.20 The barriers and enabler for using app-based ride hailing services over the next 12 months

Rank	Barriers	n	Enablers	n
1	I own a car	372	If these services were cheaper than other options	249
2	Service not available	227	If these services were available	228
3	I don't know how to access/use these services	201	Learning how to use/access these services	194
4	These services are more expensive than other transport options	137	Seeing other people use these services	171
5	I wouldn't feel safe	124	Finding out more about the safety	150
6	These services don't meet my needs (eg car seats)	123	If these services could meet my needs (eg car seats)	87
7	Other	88	Having a smartphone	75
8	I don't own a smartphone	74	Other	59

The barriers and enablers for using carsharing/carpooling are shown in table 3.21. Car ownership was the most commonly selected barrier, followed by not being aware of carsharing services and losing convenience. The most frequently selected enablers were the service being available, ensuring everyone paid fairly and knowing how to find others to carshare with. The 'Other' barriers included availability of good public transport, preferred to walk or bike, and the service did not fit transport needs (due to medical conditions, family commitments etc). Other enablers included availability in rural communities, the need to have regular work hours for carsharing/pooling to be feasible, and lack of time to plan trips so far in advance.

Table 3.21 The barriers and enablers for using carsharing/carpooling over the next 12 months

Rank	Barriers	n	Enablers	n
1	I own a car	309	If these services were available in my area	211
2	I'm unaware of carsharing options in my area	229	Ensuring everyone pays fairly for how much they use the vehicle	166
3	Losing convenience	207	Knowing how to find other people who want to carshare	165
4	Losing freedom	164	Ensuring insurance was covered in the event of an accident	156
5	Reduced ability to get somewhere in an emergency	131	Making it part of the community infrastructure	151
6	Negotiating terms of use with others using the vehicle	127	Having an accessible booking system in place	124
7	I don't know how to access/use these options	105	Having a firm agreement about use	121
8	Insurance concerns	64	Having access to online carsharing groups	98
9	I wouldn't feel safe	54	Finding out more about the safety	96
10	Other	54	Having access to a variety of car types for different purposes	94
11	-		Other	54

Barriers and enablers for car clubs are shown in table 3.22. As with the two other transport sharing options, car ownership was the most commonly identified barrier, followed by not knowing about car clubs in the area and losing convenience. The enablers were the service being available, low cost and knowing how to access and use the service. Other identified barriers included simply not being interested, current use of public transport, not being able to drive, doesn't meet current transport needs. The 'Other' enablers identified by participants were mainly barriers and reflected issues already raised, including the suitability of cars for people with health/disability issues.

Table 3.22 The barriers and enablers for using car clubs over the next 12 months

Rank	Barriers	n	Enablers	n
1	I own a car	389	Having the service available in my area	422
2	I'm not aware of car clubs in my area	361	If car club fees were less than car ownership costs	301
3	Losing convenience	225	Learning how to use/access these services	297
4	I don't know how to access/use these options	207	Having an accessible booking system	247
5	Losing freedom	167	Ensuring insurance was covered in the event of an accident	227
6	Reduced ability to get somewhere in an emergency	161	Access to a variety of car types for different purposes	165
7	Insurance concerns	108	Other	79
8	These services are more expensive than other transport options	65	–	
9	Types of vehicles available don't suit my needs	47	–	
10	Other	38	–	

3.5 Summary

Over 80% of the respondents had heard of app-based ride hailing, with fewer having heard of ridesharing/carpooling (76%) and carsharing (64%). The terminology used to describe the new transport sharing option appears to make a difference with only 20% of respondents to the MoT survey having heard of 'car clubs' even though the definition/description was the same as 'carsharing' in our survey. Interestingly the older respondents (>65 years) were least likely to have heard of app-based ride hailing whereas the youngest respondents were least aware of ridesharing and carsharing. Respondents' knowledge about the new transport options was greatest for app-based ride hailing and least for carsharing, but a significant proportion (40%) reported that they knew 'nothing' or 'very little' about app-based ride hailing; this figure was even higher for carsharing, 61% of the sample. Knowledge about app-based ride hailing decreased with age, whereas the middle age groups (25 to 44 years and 45 to 64 years) knew the most about ridesharing and carsharing.

Of these new transport options, a third of respondents had used app-based ride hailing, a quarter had used ridesharing /carpooling (18% in MoT survey) and a fifth had used carsharing (1.1% had used car clubs). Urban residents were more likely to use app-based ride hailing than rural dwellers, while use of ride- and carsharing was greatest by those aged 25 to 44 years, and those who usually travelled as passengers rather than drivers.

The regression analyses did not predict a large amount of the variance in the data (maximum of 20%), which indicates factors other than those measured here are also important in predicting use of these transport sharing options. For app-based ride hailing the 16 to 24 year olds were eight times more likely than the oldest aged group (> 65 years) to have used this service in the previous 12 months, while those aged 25 to 44 years were 7.4 times as likely to have used it. In addition, those living in an urban area were 2.5 times more likely than those living in a rural area to have used app-based ride hailing in the last 12 months. For ridesharing, younger males (16 to 24 years and 25 to 44 years) were approximately four times more likely to have used the service in the last 12 months compared with older males. Interestingly in the oldest age group (65 years and over), women were three times more likely to have used the service than men. The 25 to 44 year olds were 1.9 times as likely to use carsharing compared with those aged 65 years and over. More specifically males in the two youngest age groups were over four times as likely to have used carsharing in the previous year compared with the other groups.

One of the most obvious factors influencing use is availability. App-based ride hailing was available to 40% to 50% of the respondents, ridesharing to 23% to 33% and carsharing to between 4% and 25%. Older people and those who are usually drivers rather than passengers were less aware of the availability of these services, particularly for ride- and carsharing. In terms of future use, 50% to 70% were not intending to use any of the services in the future, with older respondents less likely to report future use. Intended use was highest for app-based ride hailing with those aged 25 to 44 years most likely to continue use at the current level or to increase use for transport options. Knowledge about the service also influenced intended use, with a greater proportion of those who were knowledgeable about the service intending to use it in the future. It should be noted, however, that even by those who knew about the service, intended use was low, particularly for car clubs (7.4%).

Those who did not use the services were asked to report barriers and enablers for transport options. Car ownership was the most commonly identified barrier for all services. Lack of availability was the next most frequently endorsed barrier for app-based ride hailing and carsharing. Other common barriers for app-based ride hailing included safety, cost and not being sure how to use the service. For ridesharing, the second barrier was not wanting to share with strangers, followed not knowing about it or not being sure how to use it. For carsharing, respondents reported inconvenience and loss of freedom, as well as lack of knowledge as major barriers to use. Availability and price were two of the most commonly identified enablers for all services, as well as a convenient booking system and knowing how to use the service. When users were asked to rate the reasons why they used each of the services, the three most commonly selected reasons were convenience, availability and price.

When respondents were asked their views on using a shared taxi, approximately 50% of respondents would not consider using one. Information about the cost of private vehicle ownership and use resulted in some respondents changing their mind about using a shared taxi, particularly females in the 25 to 44 year aged group. Interestingly, respondents were willing to consider using a shared taxi even with relatively small time savings (less than five minutes), cost savings of $6 to $10, and pick up/drop off points within five minutes of home and their final destination (this is a little longer than their current parking to destination times in a private car).

In terms of the journey, the largest proportion of respondents were willing to share with three passengers on average but older people were happy to share with more. Respondents indicated they would be most likely to use a shared taxi for one-off trips, as well as daily and routine trips to work. Even though approximately half the respondents would not consider using a shared taxi, if they were available, the survey responses suggest that it would lead to a 20% reduction in car ownership; however, those in single car households were unlikely to sell their only car. The most frequently identified barriers to using a shared taxi were time, convenience and cost (cost was the most commonly endorsed enabler);

respondents reported that it would need to be cheaper and more convenient than using their own car. Loss of freedom was also an important barrier in addition to concerns about the suitability of a shared taxi for children and those with mobility issues.

4 Shared mobility group interviews

A series of group interviews (12) were undertaken at various locations across New Zealand to explore in more detail New Zealanders' attitudes to shared mobility.

4.1 Method

4.1.1 Participants

A total of 58 participants took part in 12 group discussions held in various locations in New Zealand (Hamilton, Christchurch, Auckland, Nelson, Pokeno and Cambridge). There were 40 female (69%) and 18 male participants with an average age of 52.5 years, SD=17.54, range=18–83 years. Fifteen participants identified as New Zealand European, four as Māori, and 38 as 'other' ethnicities (including European, Middle Eastern, Indian and Chinese). The majority of participants held a current driver licence (n=50) and had been licensed drivers for an average of 26.35 years. Seventeen participants (29.3%) reported having a long-term disability lasting more than six months.

With regard to current transport options, 52 (90%) participants reported that they or their family owned a car. During the week, the most common form of transport was a car (n=32, 55%), four (6.9%) participants reported using the bus, three walked (5.3%), three used taxis and one cycled. The remaining participants used multiple forms of transport. On the weekend the car was the main form of transport for 35 participants (60%), two used the bus, three walked, one used taxis, another cycled and another used a motorbike. The others used multiple transport options (including train, Uber, family car).

4.1.2 Structured discussion

The groups were first led through a structured discussion focusing on each shared mobility option in turn prompted by the following questions/topics: i) What is the range of current experiences with car/ridesharing and attitudes towards ownership? ii) What are the enablers or incentives that lead them to use the service/carpool? iii) What are the specific advantages and disadvantages of each transport sharing option? iv) How could the experience of the shared transport be improved? And v) Would new technologies encourage them to use it/or use it more (beyond their current use)?

Next, a series of scenarios to examine transport-related decision making were described and the groups led through a discussion of what would make the transport sharing option work for them. For ridesharing/carpooling the groups were asked to think about getting to their workplace or equivalent, travelling into the CBD for a large one-off event such as a rugby match, and older parents/adults needing to travel to do their shopping. The app-based ride hailing scenarios focused on getting to/from a restaurant for an evening meal, travelling to the airport to catch a plane, or to provide transport for a relative or child who cannot drive themselves. For carsharing, participants were asked to think about car ownership (particularly purchasing their first or a second car) and travelling to another New Zealand city.

4.1.3 Method

Advertisements about the study were distributed via email to business and community groups in six New Zealand towns/cities (Hamilton, Auckland, Christchurch, Nelson, Pokeno and Cambridge). The locations were chosen to provide a mix of urban and rural locations and to encourage participation from a diverse population. The advertisement explained that we wanted to understand peoples' opinions and experience with shared mobility services (like YourDrive, Uber and CityHop) and ask people what they think about the future of mobility services. Those interested in participating were sent an information sheet about the

study, asked to contact the research team with any questions and were provided with details about the date, time and venue for sessions in their area.

Each session was conducted in the same way; once all participants had arrived, the facilitator went through the information sheet and the purpose of the study, answered any questions the participants had, carried out introductions and obtained written consent from each person. After this, the facilitator provided the group with an overview of the format of the session, and verbal definitions of ridesharing/carpooling, app-based ride hailing and carsharing. The video/audio recorder was started and the participants were taken through the structured discussion as described in section 4.1.2. At the end of the discussion (60–90 minutes), participants were thanked for taking part, given a $30 voucher and reminded to contact the research team if they had any questions or feedback.

4.1.4 Analysis

The group discussions were transcribed verbatim from the video/audio recordings with contributions from each participant identified using a unique study ID number. The responses were then collated across all focus groups to address the questions posed during the structured discussion and to extract information about social impact. As the group discussions were undertaken to provide a more detailed and nuanced understanding of the findings from the surveys, a full thematic content analysis was not conducted. Instead, key themes that related to the overall research questions, and the findings from the questionnaires were identified and summarised.

4.2 Results

4.2.1 Current experiences with car/ridesharing and attitudes towards car ownership.

The majority of participants reported they had experienced car/ridesharing with family, friends, neighbours and colleagues, for various types of trips including one-off recreation trips, regular social or leisure activities, or work:

> *...Recreational, I would pick up a friend and drive somewhere. Mostly in the summer to go to the beach* (FG2.4[3]).

There was a general consensus that sharing with people you know was preferable to sharing with strangers for a number of different reasons including the practicalities of arranging a shared trip (particularly for those with disabilities), having to talk to strangers and safety more generally

> *Inviting a stranger into my personal space….like even if it's just a 10 minute drive that's still like you have to make awkward conversation… or like, what if they are a complete psychopath you just don't know'* (FG2.2).

Others noted that while carsharing and ridesharing/carpooling were a good idea, differing work hours, timing trips to avoid heavy traffic and additional flexibility required for those with other responsibilities (eg child care) meant shared transport was not a feasible option for many

> *I think we need to recognise the changing work force, like not the 9 to 5, but like you might be a shift worker, and we get on the highway at 5 in the morning to beat the traffic, and not*

[3] These numbers are the unique ID given to each participant.

> *everyone wants to carpool at 5 in the morning. And also coming back as well, you don't want to be there at 4:30 or 5:30, it will take you two hours* (FG 3.5).

Some participants, particularly those who cannot drive, or do not drive frequently, discussed the social side of carpooling and ridesharing. In this context their relationship with other passengers as well as the driver was important. In some cases this extended beyond the actual trip, to checking if passengers who failed to turn up for the shared taxi were actually ok, and enjoying the encouragement and support of others

> *The taxi I share has the same people in it, coming there, it's great because you become like a team. You know if somebody is not there yet, ten minutes later, what's wrong with her, you know* (FG4.3).

> *It's not just the transport, it's the socialising that goes on within the group, and if you do it two or three times or more… you get to know different people* (FG9.1).

The driver was also key to the positive experiences of those using taxis, app-based ride hailing services, and shared transport in terms of good conversation and more general support:

> *The Uber drivers are really cool. I've met a few now. And they're really chatty…* (FG6.3).

> *I can't speak highly enough of the taxi drivers I've been using…They become friendly.. one particular driver has given me his card. He gets so excited when he sees me improving… Complete strangers can make a big difference* (FG4.8).

Others, particularly the older participants or those with a disability highlighted some of the issues with using shared transport options, particularly getting between their home and the car, and to their final destination at the end of the trip.

> *We have to use taxis or Driving Miss Daisy but I have trouble with the call centres especially those with out of town offices who are not familiar with the local area, so I have this arrangement with the taxi driver who has given me really good service and I text him directly* (FG11.5).

> *…it's a little bit like airport shuttles so you catch your transport to where you are going but then you have to get from there into the counter and that is where there is no assistance but if you have a good taxi/shuttle/Uber driver they might take you in* (FG11.2).

With regard to car ownership, participants acknowledged that ridesharing/carpooling and carsharing was a good thing and may decrease car ownership. One participant explained that they have reduced the number of cars in their household and now carshare.

> *In our household, we dropped our cars, we have just bought an electric car, and then me and my husband we carshare so that's one car off the road* (FG3.6).

However the majority of participants did not think the new transport sharing technologies would lead to decreased car ownership due to people liking their independence, the increased time required to use transport sharing options and the attachment people have to their cars:

> *Independency, people just want to do their own thing* (FG 5.3).

> *We're addicted to our cars, we also don't have public transport that works…. It would take 57 minutes and I can drive in 17. So why would I? And it would cost so much money... and anyway I don't care because comfort and ease is the top priority. If I was old and retired and*

> *just making trips like that, I probably wouldn't mind, not worried too much about time, but when you're young and busy, it's just like no way spending two hours commuting* (FG6.3).

A number of participants discussed the importance of cars to New Zealanders and saw this as one of the biggest barriers to reducing car ownership:

> *We're New Zealanders, we always have to have a car and I think it would be hard to change New Zealand psyche away from owning cars* (FG 12.2).

> *Car ownership is part of our culture. I feel it myself. Every time I contemplate selling my car so I would have more travel funds, for instance, you know it's something very dear to my heart, but oh giving up my car, I don't, I can't, it's hard to contemplate* (FG12.1).

4.2.2 Enablers and incentives

Discussions around enablers and incentives focused predominantly on Uber. Several participants reported they first used Uber with friends (and some continued to do so):

> *…my friend, he guided me how to use it, at first I travelled with him and after that I started to use it on my own* (FG1.2)

Whereas others reported that their first experience with Uber was overseas where it was cheap and got over any language barriers:

> *You don't even have to talk to the person, it's all there, and you know, my foreign language skills are zero, so but yeah, I can (motions tapping onto a phone), sweet, and go* (FG3.4).

Participants reported that the app made booking easy, provided a definite price and they knew exactly when their ride would arrive.

> *One of the things with cabs, like compared to the Uber, with Uber you book them and on your phone you can see where the car is* (FG4.2).

Participants also commented that Uber was a cost-effective way to travel:

> *I Uber-ed in and it was so cheap. I was like wow, I'm going to do that again. Because taxis are notoriously expensive* (FG6.3).

Uber was also perceived as being quicker than taxis, particularly at peak times, even though the cost may be higher than the same journey at a different time of day:

> *...and quicker than taxis; you know when people are available rather than at peak times with a taxi you could be waiting a really long time* (FG8.1).

Feedback from friends and the fact that cars could be tracked via the app contributed to participants' perception that Uber was a safe transport option

> *the first time I used it alone on my own I wasn't worried about it because I'd heard enough and it's all GPS tracked so it wasn't such an issue for me* (FG8.1).

Participants also mentioned that they would use Uber, ridesharing or carsharing as it was easier and cheaper (in terms of petrol and parking) than taking their own car. In addition these transport options often took them closer to their destination

> *Parking in Auckland is horrendous and sometimes trying to actually find a park and then it's, like you said, very expensive, you're paying $40 to $60 a day, and it's like, so, if you can actually join with other people, like going to concerts or going someplace like that* (FG4.6).

Participants also commented that as well as saving money, ridesharing had a social element that made even quite mundane trips, such as supermarket shopping, more fun.

4.2.3 The advantages and disadvantages of each transport sharing option

Reduced cost was the main advantage of most of the transport sharing options (ridesharing, public transport, Uber and carsharing). Other advantages were more specific to the mode of travel. As well as discussing new transport sharing options, participants also discussed public transport, possibly one of the first forms of ridesharing. The advantages included not having to worry about parking, the high degree of regulation, and safety, in part due to the large number of other users. Interestingly though trips on public transport were not viewed as sociable (unlike ridesharing), and participants reported that they liked the anonymity and not feeling the need to talk to other passengers (because there were so many):

> *I prefer public transport, which is kind of a ridesharing thing. You don't need to worry about parking, and there is no forced social interaction* (FG1.4).

Ridesharing was viewed as a good way to travel to events with friends, particularly when there were no suitable bus routes, and people can be collected en route. The social side of ridesharing was one of the most commonly reported advantages, as well as getting to know other regular passengers. As well as ridesharing being cheaper (as noted above), participants also reported that ridesharing reduced the number of cars on the ground and was better for the environment.

Uber was the focus of a great deal of discussion during each of the group interviews. As noted in the previous section, the majority of participants liked the app-based booking system

> *Replacing taxi service because of the app. It's just all in one place, you book it, you pay for it, you can see your driver, you know what is coming* (FG1.6).

The app also provides information about the fare (unlike a taxi), tracked the car, and provided information and feedback about the driver:

> *I like the idea that you know how much you are paying before you finish, 'cause taxis and stuff sometimes you will end up pay ridiculous amounts.* (FG2.3).

Participants also liked that they could use the same Uber app overseas and no cash was needed. The map-based tracking system meant that passengers knew when cars/drivers were available, and if booking for someone else you could see that they arrived home safely. Uber was generally thought to be quicker (in terms of pick up time) than a taxi:

> *One of the things with cabs, like compared to the Uber, with Uber you book them and on your phone you can see where the car is* (FG4.2).

Two participants with a disability reported that 'Assist Uber' cars, equipped with a hoist, are becoming available for those with mobility difficulties.

The most commonly reported advantage of taxi services was the screening and training of drivers. Specifically, drivers had been screened by the police, received training, held a licence to carry passengers, and had security cameras in their vehicles:

> *With taxis we had to go a long process, it was a long process where I was screened, get taxi license, the taxi whenever it wasn't warrant of fitness was done, it was certified, it was certificate of fitness done on it, so in terms of safety I would say that taxi was more safer than Uber* (FG1.8).

A few of the people with disabilities had taxi drivers they used regularly who were willing to provide them with appropriate help and support. Participants also mentioned that wheelchair accessible vans were available.

A number of advantages of carsharing were identified in the group discussions. These included: lower costs than owning and maintaining a car; no responsibility for maintenance or repair costs; reducing the number of cars on the road; high level of convenience due to reserved parking in the city centre; and good alternative to a rental car if transport is only needed for a few hours.

As described in the first section, the most common disadvantage for all transport sharing options was reduced flexibility, and the transport options just not fitting the needs of many people. One participant summed up the advantages of using their own car as follows:

> *Personal space, flexible, you're in control, convenient/no hassle – can have your music on, take your dog, smoke. No one in the backseat distracting you. Some people enjoy driving.* (FG2.3)

These sentiments were echoed by the majority of car owning participants, and clearly highlight the barriers that need to be overcome to encourage transport sharing.

In terms of specific disadvantages, the main issue with public transport was timing, with trains/buses being consistently late 'the buses do not come on time, and I'm in the CBD there is like none and then all of a sudden you see 5, nose to tail' (FG3.5) which led to long waiting times. Given this, journeys that required several buses often took longer than planned due to missed connections. This was further exacerbated by timetables, for example, buses that only run every hour. Using public transport at peak times was often challenging due to the large numbers of passengers trying to use the service. Participants also reported that bus stops may be a long distance from home or work.

The disadvantages of ridesharing were generally very practical issues for example, trying to make the journey fit with everyone's schedule, what to do if people were late, and the possibility of disagreements with the driver:

> *we have to be some place in 10 minutes and we believe they are going to come but if they don't turn up, we will be affected* (FG1.2).

There was also concern about some people wanting to make extra stops on the journey (eg at the supermarket) whereas others did not.

> *So if I'm carpooling, you'll have to be happy for me to drag you around to the shops, on my way home, then that's fine* (FG3.1).

Finally, participants reported that by ridesharing they may feel like they were inconveniencing others, they would be giving up their freedom and it would not always be practicable.

Concerns about Uber focused on the relative lack of regulation compared with taxis, and wider issues with the Uber business model, specifically drivers' earnings. In terms of regulatory issues, participants were worried about safety, and were unsure about the extent of training drivers received and whether they had background checks:

> *…so in terms of safety I would say that taxi was more safer than Uber. Because Uber just has people with private licence and then they can start driving* (FG1.8).

Others reported that the driver in the car was not always the person listed on the app.

> *You wouldn't know on that day if it was the police-vetted Uber driver driving you or his mate* (FG1.7).

For those who used Uber (or wanted to), availability was one of the biggest barriers to use, due to insufficient cars to meet demand or the service not being offered in some areas. The general consensus was that Uber worked well in city centres but less so in the outskirts of the city and rural areas. Some participants wanted more information about Uber policies, for example, whether car seats were available, and if they would transport assistance dogs. For others practical issues prevented them from using Uber, for example not being able to get a GST receipt to claim travel from work, and that they did not accept Total Mobility vouchers as payment (due to their online payment). Finally, a significant proportion of participants (the older participants and those with a disability) did not like the app-based booking system, as only those with a smartphone were able to book a car, and some were concerned about having to provide banking information.

> *I was looking at Uber and I looked up on google and of course you can't find it on there and someone said 'oh you have got to have an app on your phone' - well there is another app. - it annoys me because I like to talk to a person* (FG7.1).

> *My granddaughter has and I think it's probably more for their age group. A lot of us wouldn't be bothered to use our phone and open our phone up to credit card or whatever to do this* (FG9.4).

The main disadvantages of taxis were cost, reliability and availability. Participants reported drivers taking longer routes to charge more and hidden costs, (eg fees per passenger and additional charges to pay by card). Almost all participants commented that taxis were often late or failed to turn up, even when booked; wheelchair users faced additional barriers as there were a small number of mobility vans. In addition several wheelchair users had experienced taxi drivers were not always reliable. There were only a few mobility vans available for people in wheelchairs and this could cause issues when they were all booked. In addition, several people who use wheelchairs or mobility aids reported taxi drivers refusing to take them (or pulling over, seeing them and driving off) because of their wheelchair.

Location of the collection and drop off sites were the most commonly cited barriers to carsharing; it needed to be within walking distance to be convenient, and cars needed to be available when needed. Other participants were concerned about the type of car that would be available, cleanliness of the car, any damages that might occur, who would be liable and how liability would be determined. The lack of availability of cars was identified as one reason why some participants were unwilling to sell their current car. In contrast, others had never heard of carsharing and suggested there needed to be more advertising to ensure people knew about the service.

4.2.4 Improving the experience of transport sharing and the use of new technologies

The responses to the last two question are presented together due to the high degree of overlap. The discussion could be summarised into six key areas: information; booking and payment systems; cost; safety; practicalities; and older/disabled users.

In terms of information, participants wanted better regulation and greater transparency with regard to how each service worked, for example, the vetting process for drivers, insurance information, crash liability and more details of the services provided (eg car seats for children wheelchair accessibility). Participants also suggested the new transport options needed to be advertised more widely via a variety of channels including television, social media and YouTube to increase use. Most of the current users knew about these services as a result of word of mouth rather than from formal advertising. One person suggested a

NZ Transport Agency advertisement showing the cost of the same journey (incorporating time, emissions, parking etc) for each service would allow the public to make an informed choice about the best transport mode for them. Use of electric/low emission vehicles across the services might also increase use (and benefit the environment). Targeted advertising of services that are age- and disability friendly was also needed to provide potential users with sufficient information to feel confident using the service, which would in turn increase use.

With regard to booking and payment systems, the groups had diverse views. Some participants thought the smartphone/app-based booking systems should be extended to every type of service; they thought they were easy and efficient to use and the app/link to booking the service should be integrated into commonly used websites. They also suggested a carpooling system (website/app) that allowed you to book online, offer seats in your car, or put up indicative travel times of when you needed a ride would be very useful, particularly if it was integrated with a map based function to show people's locations. In contrast, other participants wanted a range of ways to access and book services such as Uber including via a website and phone. Both options would allow the services to provide potential users with more information and might help make the booking system accessible for users with a disability. A number of participants indicated they would like workshops or education sessions in the community to show them how to use and book these new services. Other suggested improvements included being able to make advance or regular bookings (in relation to Uber specifically), discounts for regular/long-term users and for Uber to allow payment with Total Mobility vouchers (to note: Uber conducted a trial providing a discount to mobility card holders in 2017, but more information about the outcome of the trial is not yet available: https://www.uber.com/en-NZ/blog/auckland/uber-mobility-trial/).

Several suggestions were made for improving passengers' feelings of safety when using shared transport (particularly Uber). First, participants suggested Uber cars should have cameras (like taxis) for the benefit of drivers and passengers. In terms of safety and trust generally, participants suggested the Uber app could be equipped with filters so passengers could request a particular type of driver (eg female). This would make users more comfortable booking a ride for an unaccompanied child or relative. (Note: a New Zealand company DriveHer has been launched – it is similar to Uber, in that users hail a car using an app but its drivers and passengers are all women www.stuff.co.nz/auckland/106242991/womenonly-ride-sharing-coming-to-nz-with-launch-of-driveher-app).

Focusing on the practical factors to improve uptake of these new transport services, the notion of an integrated transport system was mentioned in all group discussions. Essentially, systems needed to work together to make it feasible for people to be car-free. Participants saw the potential in these transport sharing options as an effective way to carry out the first and last legs of their journeys, but at the moment this is often not feasible (due to lack of parking at bus/train depots for example).

Finally, a lot more attention needs to be given to making the transport system as a whole work more effectively for those with disabilities. Each step in arranging a trip is more complicated. First the booking system needs to be universally accessible (eg apps on a phone are unsuitable for people with visual impairment), the vehicle needs to meet their needs (eg large enough to carry a wheelchair), assistance needs to be provided to transfer from home to the car and from the car to their destination, and the person needs to feel comfortable and trust the driver providing the service. Participants with disabilities noted that most of the cars currently available for carsharing would not meet their needs, as they were too small to take a wheelchair or other mobility aids, and there were no cars available with hand controls to replace the brake and accelerator pedals.

4.2.5 Social impact

Automated vehicles, shared mobility and MaaS options of course have significant potential consequences for the quality of peoples' lives. To assess the social impact of these transport options, it is necessary to have a good understanding of how the options would be introduced and used. As can be seen in the results of our surveys, however, the quality of New Zealanders' knowledge about these options is highly variable (and often incorrect). Further, as we will demonstrate a little later, the implementation timeline for these transport options is also difficult to forecast for New Zealand. This makes conducting a good social impact analysis for New Zealand problematic; the economic, environmental and cultural effects of the technologies cannot be adequately forecast in the absence of better public knowledge of them. Although these difficulties (due to lack of knowledge) were also present for our group interviews, we were able to identify some important attitudes towards the possible impacts of MaaS, ridesharing and other transport technologies in the context of the group discussions. For example, our group participants could see the benefits of app-based ride hailing, particularly if they no longer held a driving licence. While taxis were viewed as a viable transport option, they were perceived as being more expensive than app-based ride hailing (ie Uber) with both providing essentially the same door-to-door service (unlike public transport). Many of our participants had no experience of using app-based ride hailing, either because it was not available in their area, or because they did not have a smart phone, but they were open to using it based on others' (positive) experiences. The majority of participants felt that app-based ride hailing would not encourage new or different journeys, it simply provided another option for existing trips

> *the alternative was a bus ride, but it was late at night, getting dropped off, it was a long walk from the bus* (FG1.4).

Concerns were raised about the environmental impacts of app-based ride hailing schemes. It was felt that these options might actually increase the amount of traffic on the road as they are used instead of taking a taxi or a bus:

> *Environmentally, I think it's a terrible idea. And traffic wise as well, there would be just so much more on the road. You can have so many people on one bus.* (FG1.4).

When describing a recent trip to Auckland, one participant noted:

> *it is gridlocked with Ubers circling. Just constant, nearly every car is an Uber. And that's really busy already, so…* (FG6.3).

Distinct from these app-based schemes, the group interviews revealed that ridesharing is something already commonplace, with all our focus group participants having some experience of it. Single car households reported the most ridesharing for trips, and also the greatest range of shared trip types, including commuting to work, shopping and recreation. Other participants reported ridesharing for 'special' trips (eg holidays and recreational trips), explaining that they rideshare because

> *it's cost sharing as well as when we are in the same car it will be quite fun* (FG1.2).

For younger participants, ridesharing was not formally planned, instead it was automatic with friends/flatmates assuming they would all travel in the same car, rather than taking several cars to the same location or having to travel by bus. In addition, for recreational or longer trips (eg from Hamilton to Auckland), participants reported they would invite friends to ensure the car was full, even if they were travelling for different purposes.

For older participants, regular ridesharing with the same group of people was also relatively common, particularly to go to weekly or monthly events such as choir practice or church. For example, one participant described her ridesharing experiences as follows:

> *Yeah, I often rideshare with friends and stuff. We organise like, we have a women's group, so we know that we will meet to somewhere and start to carpool to get to the destination, even if it's not very far.* (FG10.1).

For these trips ridesharing was usually arranged via a signup sheet on a clipboard, meaning it was accessible to those without a smartphone or internet access. A common theme throughout the discussions was that ridesharing was not just to save costs, it was also about the social connections; in particular sharing with people you knew made the trips more fun and enjoyable.

Participants living outside major urban areas were acutely aware of transport-related costs and the lack of current transport options. One person planned to sell their car when they moved into town to decrease costs:

> *When I shift into town I'll definitely be getting rid of the car* (FG9.1)

as they would be able to walk instead. The lack of experience with the new transport sharing options, particularly carsharing, meant many people were sceptical about how useful these services would be. Concerns were raised about how the service worked, who was responsible for damage, insurance and security:

> *For me, car sharing is the same to rental cars, as Ubers are to taxis. It's similar competition. You will pay less but you get less security* (FG1.1).

Participants also had concerns about having to drive a different car:

> *Well, the elderly get used to their own car, don't they? But hop and jump into a speedy car or a slow car… I wouldn't like it".* (FG9.4).

One participant simply said:

> *I can't see how that's going to work.* (FG9.2).

Despite their reservations, participants acknowledged that carsharing would be useful for some people (eg young people living in the city) and for some types of trips (eg to the airport) but largely agreed that it was not for them.

Public transport was mentioned frequently during the group interviews. Many of the participants viewed using public transport as ridesharing and suggested they would use it more frequently if it was more accessible (bus stops closer to home, and buses that were easier to get onto). Those who already used public transport were concerned about the impact of the new transport options on this service, with the possibility that a wider range of transport options would mean the public transport currently on offer would no longer be economically viable.

In addition (and as mentioned in earlier sections of this report), the group interviews highlighted how technological literacy and residential location influence the potential social impact of the new transport options. For people living in smaller towns with limited public transport, and in some cases without a taxi service, it is almost impossible for them to imagine using (or ever needing to use) these new services. In addition, the technology required to access these services is currently beyond many people. To fully realise the benefits of the new transport technologies this is something that needs to be addressed to avoid creating further disparities between rural and urban dwellers. This sentiment is possibly best summed up by one of the participants:

...I would say there are a lot of isolated people in the community that people don't know about. They are so hidden away. If they could be considered in all of this, that would be wonderful.

4.3 Summary

Generally the discussion in the group interviews reflected the findings from the surveys. For the transport sharing options to be a feasible alternative to using a private car the service needed to be comfortable, convenient, cost-effective, flexible and meet the needs of the traveller. It was also noted that app-based booking meant language was less of a barrier to using shared transport, a factor that is of particular relevance in New Zealand with a large immigrant population and high numbers of tourists. One of the greatest motivators for using shared transport was not needing to worry about parking (particularly for those living in or travelling to the city). In terms of barriers, lack of availability and not knowing about the service or how to use them were key issues. To increase use, the services needed advertising more widely and alternative internet or telephone booking systems needed to be provided for those without a smartphone or who were less technologically skilled.

In terms of accessibility of shared transport, participants reported that not all people had access to the same transport choices, even when those choices existed 'on paper' in a community. For example, some participants could not drive themselves; some could not walk far and were therefore more likely to require door-to-door services; and some required wheelchair-accessible vehicles, which limited the viability of app-based services such as Uber. Further, many of these participants also reported that accessible services (such as companion taxis, for example 'Driving Miss Daisy') were generally more expensive and required advance booking, making them less convenient than alternatives. Several participants with specific access needs expressed hope that technology might result in more accessible transport choices in future. Many participants stated that if they could not find suitable transport choices, they would make fewer trips, and that the trips they did make came at significant financial cost.

There were specific barriers for people with disabilities; many blind people cannot use apps (that is, apps themselves are not universally accessible). In contrast, people who are deaf rely on texting and apps to arrange travel. However, people with disabilities all stated they felt particularly vulnerable requesting shared transport with strangers, because they were less likely than other people to have a 'back-up plan' if that transport did not work out.

5 Adoption timeline for automated vehicles and MaaS

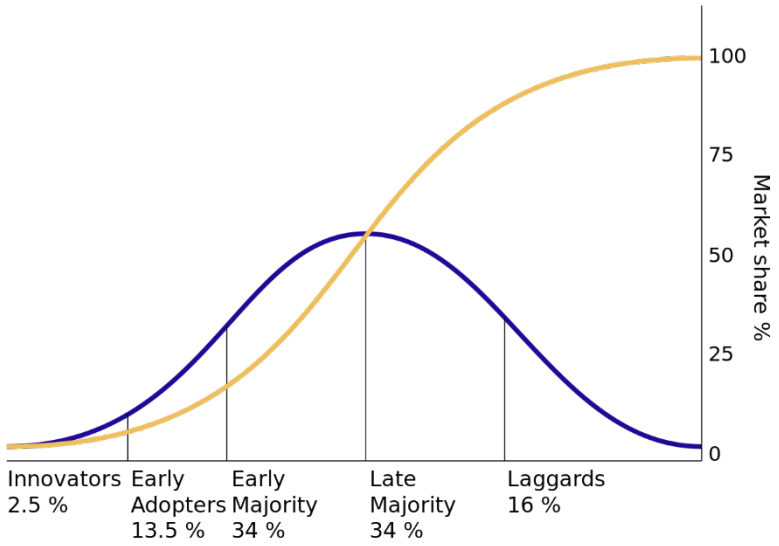
The final objective of the research was to identify the likely adoption timeline and social impact of these novel transport technologies. To address this, we reviewed existing projections of likely adoption scenarios and their applicability in the New Zealand context was assessed and is described below.

5.1 Existing adoption and technology diffusion models

The ways in which innovative products and services are adopted by the general public have been studied by consumer psychologists and behavioural economists for over 60 years. Diffusion models are frequently used by marketing firms, advertisers and policy makers to estimate the rate of adoption. The most influential model of this process was Rogers' (1962) diffusion model. The model identified five groups of consumers that are differentiated by the timing of their adoption of new ideas and products. Underlying this model was the assumption that the categories of adopters and their rate of adoption was normally distributed as shown by the blue line in figure 5.1. (Note: adoption refers to specific individuals, diffusion refers to the population or social network level).

The rate of diffusion, or adoption, is typically depicted as an ogive or s-shaped curve that results from plotting the hypothesised normal distribution of adopters as a cumulative frequency (the yellow line in figure 5.1).The characteristic shape of these curves is a consequence of the shape underlying distribution. With a bimodal, exponential, or other non-normal distribution, the cumulative frequency plot of diffusion rate would look quite different.

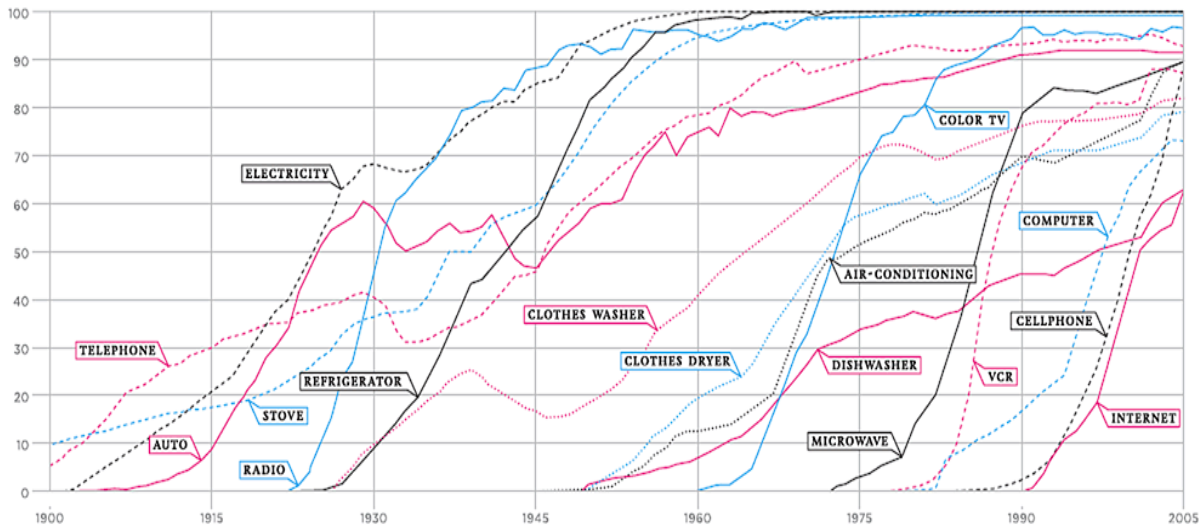
Figure 5.1 Categories of adopters and time frame for adoption (blue line) and the cumulative rate of adoption (yellow line). Adapted from Rogers (2003)



Examining the diffusion curves across a range of products and technologies over the past 100 years (in the US), the range of diffusion rates is extremely large, and one can question whether the s-curve accurately describes the diffusion of many of these common technological innovations(see figure 5.2) (Cox and Alms 2008). The authors of this work suggest that more fundamental economic principles such

as the distribution of wealth, or general economic prosperity may drive diffusion rates for many products and services at a more fundamental level.

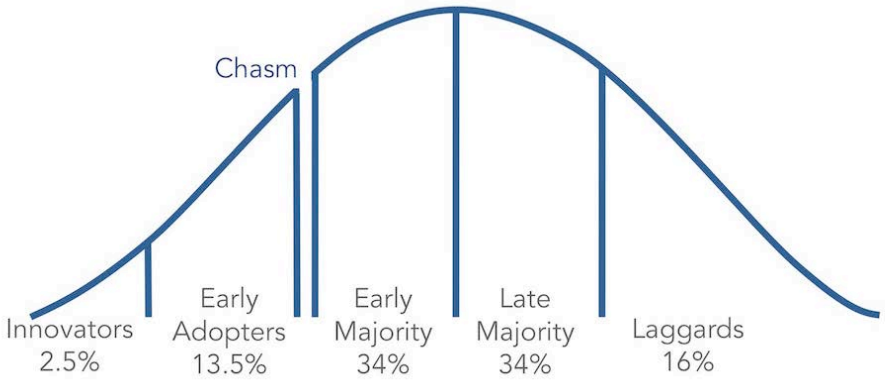
Figure 5.2 The rate of diffusion for a range of products and technologies in the US (Cox and Alms 2008)



The time course or rate of diffusion can be estimated, often based on fitting early adoption data to the s-shaped curve. The Bass diffusion model (Bass 2004) is one of the more widespread estimation functions and its calculation of the rate of adoption relies heavily on two key parameters: p, the coefficient of innovation; and q, the coefficient of imitation. Bass and his colleagues (Mahajan et al 1995) identified typical values of p and q as 0.03, and 0.01 respectively. As Bass models have been applied to real data from the transport sector, the estimates of these parameters have been widely variable, ranging from 0.01 to 0.0000365 for p, and 1.45 to 0.0905 for q (Wolken et al 2018).

One issue affecting the timeline of adoption has been called the adoption curve chasm (Moore 1991). As shown in figure 5.3, there is often a noticeable lag, or chasm between the time when a technology or product has become saturated (fully taken up) for early adopters and the time when the early majority begins to take up the new technology. Rogers himself noted the criticality of this stage and identified examples of failed diffusion where innovations were not adopted throughout the entire social network or population because of competing ideas or attitudes (Rogers 1962). When new technologies or ideas do not bridge the chasm and begin to be adopted by early majority demographic, the diffusion fails to become self-sustaining. This can be because of lack of availability of the technology, or characteristics of the early majority that were not present in the early adopter demographic. [Note: the diffusion chasm has also been suggested as one of the reasons for the ‘trough phase’ of the ‘Gartner hype cycle’ another diffusion curve depiction based on the effects of over-zealous marketing (Linden and Fenn 2003) originally associated with the release of new media applications or platforms.]

Figure 5.3 The adoption curve chasm (Moore 1991)



5.2 Adoption of vehicle technologies

The historical record shows that diffusion of motorised vehicle technologies takes decades, and transportation innovations are among the slowest of product and service adoption timelines that have been studied. For example, the first mass-produced, affordable car (Ford's Model T) was introduced in 1908, but in the USA the midpoint of the diffusion curve was not reached until the 1960s, and market saturation was reached after 1980 (Litman 2018). The reason for this long-time course is related to some of the properties of transportation technologies that set them apart from other consumer products and services. Not the least of these properties is that transportation and mobility fills a well-entrenched economic need in most societies, it is not a luxury or new activity to most consumers. Further, motor vehicles are among the most expensive and durable items that most households possess, new purchases are relatively infrequent, and thus adoption of new innovations in vehicles often takes decades (Litman 2018). Automatic transmissions were first introduced in light vehicles in the 1930s. The diffusion of this technology took approximately 50 years to reach 90% saturation in the US, and their market share is still only 50% in Europe and Asia (Litman 2018). The slow time course of transportation technology diffusion is particularly pronounced in New Zealand where the average age of our light vehicle fleet is 14.1 years and is increasing (MoT 2017; 2018), primarily due to our heavy reliance on imported used vehicles.

In the case of new transportation technologies such as automated vehicles and MaaS, analyses of likely diffusion scenarios have been undertaken based on existing transportation technologies (Clark et al 2016; KPMG 2015; Litman 2018; ITF 2017; Wolken et al 2018). For example, in one highly cited forecast, Lavasini et al (2016) developed a Bass diffusion model to predict diffusion rates of autonomous vehicles in the US. Lavasini and his colleagues began with the assumption that autonomous vehicles would become available for adoption in the US by 2025. Basing their diffusion model on data available from the adoption rates of the internet, mobile phones, and hybrid electric vehicles, they forecast autonomous vehicles' market saturation at 83.6% by 2050. The authors note there will be many other factors affecting the diffusion of autonomous vehicles that may differ from the technologies used to develop the model. These factors include legal frameworks, personal preferences and the effectiveness of the technology.

More recently, Litman (2018) used diffusion data from the introduction of automatic transmissions, air bags, navigation systems and hybrid vehicles to estimate that adoption timelines for new vehicle technologies fall somewhere between three to five decades from introduction to penetrate 90% of

operating fleets. For autonomous vehicles in particular, and based on the assumption that autonomous vehicles became widely available commercially in the 2020s, Litman estimated autonomous vehicles would become available with minimal price premium by the 2040s and reach saturation of new light vehicle sales (defined as 'everybody who wants it has it') no sooner than the 2060s. Litman noted that this was an optimistic estimate, and accompanied his estimate with a lower bound to provide a kind of confidence interval for the forecast as shown in figure 5.4.

Figure 5.4 Estimated adoption timelines for autonomous vehicles (Litman 2018)

These forecasts differ considerably from some of the more ambitious forecasts (eg 40% market penetration by 2030, and most vehicle travel to be autonomous by 2035 (KPMG 2015) and Litman points out that in order to achieve this rate of diffusion, almost all new vehicles purchased after 2025 would need to be autonomous, and new vehicle purchase rates would need to triple (Litman 2018).

In New Zealand, Wolken et al (2018) developed a transport technology diffusion model to aid in making 'judgements about how technology diffusion will affect transport in New Zealand' (Wolken et al 2018, p7). Their diffusion model is an Excel-based calculation engine based on a Bass diffusion algorithm. To demonstrate the model, two new transport technologies were used as examples, electric vehicles and MaaS. In the case of electric vehicles two data sources were used to derive the model parameters, sales data for new light vehicles from the NZ Motor Industry Association, and vehicle registration data from the Ministry of Transport. The resulting calculations from the model indicated a fairly rapid diffusion of electric vehicles for New Zealand, with a forecast of approximately 300,000 of these vehicles in New Zealand by 2025. The authors noted they assumed a maximum market size of only 400,000 (based on government targets), whereas the current light vehicle fleet in New Zealand is nearly four million vehicles (MoT 2018). At the end of December 2018 the size of the electric vehicle fleet in New Zealand (including heavy vehicles) was 11,748 vehicles with the vast majority of them located in the Auckland (47.6%), Canterbury (13.3%) and Wellington (13.1%) regions (MoT 2019). The technology diffusion model forecasts 120,000 electric vehicles by 2021, which would require an average monthly registration rate of over 9,000 vehicles for the coming year; the monthly average for 2018 was 362 vehicles, which is less than half the number required to meet the 2021 forecast. This suggests that if adoption continues at the same rate it may take almost twice as long as predicted to reach the target. This also suggests that Litman's figures may be over-optimistic when applied to New Zealand, particularly with our heavy reliance on imported used vehicles.

The authors acknowledge that the transport technology model results in an overestimation of diffusion in the case of electric vehicles. For estimation of the diffusion rate of MaaS the data was more limited owing to difficulties implementing MaaS worldwide, and so the Baas model parameters were taken from a study of the diffusion of online shopping in Australia. The resulting diffusion rate suggested that diffusion of MaaS would take approximately 17 years to reach saturation from the date of first introduction (which the authors note could be up to 10 years away in New Zealand) (Wolken et al 2018). Similar to Lavasini et al (2016) the authors identified several factors that could affect the accuracy of the forecasts from their Bass model of transport technology diffusion in New Zealand. These factors include perceived safety, time cost, privacy (and personal space), wellbeing (desire for active transport as exercise), flexibility (choice of when and where to travel) and ownership. In the earlier portion of this report, the data collected on attitudes and public readiness to adopt autonomous vehicles and MaaS clearly align with many of these diffusion factors and we can review how they will moderate adoption rates in New Zealand.

5.3 Factors affecting adoption of transport technologies in New Zealand

5.3.1 Connected and autonomous vehicles

The survey data identified three key areas that might impact on the adoption of CAVs: these were perceived safety, time costs and flexibility. With regard to perceived safety, the respondents' answers to the surveys indicated that although improved safety was one of most widely perceived potential benefits of autonomous vehicles (55.5% of respondents), there were still many respondents with significant concerns about their safety; 35.3% in 2016 and 33.8% in 2017 said they would feel 'extremely unsafe' travelling in a self-driving car. Together, concerns about safety and trust in the technology were identified as barriers to the use of autonomous vehicles by 37.1% of respondents. In contrast, being able to spend their time in an autonomous car to do other things was the most often identified potential benefit with 47.6% of respondents identifying this as a reason they might like to use an automated car. Finally, for nearly 20% of respondents, the combination of lack of control and the enjoyment of driving themselves was seen as a barrier to the use of automated vehicles. There were also some limits on the trip types that automated vehicles were identified as being appropriate for. For example, very few would use a CAV to pick up their children from school or take them to soccer practice (18.8% overall, but only 10.6% of women). Commuting to work and carrying out everyday errands were also trips that only a minority of respondents (41.4% and 28.2% of respondents) wanted to undertake with an automated vehicle. It is worth noting that over one quarter (25.59%) of the respondents said they would not use a CAV for any reason. These attitudes combined with concerns about cost and satisfaction with existing transport modes could serve to slow the diffusion of automated vehicles in New Zealand. However, the proportion of respondents indicating they would never use a CAV is lower, and awareness and knowledge about CAVs are higher in New Zealand compared with international data, suggesting that the New Zealand public is more ready than in many other jurisdictions for the introduction of CAVs.

5.3.2 Ridesharing and carsharing

Only 53% of respondents reported having access to app-based ridesharing, 35% with access to rideshare/carpooling and 27.5% to carsharing. In addition, a significant proportion of respondents did not know if the services were available in their areas, a significant barrier to increased use of these transport sharing options.

The primary barriers to use included car ownership (and no need to use shared transport), safety concerns and cost. Other concerns focused on lack of flexibility, convenience and transport options not meeting participant's needs, particularly for those travelling with children, or those with mobility or health issues. Respondents also reported a lack of satisfaction with the current business models for app-based ridesharing in particular. In addition, those who currently used public transport, cycled or walked did not see the need to use new transport sharing options. Further, users of public transport expressed concern that the new transport sharing options may make public transport less viable. Overall, there are a number of issues that need to be addressed to facilitate the adoption of these new transport sharing technologies.

5.4 Summary

This review of the adoption and technology diffusion models highlights the difficulties predicting transport-related adoption, many of them related to the fact that the purchase of a new car is not a frequent event. There have been several attempts to estimate diffusion of CAVs, but many are over-ambitious (eg KPMG 2015). Litman's (2018) estimated adoption timelines for CAVs appear to the most realistic but even he acknowledges they are likely to be over-estimates and to address this he also incorporated 'pessimistic' predictions. The main problem with these models, however, is that they fail to take into account other factors likely to influence adoption, notably public perceptions of the technology, cost, flexibility and private car ownership, all of which were identified as barriers or enablers to using CAVs in the surveys we described earlier.

For MaaS, Wolken et al (2018) developed a model suggesting that saturation would be reached within 17 years of introduction, but the authors themselves noted that this estimate did not take into account a number of factors that might affect the accuracy of their model; ie perceived safety, time cost, privacy (and personal space), wellbeing (desire for active transport as exercise), flexibility (choice of when and where to travel) and ownership. These issues were reflected in our survey findings with car ownership, safety and cost being the most commonly identified barriers. Our survey respondents also identified flexibility, convenience and transport options not meeting their needs as other important barriers. Overall further work is needed to develop more comprehensive models that can provide accurate adoption timelines. Development of these models will be particularly challenging for the New Zealand context, given its reliance on imported second-hand vehicles.

6 Conclusions and recommendations

The overall purpose of the research described in this report was to explore the New Zealand public's readiness to adopt four key mobility changes: autonomous vehicles, connected vehicle technology, carsharing and ridesharing schemes. To achieve this we analysed the data from five surveys, three focusing on connected and autonomous vehicles (total n= 2,616) and two on ride- and carsharing (one conducted specifically for this study, total n = 1,766), conducted 12 group interviews (n=58) and reviewed the existing adoption and technology diffusion models.

The research aims were to:

1 Identify the main attitudinal and social impact issues recognised in overseas studies.

2 Combine results from existing surveys of the New Zealand public.

3 Identify remaining gaps in demographics and knowledge, collecting additional survey data if required.

4 Conduct targeted focus groups to reveal underlying public attitudes

5 Review the adoption and technology diffusion models for autonomous vehicles and mobility as a service to determine their applicability in the New Zealand context.

To facilitate comparison of the New Zealand public's awareness, knowledge and use of each of the new transport options we collated the data in table 6.1. As shown in the table, participants were most aware of CAVs, and least aware of carsharing and car clubs. Knowledge was greatest for app-based ride hailing, closely followed by CAVs, with fewer participants reporting that they knew anything about carsharing or car clubs. App-based ride hailing was used by the largest proportion of participants, followed by ridesharing/carpooling, but there was a sizeable number of participants who reported they would never use any of the transport options.

Table 6.1 The percentage of respondents reporting they were aware, knowledgeable, had or intend to use, or would never use each of the new transport options (answers are presented as a range where similar information was obtained in two surveys)

	Aware (%)	Knowledgeable (%)	Used (%)	Never use (%)
CAVs	90–95	74–79	2–3	20–25
App-based ride hailing	86–87	78–81	28–35	31–52
Ridesharing/carpooling	76–81	65–77	18–25	21–63
Carsharing	64	65	21	69
Car clubs	22	23	1	4

For CAVs, up to 95% of the sample had heard of self-driving cars (like the Google car), higher than reported in the international literature with rates ranging from 57% in Japan to 87% in China (Schoettle and Sivak 2014); the increased knowledge in our sample may have been due to the publicity about this technology between 2014 and the current survey in 2016. In contrast, although many of the respondents had heard of a range of ADAS, their experience with them was lower than overseas, for example approximately 10% of our sample had experience of intelligent parking assistance compared with 40% in Germany (Wolf 2016). This may be a result of the relatively old vehicle fleet in New Zealand. The expected benefits of CAVS identified by our sample were similar to overseas data with a reduction in crashes being the most highly rated (55.5% rated it a significant benefit) followed by better fuel economy

(35.4%) and less congestion (34.3%) (Howard & Dai 2014; Schoettle and Sivak 2014). This data is summarised in table 6.2. Interestingly, the New Zealand sample rated reduced emissions as the least likely benefit which differs from the overseas data shown in table 6.2. This may in part be due to the way in which the question was asked and the response options provided to participants.

Table 6.2 The highest and lowest ranked benefits of CAVs by country including New Zealand (adapted from Schoettle and Sivak 2014).

	Most likely benefit (% of sample)	Least likely benefit (% of sample)
New Zealand	Reduction in crashes (55.5%)	Lower emissions (33.2%)
China	Improved emergency response to crashes' (88.8%)	Less traffic congestion (72.0%)
India	Better fuel economy (85.9%)	Lower insurance rates (69.3%)
Japan	Fewer crashes (81.1%)	Shorter travel time (42.4%)
US	Improved emergency response to crashes (71.6%)	Shorter travel time (45.9%)
UK	Better fuel economy (75.9%)	Shorter travel time (39.3%)
Australia	Reduced severity of crashes (73.5%)	Shorter travel time (44.8%)

Respondents were also asked why they would like to use a CAV; the most common response was so they could do other things. In spite of these benefits, approximately 25% of the sample indicated they would never use a CAV. This is lower than rates reported for the US (37%), Japan (30%) and Germany (29%) but higher than China (10%) (Sommer 2013).

The most concerning issue identified by our participants about CAVs was trust in technology/hacking, which is similar to findings from other countries where respondents reported being most worried about equipment/system failure (table 6.3). In keeping with the overseas data, learning to use CAVs was the least concerning issue. Interestingly though, a much higher proportion of New Zealand respondents identified this as concerning compared with respondents in China, India, Japan, US, UK or Australia. This may be a result of the increased publicity about CAVs between the international surveys and those reported here.

Table 6.3 The most and least concerning issues related to CAVs by country including New Zealand (adapted from Schoettle and Sivak 2014).

	Most concerning (% of sample)	Least concerning (% of sample)
New Zealand	Trust in technology/hacking (85.3%)	Learning to use self-driving vehicles (65%)
China	Safety consequences of equipment/system failure (68.0%)	Self-driving vehicles not driving as well as human drivers (35.1%)
India	Safety consequences of equipment/system failure (59.0%)	Interacting with non-self-driving vehicles (35.5%)
Japan	Self-driving vehicles confused by unexpected situations (32.3%)	Learning to use self-driving vehicles (9.6%)
US	Self-driving vehicles confused by unexpected situations (53.1%)	Learning to use self-driving vehicles (29.1%)
UK	Safety consequences of equipment/system failure (44.8%)	Learning to use self-driving vehicles (15.4%)
Australia	Safety consequences of equipment/system failure (44.4%)	Learning to use self-driving vehicles (20.8%)

Respondents were also uncomfortable putting their children in a self-driving car (49%) or using a self-driving car without a steering wheel (54%), but were more inclined to use one if they were over the drink-drive limit (83%) or if they were tired (78%). In general women were more worried about the CAV technology than males. Respondents were most likely to use the self-driving technology on motorways, similar to other reports (eg Robertson et al 2016), but were not willing to pay much for fully automated vehicle technology, with 20% not willing to pay any additional amount and 30% willing to pay $1,000 to $5,000. This rate is lower than those in the international literature with 67.5% of a Japanese sample not willing to pay extra for complete self-driving technology, followed by the UK (59.8%), Australia (55.2%), US (54.5%), India (29.8%) and China (21.6%) (Schoettle and Sivak 2014). It should be noted that willingness to pay may increase as experience of the technology increases; we found that those who had used ADAS were willing to pay more than those who had not used it.

With regard to app-based ride hailing, ridesharing and carsharing, a large proportion (>75%) of respondents had heard about these services, which was somewhat higher than rates of awareness reported in Texas (66%) (Bansal and Kockelman 2015) Unsurprisingly, awareness of the service is associated with the availability (Bansal and Kockelman 2015) and it has been suggested that the availability of app-based ride hailing services can be a positive influence on the use of ridesharing services, particularly when the booking system is similar (Uber 2016). Overall, 28% to 35% of respondents had used app-based ride hailing, 18% to 25% had used ridesharing/carpooling, and 21% had used carsharing, with use being highest in the 25 to 44 age group. One of the greatest obstacles to use was not knowing if the service was available; this was particularly an issue for older respondents and over half the respondents said they were not intending to use any of the shared transport options in the next 12 months (table 6.1). The most frequently identified barrier to use of any of the services was car ownership. Other barriers included lack of availability, safety, cost, not wanting to share with strangers and convenience. The most commonly endorsed enabler was availability; both cost and knowing how to use the service were also highly ranked. These findings are similar to those from previous reports (Circella et al 2018) who also identified car ownership as the primary barrier to service use, followed by comfort, safety and cost.

As in the ITF (2017) report, respondents were also asked to answer a series of questions about using a shared taxi. The current findings are different from those in the ITF report, possibly because we had a larger and more diverse sample recruited from across New Zealand. The proportion of respondents indicating they would not use a shared taxi was twice that in the original report (50% vs 25%). A reasonable proportion of those willing to use the shared taxi would do so for time savings of up to five minutes and cost savings between $6 and $10, and for drop-off and collection points to be within five minutes of home/their destination. Essentially they would like a faster and cheaper journey than their current commute, and would be happy to share with three to four people.

The group interviews supported the findings from the surveys. For transport sharing options to be a feasible alternative to using a private car the service needed to be comfortable, convenient, cost-effective, flexible, and meet the needs of the traveller. This is one of the biggest challenges facing these new transport options with one participant summarising the advantages of using their own car as follows:

> *Personal space, flexible, you're in control, convenient/no hassle – can have your music on, take your dog, smoke. No one in the backseat distracting you. Some people enjoy driving.*

The discussions also highlighted the importance of better advertising via multiple channels (to increase awareness), as well as improved accessibility by developing alternative booking platforms. However, advertising alone would only increase use if sufficient cars were available. Participants also wanted an

easy way to compare costs of the same journey using different transport options, to allow them to make an informed choice about how to travel.

Many of these new transport sharing options are not suitable for people with a disability, as the vehicles cannot accommodate those with mobility impairments, and the app-based booking systems cannot be used by those with a visual impairment. Overall, more consideration needs to be given to how the transport system as a whole can work more effectively for those with disabilities, specifically provision of a door-to door (or possibly indoor) service, with booking systems and vehicles that meet the needs of the user without sacrificing convenience or increasing cost. This could be addressed via offering booking systems that allow users to make specific requests as part of the booking. For example, users could request a driver collect them at the door, request a specific type of vehicle to meet their needs and request assistance to get from the car to their final destination. As is the case in many developed countries, the population of New Zealand is ageing. Furthermore, the 2013 New Zealand Disability Survey found that almost a quarter (24%) of people living in New Zealand identified as disabled, equating to over one million people (Statistics NZ 2013). Disability rates are highest in those aged over 65 years, with physical impairment being the most common, affecting 14% of the population. The combination of an ageing population and high rates of disability highlights the importance of developing a transport system that meets the needs of a diverse range of users to maximise health and wellbeing.

The review of the adoption and technology diffusion models highlighted the difficulties of predicting transport-related adoption, in part because purchasing a new car is not a frequent event. There are several estimates for diffusion of CAVs, but they all fail to take into account many other factors that influence adoption, notably public perceptions of the technology, cost, flexibility and private car ownership. Such models are particularly challenging to develop for New Zealand given its reliance on imported second-hand vehicles. The adoption timelines that have been developed to date appear to be over-ambitious, and given the findings from the surveys and focus groups, widespread adoption of any of the transport options is likely to be much later than any of the published estimates. It would be useful to develop more complex models that incorporate a wider range of factors specific to New Zealand, including public attitudes to produce more accurate adoption timelines.

The research undertaken for this report has limitations; most of the data was self-report survey data which is open to bias. To address some of the sources of bias, we advertised and recruited participants from across New Zealand, living in both urban and rural locations. Our sample was a relatively even split of males and females and covered a wide age range. The face-to-face group discussion provided some degree of validating the survey findings given the similarity in the findings. The strengths of the study are the large sample size, the diversity of the sample and the use of multiple data sources.

In summary, there is some way to go in encouraging New Zealanders to willingly adopt these new transport technologies, and it will be a long time before these options will lead to reductions in car ownership. For CAVs, however, comparisons with international data suggest the New Zealand public is more aware and ready to use CAVs than some overseas jurisdictions.

To further prepare the New Zealand public for use of CAVs we recommend the following:

1 Increase awareness of ADAS systems and their safety benefits (to increase uptake).

2 Provide education about the security of CAVs to allay public fears about vehicle hacking and technology failure. Even though the New Zealand public appears to be more CAV ready than other countries, widespread adoption is some time away, and cannot be relied upon to solve current transport safety issues.

Rather than advocating that these new transport sharing schemes completely replace the private car, the initial focus should be on ensuring these alternatives are well integrated with the existing transport network, and encouraging people to explore the best transport option for each type of trip they are taking. To increase use of the transport sharing options we suggest the following steps:

1 Prepare/produce cost and time information for different journeys (eg work commute, trip to airport) for each of the new transport modes and a private car. This information will allow people to make an informed choice about how to travel (and could include transport options not covered by this report such as e-bikes and scooters).

2 Advertise the services widely across different media platforms and include information about safety checks/processes.

3 Develop transport sharing options that better meet the needs of those living with a disability.

4 Have more accessible booking systems and cater more effectively to the needs of a diverse population, to allow people to make regular bookings.

5 Run community-based workshops to show people how to access and use the new transport options.

6 Ensure the services promoted are available and provide travellers with a good experience to encourage further use.

7 References

Abraham, H, B Reimer, B Seppelt, C Fitzgerald, B Mehler and JF Coughlin (2017) *Consumer interest in automation: preliminary observations exploring a year's change*. Cambridge, MA: Massachusetts Institute of Technology. Accessed 8 April 2019. https://agelab.mit.edu/sites/.../MIT%20-%20NEMPA%20White%20Paper%20FINAL.pdf

Agatz, N, A Erera, M Savelsbergh and X Wang (2012) Optimization for dynamic ride-sharing: a review. *European Journal of Operational Research 223*, no.2: 295–303.

Amirkiaee, SY and N Evangelopous (2018) Why do people rideshare? An experimental study. *Transportation Research Part F: Traffic Psychology and Behaviour 55*: 9–24.

Anderson, DN (2014) Not just a taxi? For-profit ridesharing, driver strategies, and VMT. *Transportation 41: 1099–1117.*

Auckland Transport (2019) *AT local*. Accessed 1 May 2019. https://at.govt.nz/local

Bansal, P and KM Kockelman (2015) Are Americans ready to embrace connected and self-driving vehicles? A case study of Texans. *Transportation 45*, no.2: 641–675.

Bansal, P, KM Kockelman and A Singh (2016) Assessing public opinions of and interest in new vehicle technologies: an Austin perspective. *Transportation Research Part C 67*: 1–14.

Bass, FM (2004) Comments on 'A new product growth for model consumer durables': the Bass model. *Management Science 50*, no.12: 1833–1840.

Begg, D (2014) *A 2050 vision for London: what are the implications of driverless transport?* London, UK: Clear Channel. Accessed 5 April 2019. www.transporttimes.co.uk/Admin/uploads/64165-transport-times_a-2050-vision-for-london_aw-web-ready.pdf.

Bjørner, T (2015) A priori user acceptance and the perceived driving pleasure in semi-autonomous and autonomous vehicles. *Paper presented at European Transport Conference 2015*, Frankfurt, Germany. Retrieved from: https://abstracts.aetransport.org/paper/download/id/4546

Bonsall, P (2002) *Carshare and car clubs: potential impacts*. West Yorkshire, England: University of Leeds, Institute for Transport Studies. Accessed 12 November 2018. www.researchgate.net/publication/237364534_Car_Share_and_Car_Clubs_potential_impacts

Brown, AE, E Blumenberg, BD Taylor, K Ralph and C Turley Voulgaris (2016) A taste for transit? Analyzing public transit use trends among youth. *Journal of Public Transportation 19*: 49–67.

Buck, D, R Buehler, P Happ, B Rawls, P Chung and N Borecki (2013) Are bike share users different from regular cyclists? A first look at short-term users, annual members, and area cyclists in the Washington, DC region. *Transportation Research Record Journal of the Transportation Research Board 2387*: 112–119.

Cervero, R, A Golub and B Nee (2007) San Francisco City CarShare: longer-term travel-demand and car ownership impacts. *Transportation Research Record: Journal of The Transportation Research Board 1992*: 70–80.

Circella, G, L Fulton, F Alemi, RM Berliner, K Tiedeman, PL Mokhtarian and S Handy (2016) *What affects millennials' mobility? PART I: Investigating the environmental concerns, lifestyles, mobility-related attitudes and adoption of technology of young adults in California*. Davis, CA: National Center for

Sustainable Transportation (NCST). Accessed 7 March 2019. http://ncst.ucdavis.edu/wp-content/uploads/2014/08/05-26-2016-NCST_Report_Millennials_Part_I_2016_May_26_FINAL1.pdf.

Circella, G, F Alemi, R Berliner, K Tiedeman, Y Lee, L Fulton, S Handy and P Mokhtarian (2017) Multimodal behavior of millennials: exploring differences in travel choices between young adults and gen-Xers in California. *TRB 96th Annual meeting Compendium of Papers, no.17–06827*.

Circella, G, F Alemi, K Tiedeman, S Handy and P Mokhtarian (2018) *The adoption of shared mobility in California and its relationship with other components of travel behavior*. Davis, CA: National Center for Sustainable Transportation (NCST). Accessed 12 March 2019. https://ncst.ucdavis.edu/wp-content/uploads/2016/10/NCST-TO-033.1-Circella_Shared-Mobility_Final-Report_MAR-2018.pdf.

Clark, B, G Parkhurst and M Ricci (2016). *Understanding the socioeconomic adoption scenarios for autonomous vehicles: a literature review*. Bristol: University of the West of England. Accessed 1 May 2019. http://eprints.uwe.ac.uk/29134/1/Venturer-LitReview-5-1-Report-Final.pdf

Cooper, J, R Mundy and J Nelson (2010) *Taxi! Urban economies and the social and transport impacts of the taxicab*. Ashgate Publishing Ltd.

Cox, WM and R Alms (2008) You are what you spend. *The New York Times*. 3 November 2008. Accessed 7 January 2020. www.nytimes.com/search?query=You+are+what+you+spend

Curl, A, H Fitt, R Dionisio-McHugh, A Ahuriri-Driscoll, A Fletcher and H Slaughter (2018) *Autonomous vehicles and future urban environments: exploring changing travel behaviours, built environments, and implications for wellbeing in an ageing society.* Christchurch, NZ: National Science Challenge 11: Building Better Homes, Towns and Cities. Accessed 7 January 2020. www.buildingbetter.nz/resources/publications.html#avue

Field, A (2018) *Discovering statistics using IBM SPSS STATISTICS* (5th ed). Britain, London: Sage.

Fitt, H, A Curl, R Dionisio-McHugh, A Fletcher, B Frame and A Ahuriri-Driscoll (2018) *Think piece: autonomous vehicles and future urban environments: exploring implications for wellbeing in an ageing society (2nd ed)*. Christchurch, NZ: National Science Challenge 11: Building Better Homes, Towns and Cities. Accessed 7 January 2020. www.buildingbetter.nz/resources/publications.html#avue

Fitt, H, B Frame, A Fletcher, A Curl, R Dionisio-McHugh, A Ahuriri-Driscoll, N Baldwin, and H Hadfield (2018) *Four plausible scenarios for transport in New Zealand in 2048*. Christchurch, NZ: National Science Challenge 11: Building Better Homes, Towns and Cities. Accessed 7 January 2019. www.buildingbetter.nz/resources/publications.html#avue

Fletcher, A, H Fitt, N Baldwin, H Hadfield and A Curl (2018) *Initial scan of policy/issues relevant to autonomous vehicle development and deployment*. Christchurch, NZ: National Science Challenge 11: Building Better Homes, Towns and Cities. Accessed 7 January 2020. www.buildingbetter.nz/resources/publications.html#avue

Fraedrich, E and B Lenz (2016) Societal and individual acceptance of autonomous driving. Pp 621–640 in *Autonomous driving: technical, legal and social aspects.* M. Maurer et al (Eds), Berlin, Germany: Springer Open.

Haboucha, CJ, R Ishaq and Y Shiftan (2017) User preferences regarding autonomous vehicles. *Transportation Research Part C: Emerging Technologies 78*: 37–49.

Henderson, P (2017) Some Uber and Lyft riders are giving up their own cars: Reuters/Ipsos poll. Reuters. Accessed 14 March 2018. https://mobile-reuters-

com.cdn.ampproject.org/c/mobile.reuters.com/article/amp/idUSKBN18L1DA (last accessed on March 14, 2018).

Hoff, K and M Bashir (2015) Trust in automation: integrating empirical evidence on factors that influence trust. *Human Factors 57*, no.3: 407–434.

Howard, D and D Dai (2014) Public perceptions of self-driving cars: the case of Berkeley, California. *In paper presented at the 93rd Annual Meeting TRB*, Washington, DC. Accessed 2 February 2019. www.danielledai.com/academic/howard-dai-selfdrivingcars.pdf

Hu, W (2017) Yellow cab, long a fixture of city life, is for many a thing of the past. New York Times. Accessed 14 March 2018. www.nytimes.com/2017/01/15/nyregion/yellow-cab-long-a-fixture-of-city-life-is-for-many-a-thing-of-the-past.html.

Hulse, LM, H Xie and ER Galea (2017). Perceptions of autonomous vehicles: relationships with road users, risk, gender and age. *Safety Science 102*: 1–13.

International Transport Forum (2017) *Shared mobility simulations for Auckland: case-specific policy analysis.* France, Paris: Author. Accessed 7 May 2019. www.itf-oecd.org/sites/default/files/docs/shared-mobility-simulations-auckland.pdf

Katzev, R (2003) Carsharing: a new approach to urban transportation problems. *Analyses of social issues and public policy, 3*, no.1: 65–86.

Keogh, B (2018) Women-only ride-sharing coming to NZ with launch of DriveHer app*. Stuff.* Accessed 7 January 2020. www.stuff.co.nz/auckland/106242991/womenonly-ride-sharing-coming-to-nz-with-launch-of-driveher-app

Kopp, J, R Gerike and KW Axhausen (2015) Do sharing people behave differently? An empirical evaluation of the distinctive mobility patterns of free-floating car-sharing members. *Transportation 42*: 449–469.

KPMG (2015). *Connected and autonomous vehicles – the UK economic opportunity*. Switzerland: Author. Accessed 14 November 2019. https://home.kpmg/content/dam/kpmg/pdf/2015/04/connected-and-autonomous-vehicles.pdf

Krueger, R, TH Rashidi and JM Rose (2016) Preferences for shared autonomous vehicles. *Transportation Research Part C: Emerging Technologies 69*: 343–355.

Kuhnimhof, T, J Armoogum, R Buehler, J Dargay, JM Denstadli and T Yamamoto (2012) Men shape a downward trend in car use among young adults – evidence from six industrialized countries. *Transport Reviews 32*, no.6: 761–779.

Kyriakidis, M, R Happee and JCF De Winter (2015) Public opinion on automated driving: results of an international questionnaire among 5000 respondents. *Transportation Research Part F: Psychology and Behaviour 32*: 127–140.

Lavasani, M, X Jin and Y Du (2016) Market penetration for autonomous vehicles on the basis of earlier technology adoption experience. *Transportation Research Record: Journal of the Transportation Research Board 2597*: 67–74.

Le Vine, S, M Lee-gosselin, A Sivakumar and J Polak (2014) A new approach to predict the market and impacts of round-trip and point-to-point carsharing systems: case study of London. *Transportation Research Part D*, *32*: 218–229.

Licea, M, E Ruby and R Harshbarger (2015) *More Uber cars than yellow taxis on the road in NYC*. New York Post. New York. Accessed 14 March 2018. https://nypost.com/2015/03/17/more-uber-cars-than-yellow-taxis-on-the-road-in-nyc

Linden, A and J Fenn (2003) *Understanding Gartner's hype cycles. Gartner Research strategic analysis report R-20-1971*). Accessed 18 September 2018. www.bus.umich.edu/KresgePublic/Journals/Gartner/research/115200/115274/115274.pdf

Litman, T (2018) Autonomous vehicle implementation predictions: implications for transport planning. Victoria, Canada: Victoria Transport Policy Institute. Accessed 15 April 2019. www.vtpi.org/avip.pdf

Mahajan, V, E Muller and F Bass (1995) Diffusion of new products: empirical generalizations and managerial uses. *Marketing Science 14*, no.3: G79–G88.

Martin, E, S Shaheen and J Lidicker (2010) Impact of carsharing on household vehicle holdings: results from a North American shared-use vehicle survey. *Transportation Research Record: Journal of the Transportation Research Board 2143*: 150–158.

Merat, N, R Madigan and S Nordhoff (2017) Human factors, user requirements, and user acceptance of ride-sharing in automated vehicles. *International Transport Forum Discussion Paper 2017-10*. Paris, France: Accessed 21 March 2019. https://search-proquest-com.ezproxy.waikato.ac.nz/docview/1928985260/fulltextPDF/C56539B7282548C5PQ/1?accountid=17287

Ministry of Transport (2015a) *Driver travel: New Zealand household travel survey 2011–2014.* Wellington, New Zealand: Author. Accessed 25 February 2019. www.transport.govt.nz/assets/Uploads/Research/Documents/97b32db72b/Drivers-2015.pdf

Ministry of Transport (2015b) *Comparing travel modes: New Zealand household travel survey 2011–2014.* Wellington, New Zealand: Author. Accessed 25 February 2019. www.transport.govt.nz/assets/Uploads/Research/Documents/1bcde6d316/Comparing-travel-modes-2015.pdf

Ministry of Transport (2018) *Annual fleet statistics 2017*. Wellington, New Zealand: Author.

Ministry of Transport. (2019) *Monthly electric and hybrid light vehicle registrations.* Accessed 16 January 2019. www.transport.govt.nz/research/newzealandvehiclefleetstatistics

Mishra, GS, RR Clewlow, PL Mokhtarian and KF Widaman (2015) The effect of carsharing on vehicle holdings and travel behavior: a propensity score and causal mediation analysis of the San Francisco Bay Area. *Research in Transportation Economics 52*: 46–55.

MOMO (2009) Car-sharing reduces the burden on both cities and the environment – the environmental impacts of car-sharing use*. Car-sharing fact sheet no.3.* Accessed 11 January 2019. https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/momo_car-sharing_f03_environmental_impacts_en.pdf

Moore, GA (1991) *Crossing the chasm: marketing and selling high-tech products to mainstream customers*. New York: Harper.

Neoh, JG, M Chipulu and A Marshall (2017) What encourages people to carpool? An evaluation of factors with meta-analysis. *Transportation 44*: 423–447.

Niall, T (2019) Residents of upmarket Auckland suburb ferried around by $1.3m Uber-style service. *Stuff 10 March 2019.* Accessed 7 January 2019. www.stuff.co.nz/auckland/110930828/publiclyfunded-13m-uber-service-needs-rain

Owens, JM, JF Antin, Z Doerzaph and S Willis (2015) Cross-generational acceptance of and interest in advanced vehicle technologies: A nationwide survey. *Transportation Research Part F: Psychology and Behaviour 35*: 139–151.

Patterson, L (2018). *Future of transport technology 2017: leading indicators of change.* Dunedin, New Zealand: Department of Marketing, University of Otago. Accessed 29 March 2019. www.transport.govt.nz/assets/Uploads/Research/Documents/ccdb615e4a/Transport-technologies-2017-survey-29Oct2018.pdf

Payre, W, J Cestac and P Delhomme (2014) Intention to use a fully automated car: attitudes and a priori acceptability. *Transportation Research Part F: Psychology and Behaviour 27*: 252–263.

Polzin, SE, X Chu and J Godfrey (2014) The impact of millennials' travel behavior on future personal vehicle travel. *Energy Strategy Reviews 5*: 59–65.

Power, JD (2013) *2013 US automotive emerging technologies study results*. Accessed 8 August 2019. http://autos.jdpower.com/content/study-auto/f85EfAp/2013-u-s-automotive-emerging-technologies-study-results.htm

Rayle, L, S Shaheen, N Chan, D Dai and R Cervero (2014) *App-based, on-demand ride services: comparing taxi and ride sourcing trips and user characteristics in San Francisco*. Working Paper, University of California Transportation Center (UCTC). Accessed 24 April 2019. www.its.dot.gov/itspac/dec2014/ridesourcingwhitepaper_nov2014.pdf

Regan, M, MV Cunningham, T Horberry, A Bender, K Weeratunga et al (2017) *Preliminary findings from the first Australian national survey of public opinion about automated and driverless vehicles*. Australian and New Zealand Driverless Vehicle Initiative. Accessed 19 June 2018. https://s3-ap-southeast-2.amazonaws.com/cdn-advi/wp-content/uploads/2017/07/ADVI-Public-Opinion-Survey-7June2016.pdf

Robertson, RD, SR Meister and WG Vanlaar (2016) *Automated vehicles: driver knowledge, attitudes and practices*. Ottawa, Ontario: Traffic Injury Research Foundation. Accessed 5 September 2018. http://tirf.ca/publications/automated-vehicles-driver-knowledge-attitudes-practices/

Rödel, C, S Stadler, A Meschtscherjakov and M Tscheligi (2014) Towards autonomous cars: the effect of autonomy levels on acceptance and user experience. *Paper presented at the Automotive UI'14 conference, Seattle*. Accessed 16 July 2018. www.researchgate.net/publication/273141501_Towards_Autonomous_Cars_The_Effect_of_Autonomy_Levels_on_Acceptance_and_User_Experience

Rogers, EM (1962) *Diffusion of innovations*. Glencoe: Free Press.

Rogers, EM (2003) *Diffusion of innovations 5th ed.* Glencoe: Free Press.

SAE International (2018) *Taxonomy and definitions for term related to driving automation systems for on-road motor vehicles*. *Standard J3016.*

Sanbonmatsue, DM, DL Strayer, Z Yu, Z, F Biondi and JM Cooper (2018) Cognitive underpinnings of beliefs and confidence in beliefs about fully automated vehicles. *Transportation Research Part F: Traffic Psychology and Behaviour 55*: 114–122.

Schoettle, B and M Sivak (2014) *Public opinion about self-driving vehicles in China, India, Japan, the US, the UK and Australia*. Ann Arbor, MI: The University of Michigan, Transportation Research Institute (UMTRI). Accessed 21 June 2018. https://pdfs.semanticscholar.org/2923/9cfbd4935100daae004ede35e29a34e85a2e.pdf

Shaheen, S and A Cohen (2008) Worldwide carsharing growth: an international comparison. *Transportation Research Record: Journal of the Transportation Research Board 1992*: 81–89.

Shaheen, S, D Sperling and C Wagner (1998) *Carsharing in Europe and North American: past, present, and future*. Berkeley, CA: University of California Transportation Center. Accessed 16 October 2018. https://escholarship.org/uc/item/4gx4m05b

Shaheen, S and A Cohen (2013) Carsharing and personal vehicle services: worldwide market developments and emerging trends. *International Journal of Sustainable Transportation 7*, no.1: 5–34.

Shaheen, S, M Meyn and K Wipyewski (2003) *US shared-use vehicle survey findings: opportunities and obstacles for carsharing and station car growth*. Berkeley, CA: Institute of Transportation Studies, University of California.

Shaheen, S, A Cohen and M Chung (2009) North American carsharing: 10-year retrospective. *Transportation Research Record: Journal of the Transportation Research Board 2110*: 35–44.

Shaheen, S and E Martin (2011) The impact of carsharing on public transit and non-motorized travel: an exploration of North American carsharing survey data. *Energies 4*, no.11: 2094–2114.

Smith, A (2014) *US views of technology and the future: science in the next 50 years*. Pew Research Center. Accessed 17 July 2018. www.pewinternet.org/2014/04/17/us-views-of-technology-and-the-future/

Smith, M (2016) Majority of public would be scared to take a ride in a driverless car. London: YouGov. Accessed 14 November 2017. https://yougov.co.uk/news/2016/08/26/majority-public-would-be-scared-take-ride-driverle/

Sommer, K (2013) *Continental mobility study 2013*. Continental. Accessed 19 April 2018. https://www.continental-corporation.com/resource/blob/7380/6cddc571cd3d3b5cacd279fe0d1a00c1/mobistud-2013-dl-data.pdf

Starkey, NJ and SG Charlton (2016) New Zealand drivers' readiness for connected and autonomous vehicles. *Transport Knowledge Conference,* Wellington, New Zealand, November 2016.

Statistics New Zealand (2018a) *Household labour force survey*. Wellington: Statistics New Zealand.

Statistics New Zealand (2018b) *Mean and median annual personal income in New Zealand*. Accessed 7 January 2020. https://figure.nz/chart/1qLKOIy7zzs1loV4

Statistics New Zealand (2013) *Population distribution in New Zealand*. Accessed 7 January 2020. https://figure.nz/chart/3OjxZbBpv5fOwovb

Statistics New Zealand (2013) *Disability survey: 2013*. Accessed 7 January 2020. http://archive.stats.govt.nz/browse_for_stats/health/disabilities/DisabilitySurvey_HOTP2013/Commentary.aspx#agedisability

Taylor, BC, R Chin, C Melanie, J Dill, LA Hoel, M Manville et al (2016) Between public and private mobility: examining the rise of technology-enabled transportation services. *Special report no.319*. Washington, D.C: Transportation Research Board.

Uber (2017) *Uber mobility trial.* Accessed 7 January 2020. www.uber.com/en-NZ/blog/auckland/uber-mobility-trial/

Uber. (2016). *Uber submission to the Transport and Industrial Relations Committee: Ridesharing is the future of mobility*. Accessed 20 March 2018. www.parliament.nz/resource/en-nz/51SCTIR_EVI_00DBSCH_INQ_68267_1_A505754/5da7671b9c11ca45beb490e252f3873a6bebd8cd

Verberne, FMF, J Ham and CJH Midden (2012) Trust in smart systems: sharing driving goals and giving information to increase trustworthiness and acceptability of smart systems in cars. *Human Factors: The Journal of Human Factors and Ergonomics Society 54*, no.5: 799–810.

Waytz, A, J Heafner and N Epley (2014) The mind in the machine: anthropomorphism increases trust in an autonomous vehicle. *Journal of Experimental Social Psychology 52*: 113–117.

Wither, D (2017) *Future of transport technology: leading indicators of change.* Dunedin, New Zealand: Department of Marketing, University of Otago. Accessed 29 March 2019. www.transport.govt.nz/assets/Uploads/Research/Documents/University-ofOtago-summer-student-Technology-attitudes-Report-November2017.pdf

Wolf, I (2016) The interaction between humans and autonomous agents. Pp103–124 in *Autonomous driving: technical, legal and social aspects.* M Maurer, JC Gerdes, B Lenz and H Winner (Eds) Berlin, Germany: Springer Open.

Wolken, AR, MJ Smith, WH Kaye-Blake, KO Curry, MC Dickson, CE Drummond et al (2018) *Driving change: technology diffusion in the transport sector.* NZ Transport Agency research report 647. 130pp.

Wooliscroft, B, D Hopkins and S Hall-McMaster (2016) *Mobility trends in New Zealand*. Dunedin, New Zealand: Centre for Sustainability, University of Otago. Accessed 10 April 2018. www.otago.ac.nz/centre-sustainability/research/otago121864.html

Youngs, J (2014) *2014 US automotive emerging technologies study results*. Accessed 8 August 2019. http://autos.jdpower.com/content/study-auto/lN3SbRs/2014-u-s-automotive-emerging-technologies-study-results.htm

Appendix A: Transport futures: public perceptions of connected and autonomous vehicles – questionnaire

Car companies are rapidly integrating new technology into their vehicles with the aim of making driving safer, reducing fuel consumption and easing congestion. The available technology varies from systems that provide assistance in particular situations (eg the Intelligent Parking Assistant System which helps drivers to park their cars) to total automation (self-driving), where the driver only needs to provide details of the destination. Technology is also enabling cars to 'talk' (or connect) to each other and the road network around them, which can provide information about cars suddenly braking in front of them or traffic congestion. We are interested in finding out New Zealanders' views of these new vehicle technologies and encourage you to take part in our survey.

The survey will take approximately 15 minutes to complete. Any answers you provide are anonymous and cannot be linked to your name in any way. You can stop taking the survey at any time by closing your browser window. The findings will be written up for publication and will be presented at relevant conferences. The study is being undertaken by the Transport Research Group at the University of Waikato and has received ethical approval from the School of Psychology Ethics Committee. If you would like further information about the study please contact a member of the study team (Dr Neha Malhotra, Assoc Professor Samuel Charlton or Assoc Prof Nicola Starkey) on trg@waikato.ac.nz.

If you are under 16 years of age and would like to take part in the survey we encourage you to talk to your parent or caregiver first.

Consent

Would you like to take part in the survey?

- ❍ Yes (1)
- ❍ No (2)

If No Is Selected, Then Skip To End of Survey

Experience with CAVs

2 Have you heard of self-driving cars such as the Google car?

- ❍ No (1)
- ❍ Yes (2)
- ❍ Prefer not to respond (3)

3 Have you heard of Adaptive Cruise Control (your car automatically maintains speed relative to cars ahead of you)?

- ❍ No (1)
- ❍ Yes (2)
- ❍ Prefer not to respond (3)

Answer If Have you heard of Adaptive Cruise Control (your car automatically maintains speed relative to car... Yes Is Selected

3.1 How often have you driven a car with Adaptive Cruise Control?

- Never (1)
- Once or twice (2)
- Once a month (3)
- Weekly (4)
- Everyday (5)
- Prefer not to respond (6)

4 Have you heard of Automatic Lane Keeping systems (your car automatically steers on the highway to keep in your lane)?

- No (2)
- Yes (1)
- Prefer not to respond (3)

Answer If Have you heard of Automatic Lane Keeping systems (your car automatically steers on the highway to... Yes Is Selected

4.1 How often have you driven a car with Automatic Lane Keeping?

Responses as above

5 Have you heard of Intelligent Parking Assistant systems (your car automatically helps you to steer into a parking spot)?

- No (2)
- Yes (1)
- Prefer not to respond (3)

Answer If Have you heard of Intelligent Parking Assistant systems (your car automatically helps you to stee... Yes Is Selected

5.1 How often have you driven a car with Intelligent Parking Assistant?

Responses as above

Scenarios

Now we will give you a few brief descriptions of driving in a car with some advanced features. We want you to imagine you are in those situations and answer a few questions about how you think you would feel.

6 Imagine driving around town on routine errands on roads that you know well. Steering is controlled by an Automatic Lane Keeping System and accelerating and braking is automatically controlled by the Adaptive Cruise Control. The driver doesn't have to worry about exceeding the speed limit or maintaining distance to the car in front. Compared to a completely manual car:

6.1 How enjoyable would you find this trip?

- Not enjoyable 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Very enjoyable 5 (5)
- Prefer not to respond (6)

6.2 How would you rate the safety of this trip?

- Very Unsafe 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Very safe 5 (5)
- Prefer not to respond (6)

6.3 How interesting would you find this trip?

- Very Boring 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Very Interesting 5 (5)
- Prefer not to respond (6)

6.4 How likely would you be to switch back to manual control of the car?

- Not at all likely 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Very likely 5 (5)
- Prefer not to respond (6)

7 Imagine driving on your daily commute on busy urban roads, where you are likely to experience traffic (e.g. driving to work, dropping the kids off at school, to university). Steering is controlled by an Automatic

Lane Keeping System and accelerating and braking is automatically controlled by the Adaptive Cruise Control. The driver doesn't have to worry about exceeding the speed limit or maintaining distance to the car in front.

7.1 How enjoyable would you find this trip?

Responses as above

7.2 How would you rate the safety of this trip?

Responses as above

7.3 How interesting would you rate this trip?

Responses as above

7.4 How likely would you be to switch back to manual control of the car?

Responses as above

8 Imagine driving on a motorway or open roads such that driving is hands-free. Steering is controlled by an Automatic Lane Keeping System and accelerating and braking is automatically controlled by the Adaptive Cruise Control. The driver doesn't have to worry about exceeding the speed limit or maintaining distance to the car in front.

8.1 How enjoyable would you find this trip?

Responses as above

8.2 How would you rate the safety of this trip?

Responses as above

8.3 How interesting would you find this trip?

Responses as above

8.4 How likely would you be to switch back to manual control of the car?

Responses as above

9 Imagine needing to travel into a busy urban area. Once you telephone or text a request for a ride, a fully automated car comes to collect you and all you need to do is provide the address of your destination. Billing is automatic and you are not in control at any time. Compared to a completely manual car:

9.1 How enjoyable would you find this trip?

Responses as above

9.2 How would you rate the safety of this trip?

Responses as above

9.3 How interesting would you find this trip?

Responses as above

Autonomous Vehicles

This section of the survey focuses on autonomous vehicles (self-driving cars) that are capable of sensing their environment and navigating without human input.

10 On which of the following occasions would you like to drive in a fully automated car (a vehicle that is capable of sensing its environment and navigating without human input)? Select all that apply.

- ❑ When driving is stressful (1)
- ❑ For commuting to my work (2)
- ❑ When I am tired (3)
- ❑ On my everyday journeys (4)
- ❑ When driving is boring and montonous (5)
- ❑ To pick up my kids from school or bring them to soccer practice (6)
- ❑ When I am impaired by alcohol, drugs or medication (7)
- ❑ I would not like to drive a fully automated vehicle (8)
- ❑ I prefer not to respond (9)

11 I would delegate the driving in a fully automated car if I was over the drink driving limit

- ❍ Strongly disagree 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ Strongly agree 5 (5)
- ❍ Prefer not to respond (6)

12 I would delegate the driving in a fully automated car to the automated driving system if I was tired

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

13 I would be willing to put my children in a fully automated car that would take them to school

- Strongly Disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Not applicable (6)
- Prefer not to respond (7)

14 I would be willing to drive in a fully automated car that belonged to someone else, like a taxi company

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

15 I would be willing to drive in a fully automated car without a steering wheel

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

16 Please indicate why you would like to drive in a fully automated vehicle (select all that apply)

- ❑ Because it is safer (1)
- ❑ Because I could spend time on other activities, such as surfing the internet (2)
- ❑ Because it would speed up my travel (3)
- ❑ Because it would reduce traffic congestion (4)
- ❑ Because it would consume less fuel (5)
- ❑ Because it would be environmentally friendlier (6)
- ❑ I would not like to drive in a fully automated vehicle (7)
- ❑ I prefer not to respond (8)

17 In which following situations would you let your vehicle drive itself (select all that apply)?

- ❑ Motorway (1)
- ❑ Rural state highways (2)
- ❑ Around town with light traffic (3)
- ❑ Around town with heavy traffic (4)
- ❑ Scenic areas (5)
- ❑ Parking (6)
- ❑ Prefer not to respond (7)
- ❑ Other (please state below) (8) _____

18 Rate the degree to which an autonomous vehicle would improve your access to:

	Not at all 1 (1)	2 (2)	3 (3)	4 (4)	A great deal 5 (5)	Prefer not to respond (6)
Services (e.g, doctors, supermarket) (4)	❍	❍	❍	❍	❍	❍
Employment (5)	❍	❍	❍	❍	❍	❍
Recreation, leisure and social activities (6)	❍	❍	❍	❍	❍	❍

19 I would be willing to allow my vehicle to receive data from road controlling authorities in order to learn about road works and other possible problems

- ❍ Strongly disagree 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ Strongly agree 5 (5)
- ❍ Prefer not to respond (6)

20 I would be willing to allow my vehicle to receive data in order to learn about traffic delays and recommended alternative routes

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

21 I would be willing to allow my vehicle to send and receive data with surrounding vehicles, in order to better coordinate its path with those vehicles

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

22 I would be willing to allow my vehicle to transmit data to organisations that maintain the roadway

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

23 I would be willing to allow my vehicle to transmit data to vehicle developers

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

24 I would be willing to allow my vehicle to transmit data to insurance companies

- Strongly disagree 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- Strongly agree 5 (5)
- Prefer not to respond (6)

25 The increasing use of autonomous and connected vehicles (ACVs) comes with a range of concerns and benefits. Please rate how concerned you are about each of the following:

	Not worried (1)	Worried (2)	Very worried (3)	Prefer not to respond (4)
Equipment failure (1)	❍	❍	❍	❍
Legal liability (2)	❍	❍	❍	❍
Hacking of vehicle (3)	❍	❍	❍	❍
Privacy breach (4)	❍	❍	❍	❍
Interactions with conventional vehicles (5)	❍	❍	❍	❍
Learning to use ACVs (6)	❍	❍	❍	❍

26 Now, please rate what in your opinion are the potential benefits of ACVs

	Minimal (or no) benefit (1)	Some benefit (2)	Significant benefit (3)	Prefer not to respond (4)
Fewer crashes (1)	❍	❍	❍	❍
Less congestion (2)	❍	❍	❍	❍
Lower emissions (3)	❍	❍	❍	❍
Better fuel economy (4)	❍	❍	❍	❍

27 How much money would you be willing to pay (on top of the price of that vehicle) for fully automated driving technology?

- ❍ $0 (1)
- ❍ $1 - $500 (2)
- ❍ $501 - $1000 (3)
- ❍ $1001 - $5000 (4)
- ❍ $5001 - $10,000 (5)
- ❍ $10,001 - $15,000 (6)
- ❍ $15,001 - $30,000 (7)
- ❍ > $30,000 (8)
- ❍ Prefer not to respond (9)

Demographics

Now we want to know a little bit about you:

28 What is your age (in years)?

29 What is your gender?

- ❍ Male (1)
- ❍ Female (2)
- ❍ Other (3)
- ❍ Rather not say (4)

30 Which ethnic groups do you belong to? Identify any that apply.

- ❑ Prefer not to answer (11)
- ❑ New Zealand European (1)
- ❑ Maori (3)
- ❑ Other European (2)
- ❑ Samoan (4)
- ❑ Tongan (5)
- ❑ Cook Island Maori (6)
- ❑ Niuean (7)
- ❑ Chinese (8)
- ❑ Indian (9)
- ❑ Other (e.g. Japanese) (10)

31 Where do you live in New Zealand (which province / district)?

- ❍ Northland (1)
- ❍ Auckland (2)
- ❍ Waikato (3)
- ❍ Bay of Plenty (4)
- ❍ Gisborne (5)
- ❍ Hawkes Bay (6)
- ❍ Taranaki (7)
- ❍ Wanganui (8)
- ❍ Manawatu (9)
- ❍ Wairarapa (10)
- ❍ Wellington (11)
- ❍ Nelson Bays (12)
- ❍ Marlborough (13)
- ❍ West Coast (14)
- ❍ Canterbury (15)
- ❍ Timaru-Omaru (16)
- ❍ Otago (17)
- ❍ Southland (18)
- ❍ Prefer not to say (19)

32 What is the total income that you yourself got from all sources, before tax or anything was taken out of it, in the last twelve months?

- Less than $5,000 (1)
- $5,001- $10,000 (2)
- $10,001 - $15,000 (3)
- $15,001 - $20,000 (4)
- $20,001 - $25,000 (5)
- $25,001 - $30,000 (6)
- $30,001 - $40,000 (7)
- $40,001 - $50,000 (8)
- $50,001 - $60,000 (9)
- $60,001 - $70,000 (10)
- $70,001 - $80,000 (11)
- $80,001 - $100,000 (12)
- $100,001 - $120,000 (13)
- $120,001 - $150,000 (14)
- $150,001 or more (15)
- Don't know (16)
- Prefer not to respond (17)

33 What is your primary mode of transportation?

- Private vehicle (1)
- Public transportation (2)
- Motorcycle (3)
- Walking/cycling (4)
- Prefer not to respond (5)
- Other (please state) (6) _____

34 Do you have a current driving license?

- Yes (1)
- No (2)
- Prefer not to respond (3)

Answer If Do you have a current driving license? Yes Is Selected

34.1 What type of driving license?

- NZ learners (1)
- NZ restricted (2)
- NZ full (3)
- NZ motorcycle (4)
- Overseas license (5)
- Prefer not to respond (6)

Answer If Do you have a current driving license? Yes Is Selected

34.2 How long have you had this license? (In years)

Answer If Do you have a current driving license? Yes Is Selected

34.3 How many years of driving experience do you have? (e.g., years since you passed your learners' test)

35 Do you have, or have you ever had, any disability that prevented you from driving a vehicle?

- ❍ No known disability (1)
- ❍ Vision impairment (2)
- ❍ Mobility issues (3)
- ❍ Prefer not to respond (4)
- ❍ Other (please state) (5) _____

36 If you have other views on the increasing use of connected and automated vehicles please provide them below:

37 Thank you for completing the survey. If you would like to receive a summary of the findings please provide your email address in the box below. Please be assured that your name / any identifying information cannot be linked with your responses.

Email address:

38 Would you be happy to be contacted again within the next few months about the possibility of participating in further research on connected and autonomous vehicles?

- ❍ Yes (1)
- ❍ No (2)
- ❍ Prefer not to repond (3)

Answer If Would you be happy to be contacted again within the next few months about the possibility of participating in further research on connected and autonomous vehicles? Yes Is Selected

39 In order for us to get in touch with you please provide your name and email address. Your name will only be used for us to contact you and will not be linked to any of the answers you provide.

Name (1)
Email address (2)

Thank you for taking part in the survey. If you would like further information about this project or if you have comments or questions, please contact the Transport Research Group at the University of Waikato (trg@waikato.ac.nz)

Appendix B: Transport technologies and you (Ministry of Transport 2016; 2017)

Thanks for agreeing to answer some questions of importance to the Ministry of Transport. They should take no more than 5-10 minutes to complete.

We would like to know what people in New Zealand think about some of the new transport technologies that have the potential to revolutionise New Zealand's transport system and make it more efficient, resilient, safe and clean.

Your participation helps us make more informed decisions about transport in New Zealand, and what the future might hold.

All answers you provide are completely confidential. Please note that once you have answered a question, you will not be able to go back and change your answer at a later stage.

Click the Next button to begin.

Transport Technology

Have you heard about…?

1. Electric cars

[ ] Yes [ ] No

2. Hybrid cars

[ ] Yes [ ] No

3. Electric bikes

[ ] Yes [ ] No

4. Self-driving cars

[ ] Yes [ ] No

5. What other new/emerging transport technologies have you heard about? (Please list)

……
……

Knowledge

6. How knowledgeable do you feel about the following?
   Electric cars:

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7
I know nothing about this						I know a great deal about this

   Hybrid cars:

7.

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7
I know nothing about this						I know a great deal about this

   Electric bikes:

8.

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7
I know nothing about this						I know a great deal about this

   Self-driving cars:

9.

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7
I know nothing about this						I know a great deal about this

Attractiveness

10. How attractive to you are the following?
    a. Electric cars:

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7
Not at all attractive						Extremely attractive

    b. Hybrid cars:

[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	[ ] 6	[ ] 7

Not at all attractive — Extremely attractive

c. Electric bikes:

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7

Not at all attractive — Extremely attractive

d. Self-driving cars:

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6 [ ] 7

Not at all attractive — Extremely attractive

Barriers

11. Please select the 3 biggest barriers that would prevent you from buying an electric car in the next 12 months, on a scale of 1-3 (1=biggest barrier, 3=third biggest barrier).

Electric cars are too expensive	[ ]
The second hand petrol/diesel market is much cheaper	[ ]
Electric cars cannot travel far enough	[ ]
Electric cars are not visually appealing	[ ]
There are not enough charging stations available	[ ]
Other/s (please describe below)	[ ]

……
……
……

12. Please select the 3 most important factors that would enable you to buy an electric car in the next 12 months, on a scale of 1-3 (1=most important, 3=third most important).

If I had enough money	[ ]
If purchasing an electric car was subsidised	[ ]
If I could try/test one	[ ]
If they could go as far and as fast as typical petrol and diesel cars	[ ]
If charging stations were more available	[ ]

If charging stations were affordable	[ ]
Other/s (please describe below)	[ ]

……
……

13. Please describe the biggest barriers for you using a self-driving car:

……
……

14. Please describe the most important factors that would enable you to use a self-driving car:

……
……

15. In the last month, how often have you used the following?
(1=everyday/almost everyday; 2=Several times a week; 3=Once a week; 4=Once or twice in the last month; 5=Not used in the last month)

Electric car	……
Hybrid car	……
Electric bike	……
Self-driving car	……
Any other new transport technologies? If so, how often in the last month?	

……
……
……

16. Do you intend to use a new/emerging transport technology in the next 12 months?

[ ]	[ ]	[ ]	[ ]
No	Yes but less than what I currently use	Yes and the same amount as what I currently use	Yes and more than the amount I currently use

17. How safe would you feel travelling in a self-driving car?

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]
1	2	3	4	5	6	7
Extremely unsafe						Extremely safe

Exit page

On behalf of the Ministry of Transport, thank you for answering these questions. Your contribution is greatly appreciated.

When you are ready, close this web page, your answers have been saved.

Appendix C: Readiness for shared mobility

Introduction/Eligibility

Q1.1 Rapid changes in technology have resulted in the availability of a number of new transport options (e.g., app-based ride services). We are interested in what car drivers in New Zealand think about transport sharing options, their experience with them and likelihood of using them in the future. The survey is anonymous, will take approximately 15 minutes to complete and you can stop taking the survey at any time by closing your browser.
The findings will be published as a report for the New Zealand Transport Agency, presented at relevant conferences and published in academic journals. The information you provide can only be accessed by the research team. The data will be stored on a password protected server at the University of Waikato for a minimum of 5 years. The findings will be available on the Transport Research Group website in early 2019 (https://sites.google.com/a/waikato.ac.nz/trg/).

If you have any questions about the research please contact a member of the research team: Nicola Starkey (nicola.starkey@waikato.ac.nz) or Samuel Charlton (samuel.charlton@waikato.ac.nz) from the University of Waikato. The research has received approval from the School of Psychology Ethics Committee at the University of Waikato and is funded by the New Zealand Transport Agency. If you have any concerns about the ethical conduct of this research please contact the convenor Dr Rebecca Sargisson (rebeccas@waikato.ac.nz)

Please read about the different shared transport options that are mentioned in the survey.

App-based ride hailing encompasses services, such as Uber and Zoomy, where people can arrange and pay for a driver to take them to a particular destination, using an app on their smartphone. This includes traditional taxi services that can be booked and paid for through a smartphone app.

Ridesharing/carpooling is where two or more people share the same vehicle to a particular destination, such as work or town. Ridesharing/carpooling may be arranged with someone you know, or through websites or apps, for travel to work, or an event, or even between cities.

Carsharing is a type of car rental service where customers can rent and pay for vehicles by the minute or hour, and where vehicles are parked at various locations within a city. Prior to use, individuals must register with a carshare service, and then they can access the carshare vehicles whenever they need them. Examples include Cityhop, Mevo and Yoogo.

Q1.2 Would you like to complete the survey?

- ❍ Yes (1)
- ❍ No (2)

Q1.3 Do you use a car as your main form of transport?

- ❍ Yes (1)
- ❍ No (2)

Skip To: End of Survey If Q1.3 = 2

Q1.4 We want to hear views of transport sharing from a diverse group of people. The first two questions are to ensure our sample includes people from different age groups and genders.

Q1.5 Please select your age group

- 16-24 (1)
- 25-44 (2)
- 45-64 (3)
- Over 65 (4)

Q1.6 What is your gender?

- Male (1)
- Female (2)
- Non binary / third gender (3)
- Prefer to self describe (4)
- Prefer not to say (5)

- *Display This Question:*
- *If Q1.6 = 4*

Q1.7 Please self describe

_____

Transport sharing - MoT questions

Q2.1 For the **majority** of car journeys you take are you the driver or passenger?

- Driver (1)
- Passenger (2)

Q2.2 Thinking about new transport sharing options. Have you heard about:

	Yes (1)	No (2)
App based ride hailing services such as Uber or Zoomy (Q2.1_1)	❍	❍
Ridesharing/carpooling options (Q2.1_2)	❍	❍
Carsharing (Q2.1_3)	❍	❍

Q2.3 Are any of the following available to you?

	Yes (1)	No (2)	Don't know (3)
App based ride hailing services such as Uber or Zoomy (Q2.2_1)	❍	❍	❍
Ridesharing/carpooling options (Q2.2_2)	❍	❍	❍
Carsharing (Q2.2_3)	❍	❍	❍

Q2.4 How knowledgeable do you feel about:

	I know nothing about this (1)	2 (2)	3 (3)	4 (4)	I know a great deal about this (5)
App based ride hailing services such as Uber or Zoomy (Q2.3_1)	❍	❍	❍	❍	❍
Ridesharing/carpooling options (Q2.3_2)	❍	❍	❍	❍	❍
Carsharing (Q2.3_3)	❍	❍	❍	❍	❍

Q2.5 In the last 12 months have you used?

	No (1)	Yes (2)
App based ride hailing services such as Uber or Zoomy (Q2.4_1)	❍	❍
Ridesharing/carpooling options (Q2.4_2)	❍	❍
Carsharing (Q2.4_3)	❍	❍

Q2.6 In the next 12 months do you intend to use?

	No (1)	Yes, but less than I currently use (2)	Yes, and the same amount as I currently use (3)	Yes, and more than I currently use (4)
App based ride hailing service such as Uber or Zoomy (Q2.5_1)	❍	❍	❍	❍
Ridesharing/carpooling options (Q2.5_2)	❍	❍	❍	❍
Carsharing (Q2.5_3)	❍	❍	❍	❍

❍ *Display This Question:*

❍ *If Q2.6 = 1 [1]*

Q2.7 Please select up to 3 barriers that would prevent you from using app-based ride hailing services in the next 12 months, where 1=biggest barrier, and 3=third biggest barrier.

_____ These services aren't available in my area (1)

_____ I own a car (2)

_____ I don't own a smartphone (3)

_____ I don't know how to access/use these services (4)

_____ I wouldn't feel safe (5)

_____ These services don't meet my needs (e.g. car seats, wheelchair transport) (6)

_____ These services are more expensive than other transport options (7)

_____ Other/s (8)

- *Display This Question:*
- *If Q2.7 [8] Is Not Empty*

Q2.8 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 1 [1]*

Q2.9 Please select up to 3 factors that would enable you to use app-based ride hailing services such as Uber or Zoomy in the next 12 months, where 1=most important factor, and 3=third most important factor.

_____ If these services were available in my area (1)

_____ Having a smartphone (2)

_____ Learning how to access/use these services (3)

_____ Finding out more about the safety of these services (4)

_____ If these services could meet my needs (e.g. car seats, wheelchair transport) (5)

_____ If these services were cheaper than other transport options (6)

_____ Seeing other people around me use these services (7)

_____ Other/s (8)

- *Display This Question:*
- *If Q2.7 [8] Is Not Empty*

Q2.10 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 2 [1]*

Q2.11 Please select up to 3 barriers that would prevent you from using ridesharing/carpooling options in the next 12 months, where 1=biggest barrier, and 3=third biggest barrier.

_____ I'm unaware of ridesharing/carpooling options in my area (1)

_____ I don't know how to access/use these options (2)

_____ I own a car (3)

_____ I wouldn't feel safe (4)

_____ Insurance concerns (5)

_____ Negotiating terms of use with others using the vehicle (6)

_____ Losing convenience (7)

_____ Losing freedom (8)

_____ Reduced ability to get somewhere in an emergency (9)

_____ I don't want to share a car with strangers (11)

_____ Other/s (10)

- *Display This Question:*
- *If Q2.11 [10] Is Not Empty*

Q2.12 If other/s, please describe

_____

- *Display This Question:*
- *If Q2.6 = 2 [1]*

Q2.13 Please select up to 3 factors that would enable you to use ridesharing/carpooling options in the next 12 months, on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

_____ Having ridesharing/carpooling options available in my area (1)

_____ Finding out more about the safety of these services (2)

_____ Ensuring insurance was covered in the event of an accident (3)

_____ Having a firm agreement about use (4)

_____ Ensuring everyone pays fairly for how much they use the vehicle (5)

_____ Having accessible booking system in place (6)

_____ Making carsharing/carpooling a part of community infrastructure (7)

_____ Having access to a variety of car types for different purposes (8)

_____ Knowing how to find other people who want to carshare (9)

_____ Having access to online carsharing groups or apps that help people connect (e.g. Uber Commute) (10)

_____ Other/s (11)

- *Display This Question:*
- *If Q2.13 [11] Is Not Empty*

Q2.14 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 3 [1]*

Q2.15 Please select up to 3 barriers that would prevent you from using a carsharing in the next 12 months, on a scale of 1-3, where 1=biggest barrier, and 3=third biggest barrier.

_____ I'm not aware of carsharing in my area (1)

_____ I don't know how to access/use these services (2)

_____ I own a car (3)

_____ Losing convenience (4)

_____ Losing freedom (5)

_____ Insurance concerns (6)

_____ Types of vehicles available don't suit my needs (7)

_____ Reduced ability to get somewhere in an emergency (8)

_____ These services are more expensive than other transport options (9)

_____ Other/s (10)

- *Display This Question:*
- *If Q2.15 [10] Is Not Empty*

Q2.16 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 2 [1]*

Q2.17 Please select up to 3 factors that would enable you to use ridesharing/ carpooling in the next 12 months, on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

_____ Having the service available in my area (1)

_____ Learning how to access/use these services (2)

_____ Having an accessible booking system (3)

_____ Having insurance covered in the event of an accident (4)

_____ Access to a variety of car types for different purposes (5)

_____ If carsharing fees were less than car ownership costs (6)

_____ Other/s (7)

- *Display This Question:*
- *If Q2.17 [7] Is Not Empty*

Q2.18 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 1 [2]*
- *Or Q2.6 = 1 [3]*
- *Or Q2.6 = 1 [4]*
- *Or Q2.5 = 1 [1]*

Q2.19 Please select up to 3 reasons why you use app-based ride hailing services such as Uber or Zoomy on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

_____ These services are available in my area (1)

_____ I don't own a car (2)

_____ It is convenient (3)

_____ I feel safe using these services (4)

_____ I know how to access/use these services (5)

_____ These services meet my needs (e.g. car seats, wheelchair transport) (6)

_____ These services are cheaper than other transport options (7)

_____ There is an accessible booking system (8)

_____ I have a health condition/s that prevent me from driving (10)

_____ My workplace requires me to use this service for business trips (11)

_____ Sustainability/ reducing carbon footprint (13)

_____ Other/s (14)

- *Display This Question:*
- *If Q2.19 [14] Is Not Empty*

Q2.20 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 2 [2]*
- *Or Q2.6 = 2 [3]*
- *Or Q2.6 = 2 [4]*
- *Or Q2.5 = 2 [1]*

Q2.21 Please select up to 3 reasons why you use ridesharing/carpooling on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

_____ These services are available in my area (1)

_____ I don't own a car (2)

_____ It is convenient (3)

_____ I feel safe using these services (4)

_____ I know how to access/use these services (5)

_____ These services meet my needs (e.g. car seats, wheelchair transport) (6)

_____ These services are cheaper than other transport options (7)

_____ There is an accessible booking system (8)

_____ I have a health condition/s that prevent me from driving (10)

_____ My workplace requires me to use this service for business trips (11)

_____ Sustainability/ reducing carbon footprint (13)

_____ Other/s (14)

- *Display This Question:*
- *If Q2.21 [14] Is Not Empty*

Q2.22 If other/s please describe

_____

- *Display This Question:*
- *If Q2.6 = 3 [2]*
- *Or Q2.6 = 3 [3]*
- *Or Q2.6 = 3 [4]*
- *Or Q2.5 = 3 [1]*

Q2.23 Please select up to 3 reasons why you use carsharing on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

_____ These services are available in my area (1)

_____ I don't own a car (2)

_____ It is convenient (3)

_____ I feel safe using these services (4)

_____ I know how to access/use these services (5)

_____ These services meet my needs (e.g. car seats, wheelchair transport) (6)

_____ These services are cheaper than other transport options (7)

_____ There is an accessible booking system (8)

_____ I have a health condition/s that prevent me from driving (10)

_____ My workplace requires me to use this service for business trips (11)

_____ Sustainability/ reducing carbon footprint (13)

_____ Other/s (14)

- *Display This Question:*
- *If Q2.23 [14] Is Not Empty*

Q2.24 If other/s please describe

_____

Current transport use and future ridesharing

Q3.1 We would like to know how you usually travel to different places.
Please select the option that best describes how you usually travel for each of the purposes listed below.

Travel to / from work or place of study (Q3.1_1)	▼ Walking (1) ... I don't make this type of trip (11)
Travel to drop off / pick up children at school, daycare or other place, if trip does not include place of work or study (Q3.1_2)	▼ Walking (1) ... I don't make this type of trip (11)
Daily shopping (e.g., supermarket) (Q3.1_3)	▼ Walking (1) ... I don't make this type of trip (11)
Social activity (e.g., visiting family or friends) (Q3.1_4)	▼ Walking (1) ... I don't make this type of trip (11)
Leisure activities (e.g., sport) (Q3.1_5)	▼ Walking (1) ... I don't make this type of trip (11)
Personal matters (e.g., doctors appointment) (Q3.1_6)	▼ Walking (1) ... I don't make this type of trip (11)

Q3.2 In a typical week which trip do you make most frequently by car?

- ❍ Travel to / from work or place of study (1)
- ❍ Travel to drop off / pick up children at school, daycare or other place, if trip does not include place of work or study (2)
- ❍ Daily shopping (e.g., supermarket) (3)
- ❍ Social activity (e.g., visiting family or friends) (4)
- ❍ Leisure activities (e.g., sport) (5)
- ❍ Personal matters (e.g., doctors appointment) (6)
- ❍ Other trips (7)

- ❍ *Display This Question:*
- ❍ *If Q3.2 = 7*

Q3.3 If other, please describe

_____

Q3.4 How long does this trip usually take? (One direction only in hours and minutes)

Hours (Q3.4_1)	▼ 0 (1) ... 59 (60)
Minutes (Q3.4_2)	▼ 0 (1) ... 59 (60)

Q3.5 Thinking about the same journey, how long does it take for you to get to your destination once you have parked your car?

▼ less than 1 minute (1) ... more than 30 mins (31)

Q3.6 How many adults and children usually take this trip with you? (if you travel alone, please select 0 in each box)

Number of adults (Q3.6_1)	▼ 0 (1) ... 6 (7)
Number of children (Q3.6_2)	▼ 0 (1) ... 6 (7)

Q3.7
In the future a number of new transport options will be available. **We would like to explore your views on one type of transport sharing option - a Shared Taxi** (similar to Uber POOL or Lyft Line).

A Shared Taxi is an on-demand door-to-door service with up to six people sharing the vehicle. Other passengers would be departing from a location close to you and travelling to a similar destination. The vehicle would be a modern minivan of 8 seats rearranged for 6 seats, with easy entry and exit and capacity to carry luggage (including prams and bikes). Shared taxis would be driven by a professional driver and include access to the internet as part of the fee. A Shared Taxi can be booked in real time via a Smartphone app, and rides are confirmed within a minute of request. A Shared Taxi is cheaper than conventional taxi services or current single pick up taxi services (e.g., Uber).

Thinking about the trip you most commonly make in your car, how much time (in minutes) would you need to save to use a Shared Taxi?

▼ I would not use a Shared Taxi (0) ... over an hour (60)

Q3.8 Car drivers tend to forget the cost of using a private car. For **15,000km** driving per year (on average 60km per day) the cost is **NZ$20 per day** (NZ$10 in fuel/energy + NZ$10 purchase price of car + insurance, licensing, Warrant of Fitness + maintenance). Including tolls and parking costs the total cost of private car use amounts to **NZ$25-NZ$30 per day**. For most people the cost of t**he daily commute** (to work or place of study) i**n a private car is approximately NZ$25.**

Thinking about the trip you most commonly make in your car, how much money would you need **to save** to use a Shared Taxi?

▼ I would not use a Shared Taxi (0) ... NZ$30 (30)

Q3.9 On this same journey, how much time would you be willing to spend **getting to a pick up point** for the Shared Taxi?

▼ I would not use a Shared Taxi (0) ... 30 mins (30)

Q3.10 On this same journey, how much time would you be willing to spend **getting to your final destination** from the Shared Taxi drop off point?

▼ I would not use a Shared Taxi (0) ... 30 mins (30)

Q3.11 If you used a Shared Taxi instead of your car for your most common car journey, how much time would you be willing to wait for a ride? (in minutes)

▼ I would not use a Shared Taxi (0) ... 15 mins (15)

Q3.12 If you used a Shared Taxi how long would you be willing to spend to collect someone or drop someone off (a detour) as compared to the **quickest route** (e.g.,)? (in minutes)

▼ I would not use a Shared Taxi (0) ... 15 mins (15)

Q3.13 How many people would you be willing share a taxi with (excluding the driver)? (the vehicle comfortably carries six passengers)

- ❍ I would not use a Shared Taxi (0)
- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 (5)
- ❍ 6 (6)

Q3.14 If a Shared Taxi were available what trips would you use it for (select all that apply)?

- ❑ Travel to / from work or place of study (1)
- ❑ Travel to drop off / pick up children at school, daycare, or other place, if trip does not include place of work or study (2)
- ❑ Daily shopping (e.g., supermarket) (3)

- ❑ Social activity (e.g., visiting family or friends) (4)
- ❑ Leisure activities (e.g., sport) (5)
- ❑ Personal matters (e.g., doctors appointment) (6)
- ❑ One off or occasional trips (e.g, travel to/from the airport) (7)
- ❑ Other trips (8)

- ❍ *Display This Question:*
- ❍ *If Q3.14 = 8*

Q3.15 If other, please describe

_____

Q3.16 How many cars do you have in your household? (include station wagons and utes, but not trucks, motorbikes or farm vehicles)

- ❍ 0 (0)
- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ 5 or more (5)

Q3.17 If Shared Taxi services were available how many cars in your household would you sell?

- ❍ 0 (0)
- ❍ 1 (1)
- ❍ 2 (2)
- ❍ 3 (3)
- ❍ 4 (4)
- ❍ All cars in my household (5)
- ❍ I do not own a car (99)

Q3.18 If Shared Taxi services were available, what would be the **barriers** to you using **a Shared Taxi** scheme ?

_____

_____

_____

_____

_____

Q3.19 If Shared Taxi services were available, what factors would **enable** you to use **a Shared Taxi** scheme ?

_____

_____

_____

_____

_____

Other demographic information

Q4.1 You have completed the transport related questions. We would now like to know a bit about you. How old are you?

Q4.2 Which ethnic groups do you belong to? Identify any that apply.

- ❑ New Zealand European (1)
- ❑ Māori (2)
- ❑ Samoan (3)
- ❑ Tongan (4)
- ❑ Cook Island Māori (5)
- ❑ Niuean (6)
- ❑ Chinese (7)
- ❑ Indian (8)
- ❑ Other (please state) (9)
- ❑ Prefer not to answer (10)

- *Display This Question:*
- *If Q4.2 = 9*

Q4.3 Please state your ethnicity

_____

Q4.4 What is your total annual personal income before tax?

- Loss (1)
- Zero (2)
- $1-20,000 (3)
- $20,001- 40,000 (4)
- $40,001- 60,000 (5)
- $60,001- 80,000 (6)
- $80,001- 100,000 (7)
- $100,001+ (8)
- Prefer not to answer (24)

Q4.5
Do you have a long-term disability (lasting six months or more) that stops you from doing everyday things that other people can do?

- Yes (1)
- No (2)

Q4.6 What is your highest secondary school qualification?

- none (1)
- NCEA Level 1 or School Certificate (2)
- NCEA Level 2 or Sixth Form Certificate (3)
- NCEA Level 3 or University Entrance, Bursary or Scholarship (4)
- Other secondary school qualification gained in New Zealand (5)
- Other secondary school qualification gained overseas (6)
- Prefer not to answer (7)

- *Display This Question:*
- *If Q4.6 = 5*

Q4.7 If other secondary school qualification gained in New Zealand please describe

_____

- *Display This Question:*
- *If Q4.6 = 6*

Q4.8 If other secondary school qualification gained overseas please describe

_____

Q4.9 Apart from secondary school qualifications, do you have another completed qualification (don't count any qualification that takes less than 3 months of full-time study to get)

- Yes (1)
- No (2)
- Prefer not to answer (4)

- *Display This Question:*
- *If Q4.9 = 1*

Q4.10 What is your highest qualification?

- Trade Certificate (1)
- Dipolma (2)
- Bachelor Degree (3)
- Postgraduate diploma (4)
- Honours Degree (5)
- Masters Degree (6)
- PhD (7)
- Other (8)

- *Display This Question:*
- *If Q4.10 = 8*

Q4.11 If other please describe

_____

Q4.12 Where do you live in New Zealand (which province / district)?

- ❍ Northland (1)
- ❍ Auckland (2)
- ❍ Waikato (3)
- ❍ Bay of Plenty (4)
- ❍ Gisborne (5)
- ❍ Hawkes Bay (6)
- ❍ Taranaki (7)
- ❍ Wanganui (8)
- ❍ Manawatū (9)
- ❍ Wairarapa (10)
- ❍ Wellington (11)
- ❍ Nelson Bays (12)
- ❍ Marlborough (13)
- ❍ West Coast (14)
- ❍ Canterbury (15)
- ❍ Timaru-Oamaru (16)
- ❍ Otago (17)
- ❍ Southland (18)

Q4.13 Which best describes where you live?

- ❍ Urban area (1)
- ❍ Rural area (2)

Q4.14 How long have you held a New Zealand driving licence (in years)?

▼ less than 1 year (1) ... I do not hold an NZ driving licence (0)

Q4.15 And finally, do you currently own a smartphone?

- ❍ Yes (1)
- ❍ No (2)

Appendix D: Transport sharing and you

Thanks for agreeing to answer some questions of importance to the Ministry of Transport. They should take no more than 5-10 minutes to complete.

We would like to know what people in New Zealand think about some of the new transport sharing options that have the potential to revolutionise New Zealand's transport system.

Your participation helps us make more informed decisions about transport in New Zealand.

All answers you provide are completely confidential. Click the Next button to begin.

Please read about the transport sharing options (also called 'mobility as a service') we will be discussing in the survey:

App-based ride services are taxi-like services where people can arrange and pay for transport to a particular destination using their smartphone. Examples include Uber or Zoomy.

Carsharing/carpooling is where two or more people share the same vehicle to a particular destination, such as work or town. Carsharing may be arranged with someone you know, or through technology, such as Facebook pages or apps, to arrange carsharing to work, or an event, or even between cities.

Car clubs are services where customers have access to vehicles when they need them without owning or paying ownership costs for those vehicles. Prior to use, individuals must register to a car club, which has a range of vehicles parked at various locations within a city. Examples include CityHop and Mevo.

Bike sharing schemes are services where customers have access to a bicycle for a short period of time. Bikes can be picked-up and dropped-off at various locations within a city.

Awareness

1. Have you heard about:
    a. App-based ride services such as Uber or Zoomy
    b. Carsharing/carpooling options
    c. Car clubs
    d. Bike sharing schemes

[ ]	[ ]
Yes	No

2. Are any of the following available to you?
    a. App-based ride services such as Uber or Zoomy
    b. Carsharing/carpooling options
    c. Car clubs
    d. Bike sharing schemes

[ ] Yes [ ] No [ ] Don't know

Knowledge

3. How knowledgeable do you feel about:
   a. App-based ride services such as Uber or Zoomy
   b. Carsharing/carpooling options
   c. Car clubs
   d. Bike sharing schemes

[ ] 1 I know nothing about this [ ] 2 [ ] 3 [ ] 4 [ ] 5 I know a great deal about this

Desire

4. How attractive do you find:
   a. App-based ride services such as Uber or Zoomy
   b. Carsharing/carpooling options
   c. Car clubs
   d. Bike sharing schemes

[ ] 1 Not attractive whatsoever [ ] 2 [ ] 3 [ ] 4 [ ] 5 Extremely attractive

Action

5. In the last 12 months, have you used:
   a. App-based ride services such as Uber or Zoomy
   b. Carsharing/carpooling options
   c. Car clubs
   d. Bike sharing schemes

[ ] Yes [ ] No

6. In the last 4 weeks, on how many days have you used: <only display options selected in Q5>
    a. App-based ride services such as Uber or Zoomy
    b. Carsharing/carpooling options
    c. Car clubs
    d. Bike sharing schemes

[ ]	[ ]	[ ]	[ ]	[ ]
Not in the last 4 weeks	1-4 days	5-9 days	10-19 days	20+ days

Maintenance

7. In the next 12 months do you intend to use:
    a. App-based ride services such as Uber or Zoomy
    b. Carsharing/carpooling options
    c. Car clubs
    d. Bike sharing schemes

[ ]	[ ]	[ ]	[ ]
No	Yes, but less than I currently use	Yes, and the same amount as I currently use	Yes, and more than I currently use

Barriers and enablers

<only ask each pair of barrier/enabler questions for the services if no in the next 12 months per Q7>

8. Please select up to 3 barriers that would prevent you from using app-based ride services such as Uber or Zoomy in the next 12 months, where 1=biggest barrier, and 3=third biggest barrier.

These services aren't available in my area	[ ]
I own a car	[ ]
I don't own a smartphone	[ ]
I don't know how to access/use these services	[ ]
I wouldn't feel safe	[ ]
These services don't meet my needs (e.g. car seats, wheelchair transport)	[ ]
These services are more expensive than other transport options	[ ]
Other/s (please describe below)	[ ]

……
……

9. Please select up to 3 factors that would enable you to use app-based ride services such as Uber of Zoomy in the next 12 months, where 1=most important factor, and 3=third most important factor.

If these services were available in my area	[ ]
Having a smartphone	[ ]
Learning how to access/use these services	[ ]
Finding out more about the safety of these services	[ ]
If these services could meet my needs (e.g. car seats, wheelchair transport)	[ ]
If these services were cheaper than other transport options	[ ]
Seeing other people around me use these services	[ ]
Other/s (please describe below)	[ ]

……
……
……
……

10. Please select up to 3 barriers that would prevent you from using carsharing/carpooling options in the next 12 months, where 1=biggest barrier, and 3=third biggest barrier.

I'm unaware of carsharing/carpooling options in my area	[ ]
I don't know how to access/use these options	[ ]
I own a car	[ ]
I wouldn't feel safe	[ ]
Insurance concerns	[ ]
Negotiating terms of use with others using the vehicle	[ ]
Losing convenience	[ ]

Losing freedom	[ ]
Reduced ability to get somewhere in an emergency	[ ]
Other/s (please describe below)	[ ]

……
……

11. Please select up to 3 factors that would enable you to use carsharing/carpooling options in the next 12 months, on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

Having carsharing/carpooling options available in my area	[ ]
Finding out more about the safety of these services	[ ]
Ensuring insurance was covered in the event of an accident	[ ]
Having a firm agreement about use	[ ]
Ensuring everyone pays fairly for how much they use the vehicle	[ ]
Having accessible booking system in place	[ ]
Making carsharing/carpooling a part of community infrastructure	[ ]
Having access to a variety of car types for different purposes	[ ]
Knowing how to find other people who want to carshare	[ ]
Having access to online carsharing groups or apps that help people connect (e.g. Uber Commute)	[ ]
Other/s (please describe below)	[ ]

……
……

12. Please select up to 3 barriers that would prevent you from using a car club in the next 12 months, on a scale of 1-3, where 1=biggest barrier, and 3=third biggest barrier.

I'm not aware of car clubs in my area	[ ]
I don't know how to access/use these services	
I own a car	[ ]
Losing convenience	[ ]
Losing freedom	[ ]
Insurance concerns	[ ]
Types of vehicles available don't suit my needs	[ ]
Reduced ability to get somewhere in an emergency	[ ]
These services are more expensive than other transport options	[ ]
Other/s (please describe below)	[ ]

……
……

13. Please select up to 3 factors that would enable you to use a car club in the next 12 months, on a scale of 1-3, where 1=most important factor, and 3=third most important factor.

Having the service available in my area	[ ]
Learning how to access/use these services	[ ]
Having an accessible booking system	[ ]
Having insurance covered in the event of an accident	[ ]
Access to a variety of car types for different purposes	[ ]
If car club fees were less than car ownership costs	[ ]
Other/s (please describe below)	[ ]

……
……

14. What are the barriers to you using a bike sharing scheme in the next 12 months?

……
……

15. What factors would enable you to use a bike sharing scheme in the next 12 months?

……
……

Exit page

On behalf of the Ministry of Transport, thank you for answering these questions. Your contribution is greatly appreciated.

When you are ready, close this web page, your answers have been saved.