Consumer awareness, understanding, and use of advanced driver-assistance systems currently available in vehicles on New Zealand roads

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Abbreviations and acronyms

ABS	anti-lock braking system
ACC	adaptive cruise control
ADAS	advanced driver-assistance systems
AEB	automatic emergency braking
BSM	blind spot monitoring
ESC	electronic stability control
FCW	forward collision warning
LDW	lane departure warning
LKA	lane keep assist
R&L	registration and licensing
SAE	Society of Automotive Engineers

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Executive summary

Introduction

Newer vehicles in New Zealand are increasingly equipped with advanced driver-assistance systems (ADAS) designed to assist and sometimes partially automate the driving task. In recent years, New Zealand has mandated electronic stability control for all vehicles entering New Zealand and anti-lock braking systems for motorcycles. Blind spot monitoring, adaptive cruise control, and lane keep assist are other increasingly common technologies that provide warnings or control of the vehicle in certain circumstances.

If ADAS technologies are to improve driver safety, drivers need to understand and value them and use them correctly. Little is currently known about the awareness, perceptions, and knowledge that New Zealanders have of ADAS. Further, for New Zealanders driving or travelling in vehicles equipped with ADAS, little is known about their understanding of safe and appropriate use, which functions are considered most useful, which are used most frequently, and which are misused. Furthermore, there is limited understanding of New Zealanders' experience of ADAS in different driving contexts and their experience of unintended events or consequences.

With better understanding, government interventions can be designed to support the correct and safe use of ADAS technologies. To address the current knowledge gaps and to provide direction to government responses, this study addressed five research objectives:

A. To understand New Zealanders' level of **awareness and knowledge** about ADAS, including knowledge of what they do and their safe and correct use

B. To understand what **training** is provided about the different functionalities when people buy a vehicle with ADAS features

C. To understand public **acceptance and perceptions** of different ADAS technologies and whether a vehicle having or not having them influences vehicle purchasing decisions

D. For people who own vehicles with ADAS technologies, to understand **how often they are using them** and, if they turn them off, what their **reasons are for turning them off**

E. To understand whether there are ways that people are **using ADAS that differ from how or when they were designed to be used.**

Conceptual framework

To provide context, this study first examined New Zealanders' awareness, perceptions, and beliefs relating to the general concept of an automated vehicle. While this exploration was outside the focus of our research on Society of Automotive Engineers (SAE) Level 0 (no automation) to Level 2 (partial automation) technologies, the findings provide important initial insights into how New Zealanders see the spectrum of automation as well as their concerns with fully automated vehicles. The initial broad exploration was followed by an examination of New Zealanders' awareness, perceptions, knowledge, and use of ADAS technologies, up to and including SAE Level 2. Seven ADAS technologies were specifically examined:

- automatic emergency braking (AEB)
- forward collision warning (FCW)
- adaptive cruise control (ACC)
- lane departure warning (LDW)
- lane keep assist (LKA)

- blind spot monitoring (BSM)
- electronic stability control (ESC).

The three stages a consumer would typically go through to potentially driving a vehicle equipped with ADAS – pre-consumer, consumer, and user – provided the conceptual framework for the study. The research objectives and key questions were mapped to these stages, and the stages provided the organising framework to present and discuss the research findings and to draw conclusions and recommendations.

The research questions on New Zealanders' perceptions and acceptance of the general concept of an automated vehicle, and their awareness and knowledge of specific ADAS technologies, were addressed in the pre-consumer stage. The research questions about the influence of the availability of ADAS technology in the decision to purchase or lease a vehicle, and information sources used to learn about ADAS technologies, were addressed in the consumer stage. Finally, the questions on how ADAS technologies are used, how well and how often, and users' experiences, were addressed in the user stage.

Literature review

A literature review was initially conducted to understand existing knowledge regarding the research objectives and to help shape the approach to this study. The review found that the public has a poor understanding of the levels of vehicle automation and that an automated vehicle is commonly thought of as a self-driving car. However, there is growing public awareness of ADAS technologies, and awareness is generally higher among men and those with higher education and household incomes.

Trust in ADAS technologies is a key determinant of their use. Trust is shaped by reliability, perceived usefulness, the ease with which technologies can be understood, and the extent to which technologies function as expected. Acceptance and trust in ADAS vary across different technologies as well as by vehicle manufacturer. There is evidence that males are more likely to trust ADAS compared to females, and that trust is greatest for drivers already using the technology. As understanding of ADAS increases, including limitations, drivers are more likely to see ADAS as a support to their driving.

Primary motivations for purchasing a vehicle with ADAS include safety, convenience, stress reduction, and the desire to have the latest technology. Those already driving a vehicle with ADAS are more likely to see the availability of technologies as a factor that will be influential in a future vehicle purchase decision.

There is evidence that trial and error is often used to learn how to use ADAS technologies. The extent to which users understand the responsibilities of the driver when driving vehicles equipped with ADAS technologies is mixed, as is their understanding of the capabilities and limitations of the technologies.

Research approach and methods

In Stage One of the study, four research activities were carried out in parallel with the initial review of the literature. ADAS technologies in New Zealand, including the size and shape of the market, were initially explored through interviews with three motoring sector experts and through an analysis of available secondary data. To gain further insights into current use, issues, and terms used, we also reviewed ADAS-related user content posted on public New Zealand-based online motoring forums and transport discussion boards.

Stage Two of the study comprised a main online survey of New Zealanders (n = 1,051), a supplementary ('boost') online survey of owners and users of vehicles equipped with ADAS (n = 152), and in-depth interviews with owners of vehicles equipped with ADAS (n = 17).

The questionnaire used for the main survey largely replicated a Canadian questionnaire with similar objectives. The survey respondents, recruited from a research panel comprising over 300,000 active members, were representative of the New Zealand driving population.

As the incidence of New Zealanders with current experience of ADAS is relatively low, the supplementary survey was conducted of additional drivers, recruited from the same panel, and with experience of at least one of the ADAS technologies examined. The same questionnaire used for the main survey was employed, with some changes to question order.

In the analysis of the survey data, respondents were categorised into four ADAS user groups based on their ADAS experience:

- driver owner (own or lease a vehicle equipped with ADAS)
- driver user (have driven but do not own a vehicle equipped with ADAS)
- non-driver user (are or have been a passenger in a vehicle equipped with ADAS)
- non-user (do not own, have never driven, nor have ever been a passenger in a vehicle equipped with ADAS).

Following the two surveys, we conducted interviews with a broadly representative sample of owners of vehicles equipped with ADAS, which allowed us to examine owners' perceptions, knowledge, and use in greater depth. We also conducted four 'ride-along' interviews, which enabled us to examine use and non-use within real-life driving contexts.

Key findings

Pre-consumer stage

Perceptions, familiarity, and acceptance of automated vehicles

Unprompted, many New Zealanders did not immediately think about the levels of automation when thinking about the concept of an automated vehicle. Common responses were a self-driving car (28%), a vehicle with automatic or automated functions (14%), and a driverless vehicle (12%). About two-thirds (63%) described themselves as not very or not at all familiar with the concept of an automated vehicle.

We found that only 2% of New Zealanders did *not* identify any disadvantages associated with the concept of an automated vehicle. Concerns include higher levels of automation, system security and data privacy issues, and that automation could have a negative impact on driver performance. However, a significant proportion of New Zealanders also understand that automated vehicles can bring benefits and advantages, particularly enhancements in driving performance and road safety.

Communications that clarify the distinction between driver aids and automated vehicles, including those currently available in New Zealand, seem important, as many New Zealanders in this study attributed risks and disadvantages to the concept of an automated vehicle that do not necessarily apply to the level of automation currently permitted. Current perceptions may distort or undermine New Zealanders' response to, and potentially use of, lower-level technologies, particularly when more comprehensive and integrated systems become available.

When asked about in-vehicle technologies generally, only 5% of New Zealanders had not heard of any technologies. Levels of awareness varied by type of technology, and in general, males were more likely to have heard of different technologies compared to females. For many technologies, but not all, older New Zealanders were more likely to have heard of them compared to those younger. This trend is in part likely to be explained by many older people being more able to afford a vehicle equipped with ADAS.

Experience and familiarity with ADAS technologies

On each ADAS technology examined, close to one-third of New Zealanders surveyed had experience with the technology as either a driver owner, driver user, or non-driver user. Not surprisingly, for each technology examined, the majority of New Zealanders had neither driven nor been a passenger in a vehicle equipped with the technology.

Closer examination showed that many New Zealanders with experience of ADAS still only had *limited* experience. Close to half (46%) of driver owners only had one technology, and about one in five only had two; further, over half (55%) of the driver owners with only one technology only had ESC.

We asked users and all others who had heard of ADAS technologies how familiar they were with each. About half described themselves as somewhat or very familiar. Examining familiarity by driver owners and driver users showed that about three-quarters or more were somewhat or very familiar, with driver owners slightly more likely to report this than driver users. Perhaps not surprisingly, while older people were more likely to have heard of different ADAS technologies, younger people were more likely to describe themselves as somewhat or very familiar.

Not surprisingly, the ‘have heard of’ and ‘how familiar’ findings show that while many New Zealanders have heard of ADAS technologies, familiarity with specific technologies depends on the type and level of use. That awareness increases with age is also not unexpected, as ADAS technologies are only available in newer vehicles and the average age of the New Zealand vehicle fleet is high. However, while many older people may be more able to afford a vehicle equipped with ADAS, our results suggest they may be less likely to feel familiar or confident with the technologies, compared to younger users.

Perhaps of most concern are the proportions of driver owners and driver users not familiar with the ADAS technologies in their vehicles; these results ranged between 5% and 32% depending on the user group and the technology. These findings suggest that any intervention to enhance detailed understanding of specific ADAS technologies should initially focus on those currently driving or likely to soon be driving ADAS-equipped vehicles, rather than the general population.

Consumer stage

Learning about ADAS technologies

We found that New Zealanders who drive or ride in vehicles equipped with ADAS are currently largely required to seek out technology-specific information themselves. Information directly from the vehicle seller was relatively rare, and quality appeared variable. About one in six driver owners and a quarter of driver users did *not* seek any information, and about a quarter of each group learnt through trial and error.

Possible risks from trial and error may vary by ADAS user type. Driver owners who were frequent users were more likely to be previous, informed, and motivated users of ADAS. Trial and error was therefore more likely to build upon an existing base of understanding and experience, and in this context may be an appropriate and relatively low-risk learning strategy. Of more concern are driver owners who use ADAS occasionally and who may have turned technologies off. These users were more likely to have limited existing knowledge and experience, may not have been specifically seeking ADAS, and may acquire limited or no further understanding through the sales process. Trial and error in this context can lead to alarming, confusing, and potentially dangerous experiences, and those that could result in technologies being disabled.

Sources of information about ADAS commonly used by driver owners, driver users, and non-driver users were vehicle owner’s manuals (23%), web-based information (22%), and friends and family (22%). Sources more commonly preferred by New Zealanders without direct experience of ADAS, and by users who had not previously sought information, were predominantly digital – online videos, online searches, and manufacturer’s websites – as well as owner’s manuals.

Influence of ADAS in decision making

Apart from LDW, at least half the driver owners of each technology felt that the technologies had been somewhat or very important in their decision to purchase or lease their current vehicle. When asked about importance in a future purchase or lease decision, a greater proportion of driver owners reported each technology being important. These findings indicate that if use is affirming and of value, ADAS technologies are important to those who use them, and perceived value can increase with use. These relationships further support the value of interventions that lead to safe and effective use.

User stage

Knowledge of safe and correct use of ADAS

We examined New Zealanders' understanding of the correct and safe use of ADAS by asking users and those aware of each technology what each technology did. Despite the possibility of correct guesses, relatively high proportions of driver owners and driver users could not correctly identify what each feature did. These results ranged between 22% and 83% depending on the user group and the technology; the lack of understanding was particularly evident for ACC and FCW. For instance, just over two-thirds of driver owners (67%) could not correctly identify that while using ACC their vehicle may accelerate if the vehicle ahead moves out of the detection zone.

We also found that correct understanding of purpose varies by technology type and by gender and age. Differences across the technologies ranged from almost three-quarters (72%) of respondents with correct knowledge of BSM to only 16% for ACC. This range is not unexpected given the range of factors likely to shape understanding (eg, exposure, frequency of activation, perceived value).

Not surprisingly, driver owners were more likely to be correct on some technologies compared to other user groups. This makes sense because understanding is likely to be a function of exposure, experience, and access to information.

Frequency of use of ADAS technologies

Interpreting the frequency with which New Zealanders use ADAS technologies requires some consideration of what is meant by 'use' as well as how respondents interpreted the meaning of 'use'. Notwithstanding these issues, we found that ESC was more commonly used frequently by driver owners and that BSM and FCW were more commonly used frequently by driver owners and driver users alike. Perhaps not surprisingly, a greater proportion of driver owners used each technology frequently compared to driver users. Driver users are likely to have more fleeting, sporadic experiences with the technologies compared to driver owners, and this may be a reason for differences. In general, males were more likely than females to report using most technologies sometimes or frequently. The number of drivers turning any of the ADAS technologies off was small for both driver owners and driver users. The technologies most likely to be turned off by driver owners were AEB (8%), LDW (8%), and LKA (8%).

The most common reason that driver owners and driver users gave for not using ADAS technologies all the time was the belief that their driving was good enough; this result ranged between 28% and 44% depending on the technology. Consistent with other findings in this study, lane-keep functions were often underutilised because warnings were considered annoying or distracting.

Driver responsibilities and experiences

A considerable proportion of driver owners did not believe or did not know that regardless of ADAS technology, they were responsible for monitoring their vehicle's functions *all of the time*. These results ranged between 28% and 37% depending on the technology. Further, only about two-thirds of driver owners reported that they would *not* be more likely to undertake secondary tasks while using ADAS; these results ranged between 58% and 67% depending on the technology. These reports differ somewhat from the views commonly expressed by the drivers we interviewed that ADAS was only a ‘back-up’ layer of safety. These drivers continued to see themselves as fully responsible and accountable for any errors; partial distrust of ADAS also appeared to further motivate full attention to driving.

Talking with passengers and talking on a hands-free phone were the two secondary activities identified most frequently as more likely when using ADAS technologies. These results ranged from between 10% and 15% depending on the technology. Whether these represent a significant safety risk, beyond what is already known about the risks presented by these secondary tasks, may need further consideration.

Across the seven ADAS technologies examined, most driver owners and driver users had *not* experienced any performance issues. Problems that were identified generally related to unnecessary or over-sensitive warnings, unexpected braking, and responses due to the system misinterpreting the situation. The driver owners interviewed described a similar range of performance issues. While many considered these as relatively minor, they had led others to turn features off.

Conclusion

For ADAS, there exists a high degree of generalised understanding. However, as summarised in Table ES.1, this research showed there is more variable understanding and use of specific technologies. While our survey indicated that the technologies examined all have relatively low levels of market prevalence on New Zealand vehicles, awareness, knowledge, and use varies considerably by technology. For instance, BSM was the technology that New Zealanders were most likely to have heard of, were most likely to consider important for a future purchase, and whose purpose was most likely to be correctly identified by driver owners. In contrast, while ESC was the only mandatory technology, New Zealanders were least likely to have heard of it and were least likely to describe themselves as familiar with it. These findings suggest that different ADAS technologies may warrant more or less attention in any future interventions to raise awareness, knowledge, and use.

The experience of using ADAS can increase perceived value and future use, so long as experiences are affirming and assuring. Quality ADAS information at the point of sale, or at the point of use for hire or fleet vehicle users, is likely to be limited, which indicates an area where improvement is needed. Trial and error appears to be a common learning strategy and one that makes sense to many existing users.

The frequency with which ADAS technologies are used is difficult to determine, but the most commonly used technologies appear to be those that routinely add value to driving. Technologies most likely to be turned off are often reported as not always performing as expected.

It will be some time before the benefits of ADAS technologies are available at scale in New Zealand. However, the findings of this research provide direction to initiatives to improve engagement and uptake. Initiatives will also be important when higher levels of automation are prevalent in New Zealand, where driver responsibility is still required for safe vehicle operation.

Table ES.1 Summary of key survey findings on consumer awareness, knowledge and use of ADAS technologies

	Awareness	Prevalence	Importance	Familiarity	Knowledge	Responsibility	Use
	Pre-consumer stage		Consumer stage		User stage		
	Respondents who have heard of the technology (%)	Respondents owning or leasing a vehicle with the technology (%)	Respondents* viewing the technology as somewhat or very important in a future purchase or lease decision (%)	Respondents* describing themselves familiar or very familiar with the technology (%)	Driver owners correctly identifying what the technology does (%)	Driver owners identifying they are responsible for monitoring the vehicle's driving functions 'all of the time' while using the technology (%)	Driver owners using the technology frequently (%)
AEB	45%	8%	67%	53%	68%	66%	26%
FCW	39%	9%	66%	54%	51%	72%	38%
ACC	38%	9%	54%	55%	33%	63%	25%
LDW	44%	8%	56%	58%	67%	68%	34%
LKA	41%	7%	52%	56%	67%	68%	38%
BSM	47%	7%	69%	61%	78%	72%	52%
ESC	33%	13%	65%	53%	73%	70%	40%

Note. The bases are the total number of respondents to the main survey for the pre-consumer stage, all respondents who had heard of each technology in the consumer stage, and the total number of driver owners of each technology to the main and boost surveys for the user stage.

* All respondents who had heard of each technology.

Recommendations

Recommendations from this research, including areas for further research, are summarised below. More detailed recommendations can be found in Chapter 7.

Pre-consumer stage

For the general driving population, popular imagery associated with automated vehicles may undermine perceptions, acceptance, and use of lower levels of automation. Further, many drivers may be unaware of the benefits of ADAS and how they fit within the future evolution of vehicles. There is a need to ensure that New Zealanders understand the driver assistance technologies currently permitted, the benefits and value provided, and driver responsibilities. Further, given the range of disadvantages and risks that New Zealanders currently associate with the concept of an automated vehicle, we also believe that the government should communicate how they are actively managing and mitigating potential risks in the transition to greater levels of automation.

Communicating the above should be targeted to the general driving population and should look to leverage existing road safety channels used in New Zealand to increase understanding of safe vehicles.

Consumer stage

Accurate and easy-to-understand information about ADAS technologies, what they do, and how to use them are important in the consumer stage. This is also relevant for consumers who come to drive vehicles equipped with ADAS technologies through other pathways (eg, hire and fleet vehicles).

Given the different consumer segments alluded to in this research, there is a need for 'demand' and 'supply' side interventions. Demand-side interventions will increase the extent to which consumers seek out information while supply-side interventions will make information more readily available and accessible.

Key initiatives could reinforce the importance of being an informed consumer; provide online, printed, and spoken information at the point of sale or other first points of use; elevate the importance to ADAS features on specification sheets, sales websites, and commonly used websites (such as Rightcar, Trade Me and Auto Trader); and potentially, require sellers of vehicles to provide an English version of instructions for advanced features in vehicles.

There are inconsistencies in the names of ADAS technologies and variations in how similar technologies perform across different manufacturers. Manufacturers are unlikely to cooperate in providing consistent language and performance. Therefore, providing clarity around the kinds of ADAS technologies, what they do, and common names, seems important.

User stage

At the point that ADAS-equipped vehicles are being used, there is a learning and familiarity process, along with eventual mastery by the driver working in partnership with the vehicle.

Learning by doing makes sense for many users of ADAS, as evidenced by this and previous research. Our findings indicate that for some drivers this natural experiential learning safely builds upon an appropriate base of core knowledge.

Knowledge, skills, and attitudes are all important for competent driving. Information around ADAS technologies could be included in the driver training and possibly licensing process and should consider how ongoing driver support might be designed considering the relationship between the vehicle user, the seller, and the land transport regulator.

Among users, the extent of knowledge regarding the safe and correct use of ADAS technologies varied by technology. Further, the risks associated with incorrect use of lower levels of automation is likely to be lower than higher automation levels that require increased interaction from the user. This suggests that of the technologies studied, information should be prioritised about ACC and LKA, as these two technologies demand higher levels of interaction with users, and current knowledge is comparatively low.

Within the wider context of using ADAS-equipped vehicles, the literature suggests there is a gap in regulation and minimum standard setting to ensure safe and educated use of ADAS, and hence at a minimum, an education pathway will be needed. Engagement with relevant stakeholders about how an education framework should proceed is a suggested first step. Later steps may necessitate use of regulatory interventions if education frameworks do not sufficiently ensure the safe and correct use of ADAS.

Areas of further research

Several areas of further research, outside the scope of our study, were identified. These include examining the influences of ADAS technologies on road safety; a more in-depth understanding of ADAS user segments; understanding New Zealanders' experiences with SAE Level 2+ functionality; and further human factors considerations.

Abstract

If advanced driver-assistance systems (ADAS) are to improve driver safety, drivers need to understand and value ADAS features and use them correctly. However, little is currently known about New Zealanders' awareness, perceptions, knowledge, use, and experience of ADAS technologies. This research addressed this knowledge gap using a mixed-method research approach that comprised an online survey of New Zealanders (n = 1,051), a supplementary online survey of ADAS vehicle owners and users (n = 152), and in-depth interviews with ADAS vehicle owners (n = 17).

The research showed that while a reasonable number of New Zealanders have some level of awareness about ADAS technologies, many only have limited experience, and many do not have any experience. Further, while New Zealanders have some general understanding of automated vehicles, their understanding and use of specific ADAS technologies vary by technology type, as well as by gender and age. Communications targeting the general driving public should focus on distinguishing the different levels of automation, educating drivers about the benefits and value of ADAS, and ensuring that driver responsibilities are clear. Information providing deeper understanding of specific ADAS technologies should be targeted to current users and those soon to be using vehicles equipped with ADAS technologies.

1 Introduction

New vehicles are increasingly equipped with advanced driver-assistance systems (ADAS) designed to assist and partially automate the driving task. However, the benefits of ADAS technologies will only be realised if consumers are aware of and value them, and if technologies are used correctly. However, little is currently known about the awareness, perceptions, and knowledge that New Zealanders have of ADAS technologies. Further, for New Zealanders driving ADAS-equipped vehicles, little is known about their understanding of safe and appropriate use, which technologies are considered most useful, and driving experiences, including the experience of unexpected events or unintended consequences.

To address these knowledge gaps, this study explored New Zealanders' awareness, perceptions, knowledge, use, and experience of ADAS technologies up to and including Society of Automotive Engineers (SAE) Level 2 (partial driving automation).

The research addressed five core objectives:

A. To understand New Zealanders' level of **awareness and knowledge** about ADAS, including knowledge of what they do and their safe and correct use

B. To understand what **training** is provided about the different functionalities when people buy a vehicle with ADAS features

C. To understand public **acceptance and perceptions** of different ADAS technologies and whether a vehicle having or not having them influences vehicle purchasing decisions

D. For people who own vehicles with ADAS technologies, to understand **how often they are using them** and, if they turn them off, what their **reasons are for turning them off**

E. To understand whether there are ways that people are **using ADAS that differ from how or when they were designed to be used.**

In addition, attitudes towards automated vehicles more generally were examined. This provides important context regarding the acceptance, perceptions, and use or non-use of specific ADAS technologies.

The research findings will inform the development of policy and programmes to ensure necessary understanding, desired behaviours, and the safe use of SAE Level 0 to Level 2 ADAS technologies.

1.1 Conceptual framework

The three stages a consumer would typically go through to driving a vehicle equipped with ADAS technology provide the conceptual framework for this research. The 'consumer journey' is conceptualised as comprising three stages, with the main research questions in this study able to be mapped to these. The three stages, and the main research questions addressed within each, are as follows:

- **Pre-consumer stage**: includes public perceptions, beliefs, and acceptance of automated vehicles, and awareness and knowledge of specific ADAS technologies
- **Consumer stage**: the process through which a person considers and then purchases or leases a vehicle with ADAS technologies; includes the influence of the availability of ADAS technology in the purchase or lease decision and any information, education, or training on ADAS sought by or provided to the consumer during the process
- **User stage**: includes how drivers of vehicles with ADAS technologies learn to use the technology, why, how, and how well the technology is used, reasons for not using the technology, and the experience of issues or problems with the technology, including unexpected events and unintended consequences.

Note, the 'consumer' within the framework includes those who purchase a vehicle with ADAS technologies as well as those who come to drive such vehicles through other pathways (eg, leasing a vehicle, driving a hire or work vehicle). A consumer does not necessarily move through the stages sequentially and may not go through all stages. For instance, a person driving a hire vehicle may have little or no existing awareness of ADAS technologies as a pre-consumer and may not go through the consumer stage at all. The experience of driving a hire vehicle may in turn increase awareness as a pre-consumer and may prompt at some future stage interest in purchasing a vehicle equipped with ADAS.

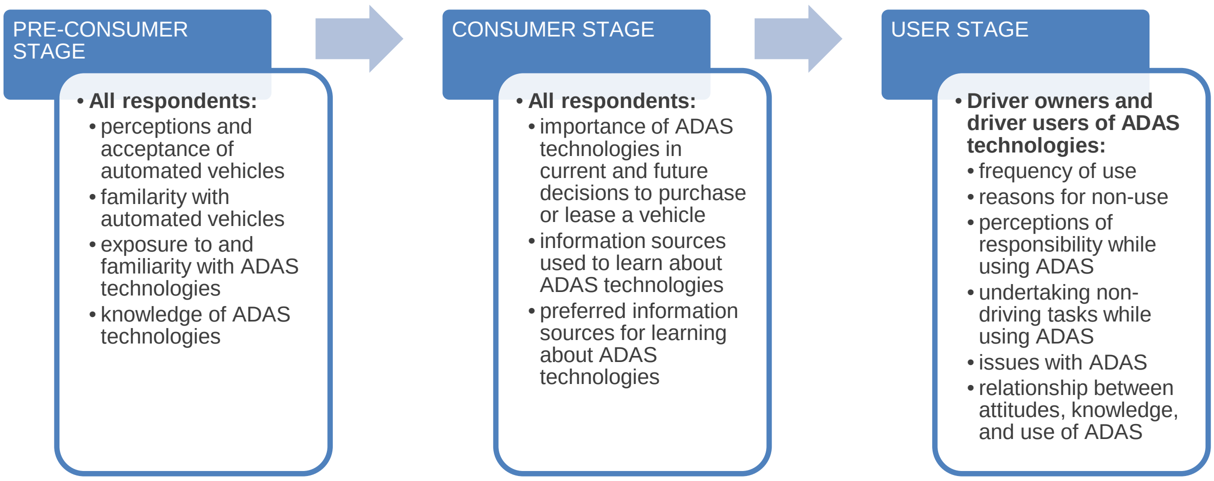
1.2 Report structure

The three stages of the consumer journey are used in this report to structure the research findings, discussion, conclusions, and recommendation sections. Table 1.1 shows how the research objectives map to each stage while Figure 1.1 shows which research findings are presented under each stage.

Table 1.1 Stage of the consumer journey and research objectives

Stage of the consumer journey	Research objective
Pre-consumer stage	A and C
Consumer stage	B and C
User stage	D and E

Figure 1.1 Stage of consumer journey and the research findings



The survey findings relating to automated vehicles in general provide important context for the findings on ADAS technologies specifically. However, because the research is primarily focused on SAE Level 0 (no automation) to Level 2 (partial automation) ADAS technologies, some of the detailed findings from the survey on automated vehicles are presented in Appendix A of this report.

Note that detailed data tables for some of the survey findings on ADAS technologies are also appended. This ensures the main body of the survey findings chapter is focused on the core objectives of the research. The appended findings are summarised and clearly referenced throughout the chapter that presents the survey findings.

1.2.1 Report chapters

The chapters of this report are as follows:

- **Chapter 2:** Literature review
- **Chapter 3**: Methodology
- **Chapter 4:** Survey findings
- **Chapter 5:** Interview findings
- **Chapter 6:** Discussion
- **Chapter 7:** Conclusion, recommendations and further questions

2 Literature review

2.1 Introduction

This chapter reviews international literature on public awareness, perceptions, understanding, and use of ADAS. After firstly discussing the broader context regarding ADAS and automated vehicle technologies, the remainder of this literature review is structured to follow the research objectives:

A. awareness and knowledge of ADAS

B. training and knowledge acquisition

C. acceptance and perceptions of ADAS technologies

D. use and reasons for non-use

E. incorrect use.

The literature review concludes with a short section about minimum standards and regulation in place to support the safe and correct adoption of ADAS technologies.

2.1.1 Literature search approach

A range of documents were considered and systematically reviewed. Most documents were sourced from academic databases with a focus therefore on peer reviewed articles and conference proceedings. Industry, consultancy, and government reports were considered for inclusion where relevant. There was no assessment of literature quality beyond the initial focus on academic publications; however, we were watchful for manufacturer funded or produced literature, which has the potential to be positively biased towards ADAS features.

An initial search, conducted in early April 2021, provided a list of prominent researchers and areas of research focus. A second search in late May addressed any gaps and expanded on the evidence. Search terms were used in a variety of combinations; for example, 'Advanced driver assistance systems' AND 'Level One' OR 'L1', and similarly for Level 2. Specific ADAS technologies were included in the search; for example, 'Adaptive cruise control' AND 'use' OR 'perceptions' OR 'attitudes' OR 'issues'. Parameters were set to focus on documents in English and those published in the last five years, though articles outside this timeframe were included if deemed relevant. Article abstracts were initially scanned, and if the content was applicable, the full article was read and synthesised. Each article's reference list was also used to source further relevant articles. A total of 47 documents were cited in the final review, including highly relevant papers from Australia and New Zealand, that this research builds upon.

Throughout this report we refer to automated vehicle technologies, which include ADAS technologies ranging from SAE Level 0 (no automation) to Level 5 (full automation). It should be noted, however, the focus of our study is only on SAE Level 0 (no automation) to Level 2 (partial automation) technologies. Where possible, the scope of the following the literature review has focused on Level 0 to Level 2 automated vehicle technologies. However, some papers included in this review have examined higher levels of automation given their relevance to our research.

2.2 Emergence of ADAS technologies

Vehicles are increasingly equipped with ADAS technologies designed to assist driving and enhance safety. Examples include lane departure warning (LDW), lane keep assist (LKA), blind spot monitoring (BSM), and forward collision warning (FCW). The technology includes sensor-based systems (senses the environment) and connected-vehicle based systems (intercommunicating with other vehicles) (Yue et al., 2020).

ADAS technologies generally function through the collection of data on the vehicle's behaviour and direct environment, matching the data with decision rules, and activating the appropriate support functions (van der Heijden & van Wee, 2001). Drivers are informed in various ways, including via auditory, visual, or vibrational warnings, and in response, the system will either assist through added driver support or through intervening in the control of the vehicle (eg, steering the vehicle back into the lane).

SAE International has defined levels of automation in vehicles, ranging from no automation (Level 0) to full automation (Level 5), summarised in Table 2.1. The levels of automation are related to the role played by the human user, the driving automation system, and other vehicle systems and components (SAE International, 2018). Level 2 and Level 3 vehicles have the ability for partial driving automation. Throughout this report we refer to 'automated vehicles' that include ADAS technologies ranging from SAE Level 0 (no automation) to Level 5 (full automation).

Table 2.1 SAE International automation levels

	SAE Level 0	SAE Level 1	SAE Level 2	SAE Level 3	SAE Level 4	SAE Level 5
Automation	No automation	Driver assistance	Partial automation	Conditional automation	High automation	Full automation
Example technologies	BSM	ACC or LKA	ACC and LKA	Traffic jam chauffeur	Local driverless taxi	Driverless taxi in any condition

Note. Grey shading represents the focus of this study.
Source: Adapted from SAE International (2021)

While Level 0 technologies provide warnings, alerts, or momentary driver assistance (eg, BSM), Level 1 technologies provide steering or braking support to the driver (eg, ACC or LKA). Although the technologies of Level 1 and Level 2 are similar, an important difference is the operating conditions for which Level 2 systems are designed. At the extreme end of Level 2 functionality, an automated operating mode is enabled, allowing the driver to disengage from physically operating the vehicle (ie, hands off the steering wheel and the foot off the pedal at the same time; eg, ACC and LKA). When partial driving automation is active, the automated driving system controls the subtasks of the driving, with the expectation that the driver monitors the situation and is ready to respond as needed. The main difference between Level 2 and Level 3 is the role of the driver. In Level 3, the driver is not required to monitor the situation when the automated driving system is operating, and instead the vehicle monitors the environment (eg, hazard identification) and responds accordingly.

The success of automated systems is affected by many factors, but first and foremost by how drivers use them (Hagl & Kouabenan, 2020; Yue et al., 2020). While some ADAS technologies promise to reduce crashes and potentially road congestion, this realisation will depend on the ability of the drivers to understand a vehicle's ADAS functions and to use them correctly (Robertson et al., 2016; Yue et al., 2020).

The introduction of ADAS has altered the role of the driver and will continue to do so as the technology develops. It is the change of driver role, the time during transition or handover (Ntasiou et al., 2021; Robertson et al., 2016), and the somewhat blurry division of responsibility between the system and the driver that has raised concern (Bronson et al., 2019; Smyth et al., 2018). The technology is developing at a rapid pace, perhaps faster than drivers' knowledge and interaction with the systems, and faster than the development of training programmes to ensure correct use (Hoyos et al., 2018; McDonald et al., 2018; Velodyne Lidar, 2019).

2.3 Awareness and knowledge of ADAS

2.3.1 Awareness and knowledge of ADAS among the general population

Awareness and interest in automated vehicle technology vary across countries, as do preferences towards certain technologies. The literature shows that most people have at least some knowledge and experience of automated vehicles and ADAS (Bronson et al., 2019; Robertson et al., 2016; Wolf, 2016) and, while varying across studies, people generally have a positive attitude towards vehicle automation (Rödel et al., 2014). A study covering the USA, Germany, Japan, South Korea, China, and India found that consumers across all countries were most interested in automated vehicle technologies that improved safety, and were least interested in technologies that provided entertainment or navigation (Vitale et al., 2017).

In a large survey of Canadian drivers (n = 2,662), 63% strongly agreed they were familiar with automated vehicle technology in general; for example, LKA or cruise control (Robertson et al., 2016). Also in Canada, Environics Research (2019) reported that one-third of respondents from a large online survey (n = 3,113) were somewhat familiar with automated vehicles, having heard of at least one of six ADAS technologies. Over three-quarters of respondents could also identify the correct definition for LDW and slightly less for AEB. Only one-quarter could correctly note the definition of ACC. However, compared with the other technologies examined in this study, ACC has a less descriptive name, making it more difficult for respondents to potentially 'guess' the correct answer. In Germany, Wolf (2016) found that in an online survey (n = 1,000), 67% had heard of at least one ADAS technology, highlighting that the most frequently used technologies among passenger car drivers was cruise control, acoustic parking assistants, and high-beam assistants.

Bronson et al. (2019) used an online survey (n = 1,008) to better understand US drivers' awareness of ADAS in their current vehicles. Over 80% of all respondents were aware their vehicles had ADAS technologies. Thirty-nine percent of all respondents rated their knowledge as considerable or expert, while over 47% rated themselves having some knowledge. In this study, men were more likely than women to rate their knowledge at the expert level.

In Australasia, researchers from the Australia and New Zealand Driverless Vehicle Initiative have undertaken two online surveys to gauge public awareness and understanding of partially and fully automated vehicles and the acceptability of these. A first survey was administered in Australia in 2016 (Regan et al., 2017) and a second in Australia (n = 5,089) and New Zealand (n = 1,044) in 2017 (Ledger et al., 2018). Overall, ownership of a vehicle with ADAS technologies was low. The proportion of respondents who reported they owned a vehicle with each of the technologies examined ranged from 3% to 6% (Ledger et al., 2018). While the 2017 survey showed a similar level of acceptance of technology across Australian and New Zealand respondents, Australians were shown to be slightly less open to technology (Ledger et al., 2018).

The previous Australian and New Zealand research on ADAS allows some assessment of how awareness and knowledge has developed over time. For example, in 2016, just over 43% of Australian respondents had never heard of LKA, and 37% had never heard of ACC (Regan et al., 2017). In 2017, these results were 30% and 29%, respectively (Ledger et al., 2018). Similarly, in 2016, 49% of respondents *had* heard of or seen a car with LKA, and 56% had done so for ACC. In 2017, these results increased to 59% and 59%, respectively.

The research also shows an increase over time in the proportion of respondents owning a car with ADAS technologies. Note, however, that ownership remains low overall. For example, in 2016, 1% of respondents owned a car with LKA, and 2% owned a car with with ACC (Regan et al., 2017). In 2017, these results had increased to 3% and 4%, respectively (Ledger et al., 2018).

More recently, Starkey and Charlton (2020) conducted research to gauge the New Zealand public's readiness for connected and autonomous vehicles. When the participants in the study were asked whether they had heard of self-driving cars – for example, the Google car – a high percentage said yes (96%). However, far fewer had heard of specific ADAS technologies. For example, 71% had heard of ACC and 58% had heard of automatic lane-keep systems.

2.3.2 Awareness and knowledge of ADAS among different demographics

Research has shown that awareness, familiarity, and knowledge of ADAS technology varies by demographic factors such as age and gender (Rödel et al., 2014; Yue et al., 2020). In a US study, self-assessed familiarity was higher for men, licensed drivers, those with higher education, and those with higher household incomes (Eby et al., 2018). In a Canadian study, familiarity with the technology was found to be higher among those who drove their current vehicles at least 25 km per day on an average weekday (Environics Research, 2019).

Environics Research (2019) showed that knowledge of specific ADAS technology was higher among Canadians aged 50 and over and highest among those aged over 65. Similarly, a US study (n = 2,990) found that advanced in-vehicle technologies were present in nearly 60% of vehicles driven by participants aged between 65 and 79 years, with 70% of this sub-group of older drivers reporting that the technology made them safer drivers (Eby et al., 2018). Another study of US drivers (n = 1,019) found that while older drivers (69 to 85 years) exhibited the least interest and comfort in advanced technology, they used ADAS at approximately the same rate as younger age-groups (Owens et al., 2015). This suggests that while older drivers might be cautious to use new technology, this does not necessarily stop them from using it. One possible explanation is that older drivers see ADAS as an aid (like a hearing aid) that can assist in areas where human performance is starting to diminish.

Bronson et al. (2019) showed that while more women reported knowing about ADAS than men, women were less likely to use the technology. Rödel et al. (2014) added that women preferred a vehicle equipped with many ADAS technologies whereas men preferred either a non-autonomous or fully automated vehicle. They concluded that men appreciated a simple and efficient way of driving without the distraction of special technologies or, alternatively, preferred complete removal from the task of driving.

2.3.3 Inaccurate perceptions and understanding of ADAS

Uncertainty or confusion about the purpose and function of different ADAS technologies may impact use and reliance on the technology (McDonald et al., 2018; Teoh, 2020). Some research indicates that many people do not fully comprehend what ADAS technologies are, are misled by the name of the technology, and can be unclear about who or what is responsible in certain situations (Smyth et al., 2018; Teoh, 2020). Respondents in a Canadian study commonly believed that an 'automated vehicle' was one that drove itself (Environics Research, 2019). Similarly, Teoh (2020) showed that participants interpreted the name 'Autopilot' to mean a self-driving car. On its website, Tesla explains that its Autopilot features do not make vehicles fully autonomous; rather they are designed to *assist* with driving tasks such as steering, braking, and accelerating within a lane and require active driver supervision (Tesla, 2021). Teoh (2020) showed that the names of the SAE Level 2 (as described in Table 2.1) driving systems influence drivers' perceptions on how to use them. In one example, they concluded that the term 'Autopilot' was a misleading name for Level 2 ADAS.

A fatal crash occurred in March 2018 involving a Tesla Model X that was in partial automation mode using the Autopilot function. In a subsequent analysis of the crash, Smyth et al. (2018) highlighted that the driver's attention appeared to be voluntarily diverted from the primary driving task with their hands off the steering wheel and their mobile phone in use. According to the definition of Autopilot from Tesla's website, and the SAE Level 2 definitions, the driver was required to be fully attentive to the driving task. These definitions place sole responsibility with the driver. Smyth et al. (2018) argued that SAE Level 2 automation is either not clearly enough defined, or that systems are being misused. They concluded that SAE levels might be well understood by industry experts but not necessarily by drivers of vehicles with ADAS capabilities.

2.4 Training and knowledge acquisition

The benefits of ADAS technologies are predicated on safe and correct use by users. However, despite the additional complexity of ADAS technologies, Robertson et al. (2016) found that 30% to 40% of Canadians believed they already possessed sufficient knowledge of vehicles to operate a partially automated vehicle. There was a common view that new knowledge would not be required and that a vehicle equipped with ADAS could be taken into possession without additional instruction. However, McDonald et al. (2018) showed that over half (52%) of the participants in a US study reported that they did not know how specific functions worked before they purchased a vehicle equipped with ADAS. In a study of older US drivers, Eby et al. (2018) also found that 30% of participants reported not knowing that certain technologies were even present in their vehicles.

In-person training at the dealership (Bronson et al., 2019), reading the owner's manual (Environics Research, 2019; McDonald et al., 2016; Smyth et al., 2018) and learning online (Bronson et al., 2019) are ways that consumers prefer to receive ADAS information and training. Almost a quarter of respondents in Bronson et al.'s study received training from a salesperson, and most reported a duration of more than 10 minutes. However, only 16% of those who received training rated it as good or very good. Eby et al. (2018) found that across the technologies, nearly half the participants chose to 'figure it out themselves', a method Abraham et al. (2017) reported as having the potential to lead to dangerous misunderstandings.

Smyth et al. (2018) highlighted that even if a driver became familiar with certain features in one vehicle, the same features may not respond in the same way in a different vehicle or updated version. For example, systems can perform differently in respect to reading lane markings or in different weather conditions. Consequently, in-vehicle information and training needs to be ongoing rather than a one-off event. Bronson et al. (2019) concluded that drivers should only use the ADAS technology if they are properly trained to do so.

2.5 Acceptance and perceptions of ADAS

2.5.1 Trust in ADAS

Public acceptance and trust in ADAS varies by feature, vehicle brand, and manufacturer. Bronson et al. (2019) found that 67% of a sample of US drivers (n = 1,008) never or rarely activated ADAS settings in their vehicle, suggesting some reluctance to use the technology. Some features only function if they are turned on, and according to Kidd et al. (2017), drivers are more likely to activate a system if they trust it.

Trust in the automated system is an important determinant of the correct use and interaction with the technology (Kidd et al., 2017; Wolf, 2016). According to Wolf (2016) and others, trust in ADAS technology is influenced by its reliability, perceived usefulness, and ease with which it can be understood. Whether the system acts as the driver expects is also influential (Itoh, 2012; Paiva et al., 2021). Kidd et al. (2017) found that trust in ADAS can decrease if the driver perceives warnings to be premature or unnecessary or if they activate in particularly demanding situations (such as high traffic). Such instances can be deemed annoying and may lead to features being deactivated (Reagan & McCartt, 2016; Wang et al., 2020). Alternatively, if no warning is issued when the driver is expecting one, or if the driver is not adequately monitoring the system, over-trust can also lead to undesired outcomes. Systems therefore need to fit drivers' expectation and intention, and drivers need to understand any limitations of the system (Inagaki & Itoh, 2013; McDonald et al., 2018; Robertson et al., 2016).

Studies have also found that levels of trust differ by feature. For example, participants in Bronson et al. (2019) were least prepared to use ACC because of a perceived lack of driver autonomy over speed, while the majority were prepared to use lane assistance systems. Similarly, Kidd et al. (2017) found that participants had the most trust in side-view assist and the least trust in active LKA. This was reflected in the number of drivers who kept side-view assist systems permanently turned on (Braitman et al., 2010).

The functionality and therefore experience and trust in ADAS features can vary between vehicle brands and manufacturer (Kidd et al., 2017; Reagan et al., 2018). In a comparative study of four vehicles (2016 Toyota Prius, 2016 Honda Civic, 2017 Audi Q7, and 2016 Infiniti QX60), participants reported that similar ADAS technologies performed differently across the vehicles (Kidd et al., 2017). Compared to the other vehicles, participants described the Honda as having a late and harsh change in vehicle speed. The Infiniti's side-view assist reportedly gave false alerts when passing static roadside objects. This same vehicle issued an auditory alarm when a vehicle in the blind spot was detected; this may have drawn greater attention to false alarms compared to vehicles with visual-only warnings such as the Audi. Similarly, participants received more warnings from Honda's FCW and felt that warnings were premature and overly sensitive, a performance characteristic that led to a slightly lower trust rating.

Finally, in a survey of 4,500 car buyers across China, Germany, Japan, South Korea, and the US, many respondents expressed distrust in the computers that controlled the vehicle, and 38% were concerned about hacking (Choi et al., 2016). More than half the participants said they were more likely to trust and use ADAS if specific concerns were addressed. Identified concerns included the risk of hacking, cost, mistrust of other drivers, loss of driving for pleasure, concern about unauthorised data sharing, concern that vehicles would drive too slowly, and concern that drivers could experience a lack of control.

2.5.2 Trust among various demographics and experience levels

A US study found that men were more likely than women to trust certain technologies, specifically self-parking (42% vs 31%), AEB (49% vs 40%), and ACC (50% vs 43%) (American Automobile Association [AAA], 2016). Further, drivers already using the technology were more likely to trust it than those without the technology – LDW/LKA (84% vs 50%), ACC (73% vs 47%) and AEB (71% vs 44%) (AAA, 2016). Similarly, Crump et al. (2016) found that as drivers increased their knowledge and understanding of systems, particularly limitations, they became more aware that systems worked to assist rather than replace the driver. Earlier studies also found that experience with the limitations of a system predicted more positive ratings among drivers (eg, Beggiato & Krems, 2013; Xiong et al., 2012).

2.5.3 Influence of ADAS on purchasing decisions

Consumer behaviours in respect to buying vehicles with ADAS can also vary between countries. For example, Vitale et al. (2017) found that consumers across six countries (USA, Germany, Japan, South Korea, China, India) were willing to pay a little extra for ADAS; however, the premium that consumers were willing to pay had decreased since 2014. It was suggested that features that were once considered premium options were now expected as standard features that should not increase price.

In a large US telephone survey (n = 1,832), 61% of drivers reported they would like to have at least one ADAS technology in their next vehicle (AAA, 2016). In another study, 95% of respondents wanted ACC in their next vehicle and 75% wanted LDW (Crump et al., 2016). However, 30% of respondents also wanted to be able to turn LDW off, suggesting the perceived value or utility of technologies can vary depending on driving or road conditions. Environics Research (2019) found that BSM was the technology deemed most important for future purchase decisions, followed by LDW. AAA's (2016) study found that participants most wanted LDW/LKA (41%), ACC (40%), AEB (39%), and self-parking technology (25%) in their next vehicle.

Environics Research (2019) found that ADAS users were more likely than non-users to think that ADAS technologies would be important in a future purchase decision. Choi et al. (2016) also reported a higher repurchase rate once users were familiar with certain technologies. Similarly, Starkey and Charlton (2020) found that respondents who had previously used ADAS were willing to pay more for it, albeit a small amount, compared to those who had not used it. Ledger et al. (2018) found that just over 34% of Australians and New Zealanders surveyed would pay extra for a partially automated car.

AAA's (2016) study found that the primary motivation for purchasing a vehicle with ADAS was safety (84%), followed by convenience (64%), reduced stress (46%), and wanting the latest technology (30%). Reasons for not seeking ADAS in the next vehicle included trusting one's own driving ability, concern the technology was unproven, and being unwilling to pay extra (AAA, 2016). Drivers with children were more likely not to want the technology, while female drivers were more likely to state that they did not know enough about the technology and that it was too complicated. Compared to women, men were more likely to want AEB in their next vehicle (42% compared to 35%) and more likely to want ACC (44% compared to 36%).

Compared to younger drivers, older drivers (aged 46 and over) were more likely to purchase a vehicle with an FCW system (Crump et al., 2016). Further, older drivers were more likely to want partial automation over no automation at all, a result that possibly indicates an awareness of potential cognitive limitations and a desire to remain driving for as long as possible.

2.6 Use and non-use of ADAS

2.6.1 The role of the driver

ADAS technologies are designed to improve safety, but they are only as safe as the users who operate them (Hagl & Kouabenan, 2020). With the introduction of ADAS technology, the role of the driver at higher levels of automation has changed from an operator in full control to a supervisor of the system, though the driver must always be ready to assume control. However, Hagl and Kouabenan's (2020) study showed that the use of ADAS can decrease the perception of accident probability and can increase the perceived ability to control risky driving situations. Alternatively, other research has reported that some drivers are likely to act more cautiously while driving a partially automated vehicle (Kidd et al., 2010).

When introduced to new safety technology, including ADAS, drivers may be more likely to engage in greater risk-taking behaviours, relinquishing control over to the vehicle and assuming the system will compensate (Crump et al., 2016). Studies have identified a range of tasks, other than driving, that participants are comfortable engaging in while using ADAS. For example, in a 2016 US survey (n = 961), drivers were more likely to engage in secondary behaviours such as eating (48%); sending or reading text messages (43% and 45%, respectively); watching a movie (21%); or reading a book (19%) (State Farm, 2016).

Although designed to improve both safety and convenience, previous research in aviation has shown that an increase in automation can increase challenges for the driver or operator, including an increase in mental workload. The increased mental workload can in turn result in the operator being 'out of the loop' and slower to both detect problems and to take corrective action (eg, Endsley, 1999). The consequences can be severe if drivers struggle to react in time to an emergency because of mental overload or distraction.

2.6.2 Use or non-use of various technologies

ADAS technologies can assist drivers only if they are activated or turned on. While not all ADAS technologies can be disabled, deactivation and non-use has been shown to vary by technology (McDonald et al., 2018). Various studies have shown that LDW is unpopular among drivers (Braitman et al., 2010; Wang et al., 2020) and that voice control (control audio or navigational features by voice) is used rarely (Eby et al., 2018). Reagan et al. (2018) found that drivers had LDW turned off roughly 50% of the time, citing that warnings were distracting, annoying, and unnecessary. Similarly, Kidd et al. (2017) found that more than half of their participants complained about the functionality and performance of active LKA, citing inconsistent recognition of risk and that steering inputs were inappropriate or discomforting. Participants also cited reasons for less frequent use of ACC, citing that the change in speed was too harsh. Being annoyed by a feature can also lead drivers to become complacent about warnings (McDonald et al., 2018) and to deactivate the feature.

Abraham et al. (2017) observed that while drivers can find some technologies to be annoying, technologies are left on because of the safety benefit. Wang et al. (2020) concluded that a driver's tolerance level, driving style, and individual characteristics affecting risk cognition impacted whether and how they accepted and used ADAS.

2.6.3 Use and usability in different driving contexts

The driving context is likely to have an impact on both the performance of ADAS and the driver's use of ADAS. The driving context includes the traffic, the road conditions, and the weather. In a recent Swedish study, Orlovska et al. (2020) revealed that traffic conditions, rather than the weather or time of day, appeared to be the most critical factor considered by drivers when deciding whether to use ADAS technologies. Participants were more likely to activate ADAS functions on longer trips and within the first 15 km, compared to when driving less than 15 km. ACC was considered most useful on long drives, aiding speed maintenance and comfort. However, drivers tended to override ACC during rush hour traffic because the time gap interval resulted in inconsistent following times and unexpected braking.

Road conditions are also a factor that drivers consider when deciding whether to turn on ADAS technologies. Research has shown that technologies are most effective on urban motorways and least effective on rural, multi-lane roads (Yue et al., 2020). This is supported by Orlovska et al. (2020), who found that drivers often considered rural roads to be unsuitable for ADAS; for example, because of a lack of clear lane markings or excessively bendy roads. Drivers were also hesitant to use ADAS during bad weather and poor light, a finding supported by Roh et al. (2020) with respect to wet weather. Consistent with manufacturer recommendations, Orlovska et al. (2020) found that drivers were willing to use ADAS in moderate but not heavy rain.

2.7 Incorrect use of ADAS

Compared to a vehicle equipped with ADAS, voluntary diversion from the task of driving is less common in a traditional, non-automated vehicle because the driver does not expect any system to take responsibility. If the limitations of ADAS are unclear and drivers overestimate system capabilities, undesirable outcomes may result. In a Canadian study, 16% of respondents strongly agreed it would be unnecessary to pay attention to the road environment when using a self-driving feature of a partially automated vehicle (Robertson et al., 2016). Further, a significant minority of drivers reported they would be willing to drive tired or fatigued (24%), engage in a non-driving activity (17%), sleep or nap (10%), or drink and drive (9%).

Learnt responses to how ADAS technologies operate may increase the risk of adverse outcomes. According to Smyth et al. (2018), drivers can use small movements such as temporary force on the steering wheel to give the impression of control and to override warning systems. Drivers can also become desensitised to familiar warning signals. In the Tesla Model X crash noted earlier, the driver received two visual alerts and one auditory alert due to improper use (National Transportation Safety Board, 2018). There may have been fatigue from the warnings or an inadequate response to the warnings if these were detected.

Accommodating a driver's inability to meet their responsibilities while using ADAS may be difficult and complex to achieve through system design alone. The Level 2 system is not fully complete without the driver's capacity to carry out required driving functions, to supervise the system, and to retake full control as required (SAE, 2018). Smyth et al. (2018) contends that future ADAS technologies must be able to measure the driver's ability to interface correctly with the system. They recommended minimum requirements and standards for driver state monitoring and that some urgency should be applied to measuring vigilance and human–machine interface effectiveness (further discussed in the following section).

2.8 Minimum standards and regulation

Researchers have suggested the need for minimum standards and other regulation to ensure informed and safe use of ADAS (Bronson et al., 2019; Smyth et al., 2018). Suggested areas of attention include driver state monitoring, refined definitions of the technology and implementation, and ensuring manufacturer compliance (Smyth et al., 2018). AAA (2019) is concerned about inconsistencies in the use of terms and in education and training materials, a situation made even more complex because of differences in ADAS performance and terminology across vehicle models and manufacturers (Regan et al., 2020); there are, for example, over 20 different names for ACC alone. AAA (2019) proposed a set of standardised technology names for use in describing the systems, ensuring consumers are knowledgeable about what they are operating and how to avoid misuse.

In a similar vein, Velodyne Lidar (2019) called for a rating system to signify milestone achievements in vehicle performance for foundational ADAS technologies. Rating charts would grade performance against a set of criteria written specifically for the performance of each technology. Criteria would include functional safety, reliability, failure monitoring, self-diagnosis functions, and performance. An example for LKA has been included below (Figure 2.1). A version of the Velodyne Lidar (2019) paper has been published by SAE International. However, it is not clear to what extent ADAS features in different vehicles by different manufactures would be assessed against the criteria.

Figure 2.1 Example rating system for LKA

Lane Keep Assistance

Vehicle System Performance Criteria	♦	♦♦	♦♦♦	♦♦♦♦	♦♦♦♦♦
Lane Positioning	Drifts within lane, frequent driver intervention	Reduced drift, fewer driver interventions	Excellent centering. occassional driver interventions	Excellent centering. occassional driver interventions	Optimized driving trajectory, no driver interventions
Lane Line Dependance	Requires clear lane lines	Requires lane lines	Requires lane lines	Requires lane lines	No lane lines required
Lane Line Detection Range	Near-range detection	Mid-range detection	Mid-range detection	Mid-range detection	No lane lines required
Dynamic Driving Inter-vention Capability	Minor late corrections, no response to peripheral activity	Better active assistance, some response to peripheral activity	Excellent active assistance, good response to peripheral activity, Lane Change Assist	Excellent active assistance, good response to peripheral activity, Lane Change Assist	Superior navigation, smooth and comfortable ride, excellent reponse to peripheral activity, Lane Change Assist
Roadway Functionality	Flat and straight roads	Flat and straight roads	Better on curves and hills	Better on curves and hills	Excellent on all roads
Light and Weather Performance	Suffers in low light and inclement weather	Better in low light and inclement weather	Better in low light and inclement weather	Performs well in all light and most weather	Performs well in all light and most weather

Source: Reprinted from Velodyne Lidar (2019, p. 5).

A recent study focused on Australia and New Zealand examined the role of registration and licensing (R&L) authorities and the current licensing framework for ADAS (SAE Levels 0 to 2) and automated driving features (SAE Level 3) (Regan et al., 2020). The researchers found that R&L authorities had a role in determining levels of ADAS and automated driving features knowledge and use among users of light and heavy vehicles. Consultation with industry stakeholders suggested that R&L agencies were best placed to deliver knowledge and skills, educate end users, assess safe technology use, and ensure consistency in terminology. Government agencies were concerned, however, about a lack of evidence on whether a lack of education or training increased the safety risk and sought further research to guide decision making. The researchers suggested that any future role for the R&L agencies and subsequent policy development should be defined in consultation with industry bodies to ensure consistency and applicability. However, they also found little evidence to suggest the sector would respond without government intervention, and an acceptance by industry stakeholders that government should take a leadership role. Finally, while it was concluded the current driver licensing framework did not require review, ongoing monitoring was recommended to ensure any future changes were evidentially based.

The studies above suggest that as ADAS technologies increase in prevalence, regulators will need to remain agile to keep up with market developments. Further, ensuring consumers have sufficient knowledge about the safe and correct use of ADAS is likely to require a coordinated approach between manufacturers, industry bodies, and government, and will require a range of education, training, and regulatory interventions.

2.9 Summary of key findings

Drivers, consumers, and the public have some general awareness of ADAS. Awareness is generally higher among men and those with driver licences, a higher education, and higher household incomes. Despite the growing awareness, drivers lack understanding of the different levels of automation. Many believe that automated vehicles mean self-driving cars, and there is less understanding of the nuanced difference between Level 2 and Level 3 automation. As vehicles become more sophisticated, clear understanding of the design parameters of ADAS features, and in the future more autonomous vehicles, will be essential for correct and safe operation. Currently it appears the understanding that ADAS manufacturers and researchers have is not shared by the motoring public.

For the full potential of ADAS to be realised, drivers need to understand the capabilities and limitations of ADAS technologies and how to use them correctly (Bronson et al., 2019; Kidd et al., 2017). Effective interaction between the driver and vehicle requires drivers to have sufficient understanding of the availability and use of ADAS technologies. ADAS technologies also need to function in ways that drivers expect (Paiva et al., 2021), and to have intuitive interfaces. Technologies need to sustain engagement, elicit appropriate reactions, and provide timely information of system disengagement (Kidd et al., 2017; Smyth et al., 2018). These elements increase trust and therefore appropriate use.

There is a misconception that as technology increases, there will be less room for human error and less need for driver training. As a result of limited driver training at, or prior to, point of sale, many drivers rely on trial and error to learn how to operate these new technologies. This in turn places more reliance on in-vehicle system explanations and the efficacy of the human–machine interface to address any gaps in consumer knowledge.

The primary motivations for purchasing a vehicle with ADAS are safety, convenience, stress reduction, and wanting the latest technology. Those who already have ADAS are more likely to think that ADAS is important in a future vehicle. However, there is still a reasonably high percentage of people who do not wish to have any automation in their vehicle (Crump et al., 2016).

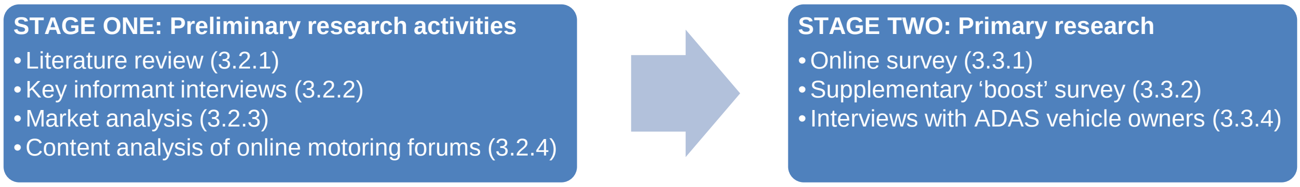
Regulators will need to remain agile to keep up with the rapid development in ADAS technology. Smyth et al. (2018) have called for standards covering driver state monitoring, refined definitions of the technology and implementation, and manufacturer compliance. Current inconsistencies in consumers' understanding about driver roles, responsibilities, technology capabilities and limitations will all need to be addressed to realise the full potential of ADAS.

3 Methodology

3.1 Introduction

This chapter describes the research design and methods used. As depicted in Figure 3.1, the research involved two main stages. Stage One included preliminary research activities to inform the final design of Stage Two, which involved an online survey of New Zealanders (*n* = 1,051), a supplementary online survey of ADAS vehicle owners and users (*n* = 152), and interviews with ADAS vehicle owners (*n* = 17). Note that the findings and direction provided from Stage One were previously reported (Appendix A), while the literature review findings are presented in Chapter 2 of this report.

Figure 3.1 Overall research approach



3.2 Stage One: Preliminary research activities

To develop an understanding of the context for the research and to inform the design of Stage Two, and all data collection tools, the research team undertook the activities described below.

3.2.1 Literature review

An initial literature search was conducted in early April 2021 to identify a list of prominent researchers and areas of research focus. A second search in late May addressed any gaps and expanded on the evidence. Details regarding the approach, search terms and dates, and publication sources included in the search are described in Chapter 2.

3.2.2 Key informant interviews

Three motoring sector experts were invited to participate in an interview about ADAS technologies within the New Zealand market. Participation in an interview was voluntary and participants were not renumerated for their time. Interviews were conducted online and ranged in length from 45 minutes to one hour. All interviews were recorded and transcribed. Thematic analysis was undertaken on the interview data to inform the development of the Stage Two surveys.

3.2.3 Market analysis

An analysis of available secondary data was undertaken to understand the size and shape of the current New Zealand ADAS market. Areas examined included:

- proportion of the light vehicle fleet currently with Level 1 or Level 2 ADAS technology
- proportion of private and fleet vehicles comprising the total Level 2 ADAS fleet
- volume and type of sales (ie, new, second hand, dealers, private sales).

3.2.4 Content analysis of online motoring forums

A review was conducted of user content posted on public New Zealand-based online motoring forums and general discussion boards with dedicated transport pages. This aimed to identify content related to use of ADAS technology, specifically: perceptions, current issues, incorrect use, and questions, as well as language and terms used to describe this technology. While individuals did not grant consent for their comments to be used in this analysis, consent is implied due to the public nature of these forums. As such, private forums, where a user is required to log on prior to posting or viewing content, were excluded from this analysis.

3.3 Stage Two: Primary research

3.3.1 Online survey

An online survey was conducted of 1,051 New Zealanders between 18 and 80 years of age. The survey examined:

- New Zealanders' awareness, knowledge and understanding of ADAS technologies (Research Objective A)
- receipt of information or training about ADAS when buying a vehicle with ADAS technologies (Research Objective B)
- New Zealanders' acceptance and perceptions of ADAS technologies and their influence on purchasing decisions (Research Objective C)
- among drivers who have had experience with these technologies, the frequency of use and reasons for non-use (Research Objective D) and incorrect use (Research Objective E).

3.3.1.1 Questionnaire

Transport Canada, the Canadian Government office responsible for transport policy and operations, recently conducted a similar survey exploring Canadians' awareness of and confidence in automated vehicles (Environics Research, 2019). The questionnaire used by Transport Canada has been used as the basis for the questionnaire used in this study. To allow for comparability between the New Zealand and Canadian results, the questionnaire was left substantially the same. However, several changes were made to address specific Waka Kotahi research objectives. In addition, some alternate phrasing was adopted to ensure fit to a New Zealand audience.

The questionnaire included sections on:

- vehicle type and use
- attitudes towards driving and automated vehicles
- awareness of ADAS technologies
- experiences with selected ADAS technologies
- familiarity and knowledge with selected ADAS technologies
- current and future information sources used to learn about ADAS
- demographics.

The full questionnaire is attached as Appendix B.

The ADAS technologies explored in the survey are detailed and defined in Table 3.1.

Table 3.1 Detail of ADAS technologies examined

Technology	Type	Definition
Automatic emergency braking (AEB)	Automated driving task	Detects potential collisions while travelling forward and automatically applies brakes to avoid or lessen the severity of impact.
Forward collision warning (FCW)	Collision alert	Detects impending collision while travelling forward and alerts driver.
Adaptive cruise control (ACC)	Automated driving task	Controls acceleration and/or braking to maintain a prescribed distance between it and a vehicle in front. May be able to come to a stop and continue.
Lane departure warning (LDW)	Collision alert	Monitors vehicle's position within driving lane and alerts driver as the vehicle approaches or crosses lane markers.
Lane keep assist (LKA)	Automated driving task	Controls steering to maintain vehicle within driving lane. May prevent vehicle from departing lane or continually centre vehicle.
Blind spot monitoring (BSM)	Collision alert	Detects vehicles to rear in adjacent lanes while driving and alerts driver to their presence.
Electronic stability control (ESC)	Automated driving task	Detects when a vehicle may lose control, such as when going around corners too fast, and stabilises vehicle.

Source: Adapted from AAA (2019)

The technologies were examined in this study due to their market prevalence in New Zealand and the availability of comparable data regarding use and awareness (eg, the Transport Canada study). The ESC feature was included due to the technology recently being mandated in New Zealand.

The questionnaire was designed to take approximately 15 minutes; however, this varied depending on whether the respondent had prior or current experience with ADAS technologies. The length and usability of the questionnaire was initially tested internally and then with a small number of external volunteers.

3.3.1.2 Sample

Survey recruitment and administration was managed by a market research company (Dynata). Dynata's New Zealand research panel comprises over 300,000 active members. Recruitment to the panel ensures members are broadly representative of the New Zealand population by age, gender, and location. Panel members are provided small, non-financial incentives for surveys completed. Members may withdraw from surveys and the panel at any time.

Invitations were sent to Dynata panel members. Respondents needed to be aged between 18 and 80 years of age. In total, 1,363 respondents indicated they would complete the survey. Of these, 45 did not meet the eligibility criteria and 65 were excluded as they comprised a quota that had already been filled. A further 205 were eligible but did not complete the survey, providing a completion rate of 84%.

Table 3.2 summarises the demographic characteristics of the survey participants and compares this with available characteristics from the 2018 Census (Stats NZ, 2018). Minimum quotas, reflecting the general distribution of the New Zealand population, were set for gender, location (urban/non-urban), age, and ethnicity (Māori/non-Māori). The data was then stratified based on the 2018 Census data for gender, age, and regional location to better reflect the New Zealand population. However, even with stratification, the final sample under-represents those on higher incomes and Pacific and Asian ethnic groups.

Table 3.2 Respondent profile (main sample)

Characteristic	Category	Unweighted (*n*)	Weighted (*n*)	Weighted (%)	2018 Census (%)*
Gender	Female	539	539	51%	51%
	Male	510	510	49%	49%
	Other gender identity	2	2	0%	0%
	Prefer not to answer	0	0	0%	0%
Valid driver licence	Yes	974	974	93%	–
	No	77	77	7%	–
Age group	18–24	129	141	13%	13%
	25–34	185	176	17%	19%
	35–44	201	197	19%	17%
	45–54	207	206	20%	18%
	55–64	173	169	16%	16%
	65–80	156	162	15%	16%
Ethnicity	New Zealand European	713	713	68%	70%
	Māori	151	151	14%	17%
	Pacific peoples	57	57	5%	8%
	Asian	103	103	9%	15%
	Other	140	140	13%	3%
	Prefer not to answer	8	8	1%	–
Location	Rural	150	141	13%	14%
	Urban	881	891	85%	86%
	Don't know/not sure	19	19	2%	–
Household income	Under $20,000	82	82	8%	8%
	$20,000 to just under $40,000	176	176	17%	–
	$40,000 to just under $60,000	175	175	17%	–
	$60,000 to just under $80,000	142	142	14%	–
	$80,000 to just under $100,000	122	122	12%	–
	*$20,000 to just under $100,000***	*615*	*615*	*60%*	*40%*
	$100,000 to just under $150,000	159	159	15%	18%
	$150,000 and above	72	72	7%	16%
	Prefer not to answer	123	123	12%	8%

Note. The base is the total number of respondents to the main survey (*n* = 1,051). Multiple responses were permitted for ethnicity.

* Ethnicity, location, income and gender are based on 2018 Census data for the entire population (rather than just those aged 18–80). Census data does not capture driver licence.

** Household income brackets used in the study for values under $100,000 differed to Stats NZ brackets. Due to these differences, it was not possible to undertake more detailed comparisons for some household income brackets between $20,000 to $100,000.

3.3.1.3 Survey administration

The survey was administered by Dynata, using their customised survey platform. Data collection occurred during June 2021 and commenced with a 'soft-launch' of 57 respondents. Following this, a minor change was made to the question on the frequency of ADAS use. Rather than a single option for 'turned off', this was separated into 'I don't use it – temporarily turned it off' and 'I have disabled it permanently'. Four of the 57 respondents were affected by this change, but we retained their responses, given the relatively minor nature of the change.

Recruitment for the survey was paused again mid-way through the data collection process to calculate the incidence rate for respondents who had experience using the ADAS technologies. As anticipated, the incident rate was relatively low, confirming the need to recruit a supplementary (‘boost’) sample of drivers with experience of at least any one of the ADAS technologies examined. Therefore, after the resumption and conclusion of the main survey (*n* = 1,051), targeted data collection continued to achieve a final supplementary sample of 152 participants (see section 3.3.2 below).

3.3.1.4 Analysis

The main survey data was exported into Microsoft Excel and IBM SPSS for analysis. For each question, responses were summarised as frequency counts and percentages overall, by age, gender, location (rural or non-rural), and, for some questions, the ADAS user group. Qualitative responses to open-ended questions on attitudes to automated vehicles and experiences with ADAS technologies were coded and the coded data then aggregated.

Note, the driver owner and driver user findings from the main survey (*n* = 364) were combined with the driver owner and driver user findings from the ‘boost’ sample (*n* = 152) to give a total of 516 users from these two groups. This final sample size provides more confidence in the user findings for the two groups and allowed for more granular analysis on user-related questions. The results from the combined user sample are used in section 4.4 for the questions regarding frequency of use, reasons for non-use, responsibility while using feature, likelihood of undertaking non-driving tasks while using the feature, and issues experienced with the feature.

In the analysis of the survey data, survey respondents were categorised into one of four ADAS user groups based on their reported experience with ADAS technologies. A respondent may have fitted different ADAS user groups for different technologies; for example, a driver owner of ESC and a non-user of AEB. In most analyses that compared experience amongst different user groups, the technology-specific definition was adopted. However, for some analyses that explored exposure to ADAS technologies amongst the general population (presented in Tables 4.4 and 4.5), survey respondents were categorised into ADAS user groups according to the rules described below:

- **Driver owner**: Respondents who own or personally lease a vehicle equipped with at least one ADAS technology.
- **Driver user**: Respondents who drive or previously drove a vehicle equipped with at least one ADAS technology (ie, as owner, rental car, lease, car share, work vehicle) *but* do not currently own or lease.
- **Non-driver user:** Respondents who have been a passenger in a vehicle equipped with at least one ADAS technology *but* who have not driven one.
- **Non-user**: Respondents who were either unsure about their level of experience with the technology *or* have neither driven nor been a passenger in a vehicle equipped with any ADAS technology.

3.3.2 Supplementary ‘boost’ survey

3.3.2.1 Questionnaire

The ‘boost’ survey included the same questions as outlined in section 3.3.1.1 but with some changes to question order. Respondents were initially asked questions about their vehicle use and driving, followed by which ADAS technologies they were aware of. The screening questions were then used to ensure respondents had experience of at least one of the seven ADAS technologies being examined. The remainder of the questions followed the same order as for the main survey.

3.3.2.2 Sample

Quotas were not established, meaning the 'boost' sample is not representative of the ADAS vehicle owner population. Further, unlike the main survey, the results from the 'boost' sample are not weighted.

As with the main survey, invitations to complete the 'boost' survey were sent to Dynata panel members. Of 732 panel members indicating a willingness to take part, 500 did not meet the eligibility criteria (ie, a driver owner or user of a vehicle with at least one ADAS feature, aged between 18 and 80 years, had not completed or had not been invited to complete the main survey). A further 80 panel members began but did not complete the survey, providing a completion rate of 66%. Their results were not included in the analysis. The lower completion rate is likely due to the longer length of this survey, as respondents were required to answer multiple questions about each of the technologies they had experience with.

3.3.2.3 Survey administration

The 'boost' survey was conducted by Dynata during June 2021 and followed the same process described above in section 3.3.1.3.

As with the main survey, responses to each 'boost' question were summarised into counts and percentages. This was undertaken for the total sample and by driver owners and driver users. Where appropriate, differences by gender were explored using chi-square tests. Open-ended questions regarding issues experienced with different ADAS technologies were coded and the coded data then aggregated. Binary logistic regression modelling was conducted to explore the relationship between knowledge and attitudes towards automated vehicles and use.

3.3.3 Total driver owners and driver users surveyed

Table 3.3 details the total number of driver owners and driver users of ADAS technologies that were surveyed. Of the total, 364 are from the main survey and 152 are from the 'boost' survey.

Table 3.3 Demographic characteristics of driver owners and driver users of ADAS technologies

Characteristic	Category	*n*	%
Gender	Male	313	61%
	Female	202	39%
	Other gender identity	1	0%
	Prefer not to answer	0	0%
Valid driver licence	Yes	516	100%
	No	0	0%
Age group	18–24	50	10%
	25–34	103	20%
	35–44	99	19%
	45–54	89	17%
	55–64	81	16%
	65–80	94	18%
Ethnicity	New Zealand European	350	68%
	Māori	47	9%
	Pacific peoples	23	5%
	Asian	70	14%
	Other	75	15%
	Prefer not to answer	3	1%
Location	Rural	76	14%
	Urban	437	85%
	Don’t know/not sure	3	1%
Household income	Under $20,000	15	3%
	$20,000 to just under $40,000	49	10%
	$40,000 to just under $60,000	82	16%
	$60,000 to just under $80,000	70	14%
	$80,000 to just under $100,000	74	14%
	$100,000 to just under $150,000	103	20%
	$150,000 and above	56	11%
	Prefer not to answer	67	13%

Note. The base is the total number of driver owners and driver users from the main and boost survey (n = 516). Note, multiple responses were permitted for ethnicity.

Compared to non-users, driver owners and driver users are more likely to be male, in a higher-income bracket, and of older age. This result is consistent with previous literature that has described individuals who are more likely to own or drive a vehicle equipped with ADAS (Crump et al., 2016; Environics Research, 2019).

3.3.4 Interviews with ADAS vehicle owners

Interviews were conducted with owners of vehicles with ADAS technologies to provide more in-depth understanding of ADAS knowledge and perceptions, receipt of information at purchase, use and non-use, and the influence of ADAS technologies on vehicle purchase decision making. A limited number of ride-along interviews were also conducted to further examine use and non-use within real-life driving contexts.

3.3.4.1 Recruitment

Interviewees were recruited from a pool of survey respondents who had signalled their interest in participating in the further research. Interviewees were compensated for their time in the form of a $100 gift voucher. Those interviewees agreeing to participate in the 'ride-along' interview component were compensated for their time with a further $150 gift voucher.

3.3.4.2 Sample

The interview participants comprised a mix of ages, genders, and urban/non-urban locations, as shown in Table 3.4. Typically, as qualitative research draws on relatively small samples of respondents, it is not possible for the sample to be demographically representative. Nonetheless, the interviewees were selected to reflect a broad range of New Zealand drivers and experiences.

Table 3.4 Demographic characteristics of interview participants

Characteristic	Category	Interviews (*n* = 17)	Ride-along interviews (*n* = 4)
Gender	Female	7	2
	Male	10	2
Age group	18–24	0	0
	25–34	6	1
	35–44	3	0
	45–54	3	2
	55–64	1	0
	65–80	4	1
Location	Urban	14	4
	Rural	3	0

Note. The demographic characteristics of the ride-along interview participants are captured in both columns.

3.3.4.3 Interview approach

A semi-structured interview format was adopted to ensure consistency of topics covered while also providing the flexibility to pursue emerging lines of enquiry. All interviews were conducted over the phone during June 2021 and ranged in length from 25 to 50 minutes. All ride-along interviews were conducted in-person, during June 2021, and ranged in length from 40 to 60 minutes.

The topic guide for the interviews and ride-along interviews was structured to follow the pre-consumer to consumer to user journey. The researcher, after explaining the purpose of the research and providing an opportunity for the interviewee to ask any questions, would ask questions regarding the interviewee's daily travel and activities. This was then followed by questions regarding the vehicle pre-purchase experience, including asking about any prior use and awareness of ADAS technologies and exploring any relevant influences on their vehicle purchase (pre-consumer stage). The researcher then asked a series of questions exploring any training provided at the point of sale, and how confident and informed the participant felt about using the ADAS technologies (consumer stage). In the final part of the interview (user stage), the researcher explored the participant's experiences and any issues using the ADAS technologies, including the reasons for turning off or not using the technology. Questions exploring the participant's trust in the different ADAS technologies, issues, and incorrect use were also explored. A copy of the topic guide is attached as Appendix C.

The ride-along component was conducted in the participant's vehicle, with the researcher sitting in the front passenger seat and the participant in the driver's seat. The interview was conducted at a location familiar to the participant, such as near their home or workplace, and comprised three parts. The first and third part was conducted while the vehicle was parked in a safe location away from hazards. In the first part, questions explored the driver's interface with ADAS technologies; that is, how visible, easy, and intuitive they found them. The second part involved a drive of approximately 10 minutes, in which participants were asked to 'think aloud' their reactions to ADAS technologies. The final part involved several follow-up questions regarding their use or non-use of ADAS technologies during the drive.

3.3.4.4 Analysis

All interviews, including ride-along interviews, were audio-recorded and transcribed. A reflexive thematic analysis of the interview material was then conducted following the process set out by Braun and Clarke (2012). Coding and theme development was primarily deductive and structured by key themes in the pre-consumer to consumer to user journey. However, the sub-themes within each of these stages were driven by the data. As such, a primarily deductive but also inductive approach to data coding was adopted. After analysing eight interviews, initial themes and sub-themes were discussed within the project team, were refined as appropriate, and then applied to the remaining interviews.

Note that the thematic analysis identified three distinct types of users of ADAS within the driver owners we interviewed: frequent, mixed and non-users. These categorisations are referred to in the reporting and discussion of the interview findings where appropriate. Note also that the findings from all the interviews have been analysed and reported as a single data set. This means that the findings are not distinguished by whether they were derived from the general interviews or from the ride-along interviews. All quotations used have been coded by their user type and a numerical reference.

3.4 Limitations of the research

The respondents to the online survey were recruited through an opt-in panel rather than using a random probability sample approach. Minimum quotas were used to ensure the sample reflected the general distribution of the New Zealand population by gender, location (urban/non-urban), age, and ethnicity (Māori/non-Māori). The survey findings were also weighted by age, gender, and regional location to reflect the New Zealand population. Despite these measures, the final sample slightly underrepresented higher-income earners and respondents identifying as Pasifika and Asian.

The survey findings wholly comprise self-reported data and therefore may have some error. Some findings will be reflective of the level of awareness or knowledge that respondents brought to certain questions. For example, there may be cases where respondents were driving vehicles equipped with ADAS technologies that they were not aware of. An example of this can be seen with ESC, an ADAS technology that became mandatory in all new and used vehicles imported to New Zealand from 2015. About one in five (22%) of the survey respondents who identified the year of the vehicle they drove most often, drove a vehicle manufactured in the last five years. We would therefore expect these respondents to identify themselves as a driver owner or driver user of ESC. However, of respondents with a vehicle manufactured from 2016 onwards, approximately two-fifths (40%) reported they had experience as either a driver owner or user of ESC, suggesting significant under-reporting of this technology.

We used several design strategies in the survey to mitigate risks associated with self-reported data and to ensure that responses to the survey were as accurate as possible. These included clear explanations of the intent of each question, the use of simple language, and precisely worded questions. Triangulation between the findings from the survey, the qualitative interviews, and key findings from the literature search also increases confidence in the reliability of the survey findings.

The four ride-along interviews conducted provided some opportunity to observe drivers' interactions with ADAS technologies. While this allowed for some examination of factors such as usability, the interviews were not designed to provide a systematic review of human factors. Such examination was outside the scope of this research.

4 Survey findings

4.1 Introduction

This chapter presents all the findings from the main and boosted survey. As previously detailed, the findings are structured by the pre-consumer, consumer, and user stages.

The base (denominator) is shown for each analysis as required. In some analyses, columns and rows may not total 100% due to rounding or because multiple responses were possible.

4.2 Pre-consumer stage

Pre-consumer stage findings address Research Objectives A and C.

4.2.1 Key findings

- New Zealanders most commonly think about fully autonomous vehicles in response to the term ‘automated vehicle’ and have concerns about vehicle automation generally, particularly higher levels of automation.
- Whether New Zealanders have heard of different ADAS technologies varies by technology. The greatest number have heard of cruise control (73%) and back-up cameras (64%). Males are more likely than females, and older age-groups are more likely than younger age-groups, to have heard of in-vehicle technologies.
- Of the seven ADAS technologies examined, about a third of New Zealanders have or have had experience with the technologies as a driver owner, driver user, or non-driver user. On each technology, the majority of New Zealanders have neither driven nor been a passenger in a vehicle equipped with the technology.
- The greatest proportion of driver owners, driver users, non-driver users, and all others who had heard of each technology were familiar with BSM (61% somewhat/very familiar). On all other technologies examined, over half the respondents were somewhat or very familiar with the technology.
- Younger respondents were more likely to describe themselves as somewhat or very familiar with ADAS technologies compared to those older. Males were more likely to do the same compared to females.
- Unsurprisingly, driver owners were more likely to describe themselves as familiar with ADAS technologies compared to the other ADAS user groups. However, a proportion described themselves as not familiar with technologies in their vehicle – ranging from 5% to 27% depending on the technology.
- Of respondents who had used or had heard of each technology, the greatest proportion correctly identified the function of BSM (73%), followed by LKA (68%) and AEB (63%). Respondents were least likely to correctly identify the function of FCW (40%) and ACC (17%).[1]

4.2.2 Perceptions of automated vehicles

When asked what comes to mind in response to the term ‘automated vehicles’, New Zealanders most commonly thought of a totally autonomous vehicle. Responses included self-driving car (28%), vehicle with automatic or automated functions (14%), and driverless vehicle (12%) (see Appendix B, Table B.1 for the full

[1] The names of some technologies are more descriptive of function than others, meaning some technologies may have recorded a higher number of correct guesses than others.

results). These results show that currently, many New Zealanders do not immediately think about or distinguish the levels of automation when initially responding to the concept of an automated vehicle.

4.2.3 Familiarity with automated vehicles

Without prompting, we asked New Zealanders how familiar they were with automated vehicles. About a third (32%) described themselves as very or somewhat familiar; however, less than 1 in 10 (9%) were very familiar. About two-thirds (63%) described themselves as not very or not at all familiar.

Analysis of familiarity by gender showed a greater proportion of males (37%) were very or somewhat familiar compared to females (28%). Analysis of age showed that younger age groups, particularly 18–24-year-olds, generally described themselves as more familiar than older age groups. The full findings on familiarity by gender and age can be found in Appendix B, Table B.2.

4.2.4 Acceptability of automated vehicles

New Zealanders' responses to questions designed to examine acceptance of automated vehicles show many have underlying concerns, particularly regarding higher levels of automation. Over two-thirds (71%) of respondents agreed or strongly agreed that system security and data privacy issues will be more of a concern at higher levels of automation. A similar proportion (64%) agreed or strongly agreed they were concerned about the idea of fully automated delivery vehicles, while half (52%) disagreed or strongly disagreed they would be comfortable riding in a fully automated vehicle. Over two-thirds (69%) thought travelling in an automated vehicle would be a somewhat or highly stressful experience.

Nonetheless, our results also show a significant proportion of New Zealanders understand that automated vehicles can bring benefits and advantages, particularly improved driving performance and road safety. Over a third agreed or strongly agreed that automated vehicles would help to keep roads safer for everyone (43%) and perform better than human drivers in routine driving conditions (38%). A similar proportion (36%) said they would be comfortable riding in a fully automated vehicle.

The full results for the questions on the acceptability of automated vehicles to New Zealanders can be found in Appendix B, Table B.3.

The full results for how relaxing or stressful New Zealanders would find driving or riding in an automated vehicle can be found in Appendix B, Table B.4.

4.2.5 Advantages and disadvantages of automated vehicles

Similar to the results above, New Zealanders identified both advantages and disadvantages of automated vehicles. However, only 2% did *not* identify any disadvantages, and 1 in 10 did not see any advantages (see Appendix B, Figures B.1 and B.2, for the full results).

Reflecting the previous findings on acceptability, commonly identified advantages related to driving performance and road safety. Performance benefits included easier driving for the elderly or persons with disabilities (52%), helping the driver to manage New Zealand driving conditions and roads (34%), and driving being less stressful (30%). The main road safety benefit identified was reduced driver error and mitigation of impaired driving (52%).

Contrary to the above, commonly identified disadvantages showed that New Zealanders were also concerned that automated vehicles could make driving in New Zealand *less* safe. Concerns included that drivers could become lazy or pay less attention (60%), the potential for equipment or system failure (59%), that vehicles may not react to unexpected situations (55%), that drivers could become less skilful (53%), and the potential for drivers to lose control of their vehicles (44%). Reflecting a different view from perceived advantages, about a third (31%) of New Zealanders were concerned that automated vehicles were not suited to New Zealand driving conditions and roads.

4.2.6 ADAS technologies heard of

Prompted with a list of ADAS technologies, we asked New Zealanders which, if any, they had heard of. Respondents were asked to consider whether they had experienced or interacted with each technology or had seen or heard about them elsewhere. Cruise control (73%) and back-up cameras (64%) were most commonly identified (Table 4.1); no others had been heard of by over half of New Zealanders. Respondents were least familiar with back-up warning systems (28%); 5% had not heard of any of the technologies.

Males were more likely to have heard of each technology compared with females, a difference most pronounced for FCW (50% vs 29%) and ESC (44% vs 23%). In general, awareness of each technology increased with age; in some cases, differences by age were extreme. For example, almost half (43%) of 65–80-year-olds had heard of ESC compared to only 14% of 18–24-year-olds. The age trend is not surprising as older New Zealanders are more likely to be able to afford to buy newer vehicles equipped with ADAS.

Table 4.1 ADAS technologies heard of by New Zealanders

	All respondents (*n* = 1,051)	Gender		Age					
		Females (*n* = 539)	Males (*n* = 510)	18–24 (*n* = 141)	25–34 (*n* = 176)	35–44 (*n* = 197)	45–54 (*n* = 206)	55–64 (*n* = 169)	65–80 (*n* = 162)
Blind spot monitoring/alert	47%	41%	53%	40%	46%	42%	48%	49%	57%
Lane departure warning	44%	35%	54%	29%	35%	36%	48%	57%	59%
Forward collision warning	39%	29%	50%	31%	34%	36%	38%	45%	52%
Lane keep assist	41%	33%	50%	32%	40%	39%	39%	43%	51%
Automatic emergency braking	45%	39%	51%	36%	39%	39%	44%	50%	60%
Adaptive cruise control	38%	31%	45%	33%	28%	35%	40%	45%	45%
Electronic stability control	33%	23%	44%	14%	26%	33%	39%	40%	43%
Cruise control	73%	70%	75%	63%	65%	64%	75%	81%	88%
Back-up warning system	28%	25%	31%	21%	19%	25%	30%	32%	39%
Automatic parking	44%	37%	52%	35%	44%	43%	43%	47%	53%
Back-up camera	64%	63%	66%	61%	59%	59%	63%	67%	78%
None of the above	5%	6%	3%	2%	3%	5%	7%	8%	2%
Not sure	6%	7%	4%	6%	7%	8%	6%	6%	1%

Note. The bases are the total number of respondents to the main survey in each gender and age category.

4.2.7 Experience with ADAS technologies

Regardless of whether respondents had any experience with, or had heard of, any ADAS technologies, all were asked to describe their experience with seven technologies.[2] Respondents were prompted with a brief introduction to ADAS and a description of what each technology did (see Appendix C). Note, the results to this question are included in the pre-consumer stage because they describe the extent and type of

[2] Automatic emergency braking (AEB); forward collision warning (FCW); adaptive cruise control (ACC); lane departure warning (LDW); lane keep assist (LKA); blind spot monitoring (BSM); electronic stability control (ESC).

experience New Zealanders have had with each technology, including passengers and those with no experience.

Table 4.2 shows the survey respondents by ADAS user group and ADAS technology. For example, the first row of the table shows that 8% of respondents were currently a driver owner of a vehicle with AEB and 8% were or had been a driver user of a vehicle with AEB.

On each technology, about a third of respondents have had experience as a driver owner, driver user, or non-driver user. As might be expected for each technology, the majority of respondents have neither driven nor been a passenger in a vehicle equipped with the technology.

Table 4.2 Respondents by ADAS user group and ADAS technology

	Driver owner	Driver user	Non-driver user	Total % of respondents with experience	Non-user	Not sure
AEB	8%	8%	14%	**30%**	58%	13%
FCW	9%	6%	12%	**27%**	62%	11%
ACC	9%	9%	18%	**36%**	51%	13%
LDW	8%	8%	14%	**30%**	61%	9%
LKA	7%	6%	13%	**26%**	64%	11%
BSM	7%	9%	13%	**29%**	59%	11%
ESC	13%	7%	12%	**32%**	52%	16%

Note. The base is the total number of respondents to the main survey (*n* = 1,051).

Table 4.3 describes the demographics of the respondents who were a driver owner of each technology. On all technologies, males were slightly more likely than females to be a driver owner. The gender difference is most pronounced for ESC. Driver owners with ESC were also noticeably more likely to be living in a rural area (20%) and to be between 65 and 80 years of age (20%).

The age result is not surprising for ESC as this technology became mandatory in all vehicles from 2015. Many older New Zealanders will be more able to afford a later-model vehicle compared to younger New Zealanders.

Table 4.3 Respondents to the main survey who were driver owners, by age group, gender and location

	Age group						Gender		Location	
	18–24 (*n* = 141)	25–34 (*n* = 176)	35–44 (*n* = 197)	45–54 (*n* = 206)	55–64 (*n* = 169)	65–80 (*n* = 162)	Female (*n* = 539)	Male (*n* = 510)	Urban (*n* = 891)	Rural (*n* = 141)
AEB	8%	10%	9%	4%	7%	8%	6%	9%	7%	14%
FCW	6%	10%	11%	7%	9%	9%	7%	11%	9%	11%
ACC	6%	12%	12%	7%	6%	12%	8%	11%	9%	13%
LDW	7%	9%	10%	8%	8%	9%	6%	11%	8%	11%
LKA	7%	7%	8%	6%	7%	8%	5%	9%	7%	9%
BSM	9%	6%	9%	7%	7%	6%	6%	8%	7%	8%
ESC	6%	11%	14%	13%	13%	20%	6%	20%	12%	20%

Note. The bases are the total number of respondents to the main survey in each gender, age, and location category.

Table 4.4 shows the number of respondents from the main survey in each ADAS user group when applying the allocation rules previously described in section 3.3.1.4 and presented again below:

- **Driver owner** was a driver owner of at least one ADAS technology.
- **Driver user** was a driver user of at least one ADAS technology and was *not* a driver owner of any ADAS technology.
- **Non-driver user** was a non-driver user of at least one ADAS technology and was *not* a driver owner or driver user of any ADAS technology.
- **Non-user** had neither driven nor been a passenger in a vehicle equipped with any ADAS technology, or were unsure about their level of experience with the technology.

About a quarter (23%) had had experience as a passenger of at least one ADAS technology. The remainder of the sample – just over two out of five respondents (43%) – had neither driven nor been a passenger in a vehicle equipped with any ADAS technology.

Table 4.4 Respondents by ADAS user group

ADAS user group	*n*	%
Driver owner	245	23%
Driver user	124	12%
Non-driver user	235	22%
Non-user	447	43%

Note. The base is the total number of respondents to the main survey (*n* = 1,051); ‘not sure’ are included in non-users.

Table 4.5 shows the percentage of driver owners by the number of ADAS technologies they reported having in their vehicle. Almost half (46%) had only one technology, while about one in five (18%) had two. Only 7% had all seven of the technologies examined.

Table 4.5 Driver owners, by number of ADAS technologies in vehicle

Number of ADAS technologies	*n*	%
1	112	46%
2	43	18%
3	23	9%
4	19	8%
5	15	6%
6	15	6%
7	18	7%

Note. The base is the total number of driver owners in the main survey (*n* = 245).

Table 4.6 shows the mix of ADAS technologies that each driver owner reported by the total number of technologies they had. For example, over half (55%) of driver owners with only one technology reported they had ESC, with ACC (11%) the next most common.

Table 4.6 Mix of ADAS technologies, by number of technologies in driver owners' vehicles

	One ADAS in vehicle (*n* = 112)	Two ADAS in vehicle (*n* = 43)	Three ADAS in vehicle (*n* = 23)	Four ADAS in vehicle (*n* = 19)	Five ADAS in vehicle (*n* = 15)	Six ADAS in vehicle (*n* = 15)	Seven ADAS in vehicle (*n* = 18)
AEB	8%	9%	17%	12%	14%	13%	14%
FCW	7%	16%	13%	18%	17%	17%	14%
ACC	11%	23%	22%	8%	13%	16%	14%
LDW	5%	8%	16%	18%	20%	17%	14%
LKA	4%	7%	12%	17%	14%	14%	14%
BSM	9%	12%	10%	16%	13%	9%	14%
ECS	55%	24%	10%	12%	8%	14%	14%

Note. The bases are the proportion of driver owners in the main survey, in each category of number of ADAS technologies.

4.2.8 Familiarity with ADAS technologies

Driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology were asked how familiar they were with the respective technologies (Table 4.7). Across all technologies, over half the respondents described themselves as somewhat or very familiar, with the greatest proportion familiar with BSM (61%).

Table 4.7 Familiarity with ADAS technologies

	AEB (*n* = 563)	FCW (*n* = 502)	ACC (*n* = 576)	LDW (*n* = 561)	LKA (*n* = 517)	BSM (*n* = 575)	ESC (*n* = 480)
Net: familiar	**53%**	**54%**	**55%**	**58%**	**56%**	**61%**	**53%**
Very familiar	10%	12%	16%	11%	12%	14%	13%
Somewhat familiar	43%	42%	39%	47%	44%	47%	40%
Net: not familiar	**47%**	**46%**	**45%**	**41%**	**43%**	**39%**	**46%**
Not very familiar	36%	35%	33%	31%	34%	31%	35%
Not at all familiar	11%	11%	12%	10%	9%	8%	11%

Note. The bases are driver owners, driver users, and non-driver users of each technology and all other respondents to the main survey who had heard of each technology.

Table 4.8 shows that both driver owners and driver users reported relatively high levels of familiarity. At least two-thirds of respondents in both groups described themselves as somewhat or very familiar across all technologies. Driver owners were more likely than driver users to describe themselves as familiar with each ADAS technology. A similar pattern emerged with driver owners and driver users – both were most likely to report highest levels of familiarity with BSM (95% vs 83%) and lowest levels of familiarity with ESC (74% vs 69%).

Table 4.8 Familiarity with each technology, by ADAS user group

	AEB (*n* = 158)		FCW (*n* = 153)		ACC (*n* = 192)		LDW (*n* = 168)		LKA (*n* = 131)		BSM (*n* = 165)		ESC (*n* = 209)	
	Driver owners (*n* = 79)	Driver users (*n* = 79)	Driver owners (*n* = 92)	Driver users (*n* = 61)	Driver owners (*n* = 97)	Driver users (*n* = 95)	Driver owners (*n* = 87)	Driver users (*n* = 81)	Driver owners (*n* = 73)	Driver users (*n* = 58)	Driver owners (*n* = 75)	Driver users (*n* = 90)	Driver owners (*n* = 136)	Driver users (*n* = 73)
Net: familiar	**82%**	**70%**	**79%**	**72%**	**84%**	**80%**	**87%**	**74%**	**90%**	**78%**	**95%**	**83%**	**74%**	**69%**
Very familiar	30%	15%	28%	20%	45%	28%	32%	22%	30%	24%	48%	21%	27%	15%
Familiar	52%	54%	51%	53%	38%	52%	55%	52%	60%	53%	47%	62%	47%	53%
Net: not familiar	**18%**	**30%**	**21%**	**28%**	**17%**	**20%**	**13%**	**26%**	**10%**	**22%**	**5%**	**17%**	**27%**	**32%**
Not very familiar	9%	28%	17%	26%	11%	16%	9%	22%	8%	22%	4%	14%	21%	26%
Not at all familiar	9%	3%	3%	2%	5%	4%	3%	4%	1%	0%	1%	2%	6%	6%

Note. The base is the total number of driver owners and driver users for each ADAS technology from the main survey.

Table 4.9 provides further description of the respondents above who described themselves as somewhat or very familiar with each technology. About half of these respondents reported being somewhat or very familiar with the technology. Respondents were most likely to be familiar with BSM (61% somewhat/very familiar) and least likely to be familiar with ESC (53% somewhat/very familiar).

While older people were more likely to have heard of ADAS technologies, younger respondents were more likely to describe themselves as somewhat or very familiar compared to older respondents (Table 4.9). Males were also more likely to do the same compared to females.

Table 4.9 Respondents who were somewhat or very familiar with each ADAS technology, by gender and age

	All respondents	Gender		Age group					
		Females	Males	18–24	25–34	35–44	45–54	55–64	65–80
AEB (*n* = 563)	53%	52%	54%	59%	64%	62%	53%	47%	39%
FCW (*n* = 502)	54%	59%	58%	63%	54%	47%	44%	46%	59%
ACC (*n* = 576)	55%	59%	59%	56%	58%	49%	49%	48%	61%
LDW (*n* = 561)	58%	52%	64%	72%	71%	69%	57%	40%	52%
LKA (*n* = 517)	56%	57%	61%	65%	54%	53%	47%	49%	62%
BSM (*n* = 575)	61%	55%	66%	68%	63%	72%	53%	56%	55%
ESC (*n* = 480)	53%	42%	59%	62%	59%	48%	50%	52%	54%

Note. The bases are driver owners, driver users, and non-driver users of each technology and all other respondents to the main survey who had heard of each technology.

4.2.9 Knowledge of ADAS technologies

Driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology were asked what the technologies did. Respondents were provided with three descriptions of the function of each technology, one being correct (see Appendix C). Note that the names of some technologies are more descriptive of function than others, meaning some may have recorded a higher number of correct guesses than others (Environics Research, 2019). Nonetheless, the greatest proportion of respondents correctly identified the function of BSM (73%), followed by LKA (68%) and AEB (63%). Far fewer were correct for FCW (40%) and ACC (16%).

Table 4.10 Respondents who correctly identified what each technology does

	% correct
AEB (*n* = 520)	63%
FCW (*n* = 471)	40%
ACC (*n* = 546)	17%
LDW (*n* = 538)	58%
LKA (*n* = 485)	68%
BSM (*n* = 534)	73%
ESC (*n* = 440)	61%

Note. The bases are driver owners, driver users, and non-driver users of each technology (excluding those 'not sure' about their technology use) and all other respondents to the main survey who had heard of each technology.

Table 4.11 compares the proportion of respondents who correctly identified the purpose of each ADAS technology by driver owners and driver users of each ADAS technology. More detailed tables, including comparisons by non-driver users and non-users, are included in Appendix B, Tables B.5 to B.11.

Driver owners are more likely to have had exposure to information and training about what each technology does; for example, through an owner's manual or at a sales dealership. As such, it is somewhat surprising that knowledge among driver owners is only slightly higher than other user groups for certain technologies. The lack of a more pronounced difference between user groups on some technologies perhaps reflects the descriptive nature of some of the terms, which likely resulted in respondents correctly guessing the answer (as discussed earlier). Nonetheless, for technologies where there is a more marked difference, these findings reinforce that both experience and exposure to ADAS technologies contribute to understanding. For example, driver owners scored noticeably higher than driver users in identifying the purpose of AEB, ACC, LDW and ESC. This indicates that certain technologies may require more direct experience to be understood by different user groups. Finally, of note in these findings is the high proportion of driver owners and driver users who still did not correctly report the purpose of certain technologies, such as ACC, FCW, and LDW.

Table 4.11 Respondents who correctly identified what each technology does, by ADAS user group

	AEB (*n* = 158)		FCW (*n* = 153)		ACC (*n* = 192)		LDW (*n* = 168)		LKA (*n* = 131)		BSM (*n* = 165)		ESC (*n* = 209)	
	Driver owners (*n* = 79)	Driver users (*n* = 79)	Driver owners (*n* = 92)	Driver users (*n* = 61)	Driver owners (*n* = 97)	Driver users (*n* = 95)	Driver owners (*n* = 87)	Driver users (*n* = 81)	Driver owners (*n* = 73)	Driver users (*n* = 58)	Driver owners (*n* = 75)	Driver users (*n* = 90)	Driver owners (*n* = 136)	Driver users (*n* = 73)
Correct	68%	55%	51%	51%	33%	17%	67%	48%	67%	71%	78%	73%	73%	62%
Incorrect/Don't know	32%	45%	49%	49%	67%	83%	33%	52%	33%	29%	22%	27%	27%	38%

Note. The base is total number of driver owners and driver users for each ADAS technology from the main survey.

Comparison of the above findings with non-driver users and non-users (found in Appendix B, Tables B.5 to B.11) show that driver owners were generally much more likely to correctly identify the purpose of each ADAS technology compared to non-users. The technologies where this is most pronounced are FCW, ACC, and ECS.

Table 4.12 describes the respondents above who correctly identified the function of each technology by gender and age. In general, male and older respondents were more likely to correctly identify the purpose of each technology. Differences by gender and age were minimal for some technologies and more pronounced for others. For instance, males were more likely to correctly identify the purpose of AEB compared to female

(70% vs 55%). Similarly, older age groups were more likely to correctly identify the purpose of ESC; for example, 75% of 65–80-year-olds correct compared to 36% of 18–24-year-olds.

Table 4.12 Respondents who correctly identified what each technology does, by gender and age

	All respondents	Gender		Age group					
		Females	Males	18–24	25–34	35–44	45–54	55–64	65–80
AEB (*n* = 520)	63%	55%	70%	47%	50%	59%	68%	70%	80%
FCW (*n* = 471)	40%	37%	42%	50%	48%	33%	39%	40%	32%
ACC (*n* = 546)	16%	12%	20%	15%	19%	21%	19%	12%	9%
LDW (*n* = 538)	58%	58%	58%	61%	59%	54%	61%	60%	53%
LKA (*n* = 485)	66%	64%	68%	44%	60%	69%	76%	72%	70%
BSM (*n* = 534)	72%	69%	74%	67%	71%	60%	71%	81%	81%
ESC (*n* = 440)	61%	53%	65%	36%	47%	50%	69%	75%	75%

Note. The bases are driver owners, driver users, and non-driver users of each technology (excluding those ‘not sure’ about their technology use) and all other respondents to the main survey who had heard of each technology, within each gender and age category.

4.3 Consumer stage

Consumer stage findings address Research Objectives B and C.

4.3.1 Key findings

- The ADAS technologies frequently identified by driver owners as very or somewhat important in their decision to purchase their current vehicle were BSM (79%), AEB (69%), ACC (65%), and FCW (62%).
- Technologies considered important when purchasing or leasing a vehicle in the future were similar to the above. Respondents to this question[3] frequently identified BSM (69%), AEB (67%), FCW (66%), and ESC (65%) as very or somewhat important.
- Driver owners, driver users, and non-driver users most commonly sought information about the technologies from the vehicle owner’s manual (23%), through conducting online searches (22%), and by asking friends and family (22%).
- The information sources most commonly used by driver owners were vehicle owner’s manuals (35%), online searches (24%), and trial and error (23%). Only 15% had received information from the vehicle seller.
- Sixteen percent of driver owners, 24% of driver users, and 38% of non-driver users had not sought any information about the technologies they used or had experience of.
- Future preferred information sources for non-users of ADAS technologies and users who had not accessed any information were online searches (50%), manufacturer’s websites (33%), online videos (26%), and vehicle owner’s manuals (25%). One in five (19%) would contact or visit a car dealer.

[3] Driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology.

4.3.2 Influence of ADAS technologies in decision making

Two questions examined how important ADAS technologies were to New Zealanders when considering the purchase or lease of a vehicle. The first asked driver owners of each technology how important the technology was in their decision to purchase or lease their *current* vehicle. The second asked driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology how important the technology was likely to be in a *future* decision to purchase or lease a vehicle.

About three-quarters (79%) of driver owners with BSM in their current vehicle considered the technology to have been very or somewhat important in their purchase or lease decision (Table 4.13). About two-thirds reported the same for AEB (69%), ACC (65%), and FCW (62%). Under half (47%) considered LDW to have been important.

Table 4.13 Importance of ADAS technologies in decision to buy or lease current vehicle

	AEB (*n* = 79)	FCW (*n* = 92)	ACC (*n* = 97)	LDW (*n* = 87)	LKA (*n* = 73)	BSM (*n* = 75)	ESC (*n* = 136)
Net: important	**69%**	**62%**	**65%**	**47%**	**53%**	**79%**	**57%**
Very important	32%	22%	28%	21%	17%	45%	26%
Somewhat important	37%	40%	37%	26%	36%	34%	31%
Net: not important	**31%**	**38%**	**35%**	**53%**	**47%**	**21%**	**43%**
Not very important	22%	20%	22%	23%	35%	13%	27%
Not at all important	9%	18%	13%	30%	12%	8%	16%

Note. The bases are driver owners of each technology in the main survey.

The results for the importance of the ADAS technologies in a future purchase or lease decision were similar to the previous findings. This question was asked of driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology (Table 4.14). BSM (69%), AEB (67%), and FCW (66%) were again considered very or somewhat important by the greatest proportion of respondents. About two-thirds (65%) reported the same for ESC.

Table 4.14 Importance of ADAS technologies in future decision to buy or lease a vehicle

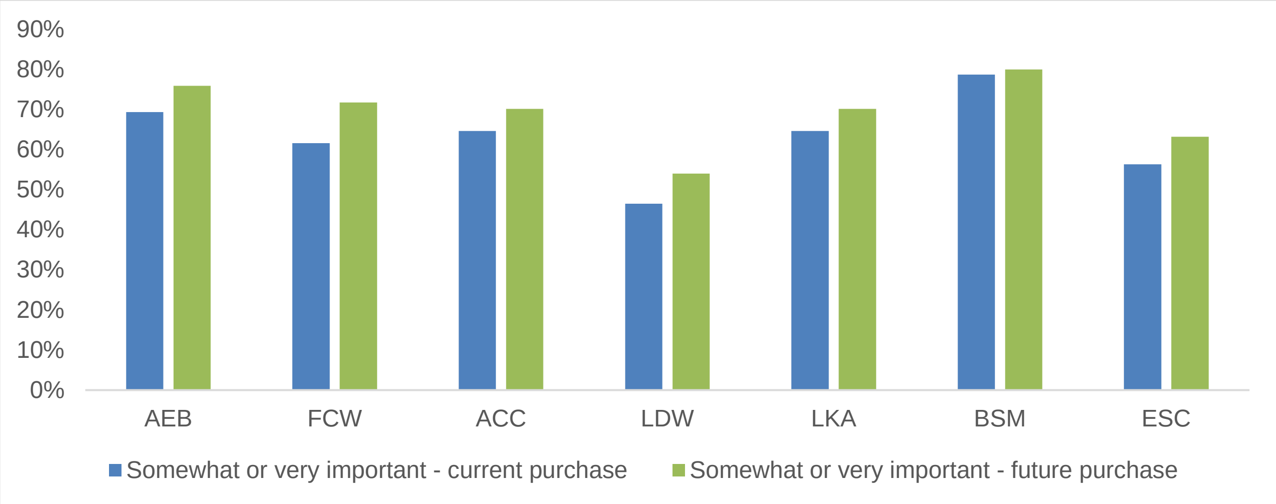
	AEB (*n* = 563)	FCW (*n* = 502)	ACC (*n* = 576)	LDW (*n* = 561)	LKA (*n* = 517)	BSM (*n* = 575)	ESC (*n* = 480)
Net: important	**67%**	**66%**	**54%**	**56%**	**52%**	**69%**	**65%**
Very important	23%	22%	15%	17%	15%	26%	20%
Somewhat important	44%	44%	39%	39%	37%	43%	45%
Net: not important	**33%**	**34%**	**46%**	**44%**	**48%**	**31%**	**35%**
Not very important	24%	23%	32%	33%	37%	23%	26%
Not at all important	9%	11%	14%	11%	11%	8%	9%

Note. The bases are driver owners, driver users, and non-driver users of each technology and all other respondents to the main survey who had heard of each technology.

Figure 4.1 compares for each technology the proportion of driver owners of each technology who rated the technology as somewhat or very important in their current and future purchase or lease decision.

Across all technologies, driver owners rated the importance slightly or somewhat higher for future decisions compared to their current vehicle. This suggests that the perceived value of these technologies has increased through the experience of using them.

Figure 4.1 Influence of ADAS on current and future purchasing decisions, by driver owners



Note. The bases are driver owners of each technology in the main survey (AEB, *n* = 79; FCW, *n* = 92; ACC, *n* = 97; LDW, *n* = 87; LKA, *n* = 73; BSM, *n* = 75; ESC, *n* = 136).

Note, among respondents who had heard of the respective technologies, with the exception of ACC, there were no statistically significant differences in the level of importance given to their future vehicle purchase, by gender. Among male respondents, 61% reported ACC would be somewhat or very important for their future purchase compared to 51% of female respondents (X^2 (3, N = 694) = 12.990, p < .005).

4.3.3 Information sources about ADAS technologies

Prompted with a list, driver owners, driver users, and non-driver users were asked which information sources, if any, they had used to learn about any of the technologies they had experience with (Table 4.15). The sources most commonly reported were vehicle owner's manual (23%), online searches (22%), and asking friends and family (22%). The least commonly reported were previous or current employers (3%), government websites (4%), and contacting a garage or mechanic (5%). Approximately one in four (26%) respondents reported not having used any information source. This group comprised 16% of driver owners, 24% of driver users and 38% of non-driver users.

Examining sources by ADAS user group showed that trial and error was used by 23% of driver owners and 24% of driver users (Table 4.15). Other common sources for driver owners were owner's manuals (35%) and online searches (24%); only 15% had received information from the vehicle seller.

Driver users and non-driver users were more likely to use online videos (16% and 20% respectively) or asking friends or family (19% and 27% respectively) compared to driver owners. While these results are intuitive, they further highlight the different information sources accessed by different user groups. The further removed a user group is from direct experience of ADAS technologies, the more they may have relied on informal information sources. These potential nuances in the user groups need to be recognised when considering implementation strategies, which will allow for a range of interventions targeted across a spectrum of user groups.

Of particular concern in the findings on information sought is the proportion of users of ADAS technologies who did not seek any information about the technologies. There is obvious potential for misunderstanding, misuse, and safety risks.

Table 4.15 Information sources used to learn about ADAS technologies

	Total % (*n* = 604)	Driver owner (*n* = 245)	Driver user (*n* = 124)	Non-driver user (*n* = 235)
Online video (eg, YouTube, car company video)	17%	14%	16%	20%
Online search	22%	24%	18%	21%
Contacted garage/mechanic	5%	6%	4%	4%
Contacted/visited a dealership	8%	13%	8%	3%
Manufacturer’s website	14%	20%	11%	8%
Government website	4%	4%	6%	3%
Books, brochures, or pamphlets	6%	7%	5%	4%
Social media (eg, Facebook, Twitter)	9%	6%	11%	11%
Read the owner’s manual	23%	35%	24%	9%
Asked friends or family	22%	19%	21%	27%
Learned by trial and error	17%	23%	24%	6%
Education/information received from seller	10%	15%	10%	5%
Previous or current employer	3%	1%	7%	2%
None – did not access any information	26%	16%	24%	38%
Other	2%	2%	1%	3%
Not sure	6%	8%	6%	4%

Note. The bases are all driver owners, driver users, and non-driver users in the main survey.

Non-users of ADAS technology and driver owners, driver users, and non-driver users who had not accessed any information or who were not sure were asked what information sources they would prefer to access to learn about ADAS technologies (Table 4.16). Half of these respondents reported they would prefer to conduct online searches, followed by accessing manufacturer’s websites (33%) and watching online videos (26%). A quarter would read the vehicle owner’s manual, while one in five (19%) would contact or visit a car dealer.

Table 4.16 Preferred information sources to learn about ADAS technologies

	Total % (*n* = 642)	Driver owners not previously seeking information (*n* = 59)	Driver users not previously seeking information (*n* = 37)	Non-driver users not previously seeking information (*n* = 99)	Non-users (*n* = 447)
Online video (eg, YouTube, car company video)	26%	23%	23%	28%	26%
Online search	50%	41%	46%	46%	53%
Contacted garage/mechanic	10%	2%	3%	10%	12%
Contacted/visited a dealership	19%	16%	26%	14%	20%
Manufacturer's website	33%	24%	45%	35%	33%
Government website	11%	5%	6%	10%	12%
Books, brochures or pamphlets	11%	2%	9%	10%	13%
Social media (eg, Facebook, Twitter)	6%	5%	3%	5%	6%
Read the owner's manual	25%	25%	35%	23%	25%
Asked friends or family	16%	7%	8%	20%	17%
Learned by trial and error	4%	4%	6%	2%	5%
None – do not want to learn about it	7%	5%	3%	8%	7%
Other	1%	0%	0%	2%	0%
Not sure	11%	17%	8%	4%	12%

Note. The bases are all driver owners, driver users, and non-driver users in the main survey who did not seek any information about the ADAS technologies they have had experience with, and all non-users of ADAS technologies from the main survey.

4.4 User stage

The user stage findings presented in this section address Research Objectives D and E. The findings are from the 364 driver owners and driver users from the main survey and the 152 driver owners and driver users from the 'boost' sample survey.

4.4.1 Key findings

- The ADAS technologies most likely to be used 'frequently' by driver owners were BSM (52%), ESC (40%), FCW (38%) and LKA (38%).
- A greater proportion of driver owners reported using each technology frequently compared to driver users. Differences were greatest for BSM (52% vs 26%), ESC (40% vs 15%), and LKA (38% vs 17%).
- The ADAS technologies most likely to be turned off by driver owners were AEB (8%), LDW (8%), and LKA (8%).
- Males were more likely than females to report using most ADAS technologies sometimes or frequently.
- The most common reason for low or non-use of each technology was 'my driving is good/not needed'.
- The majority of driver owners understood they were responsible for monitoring the vehicle's driving functions 'all of the time' when using ADAS technologies. However, a significant proportion reported less than 'all of the time' (ie, most, some, only when needed) or were unsure. These proportions ranged between 28% and 37% depending on the technology.
- About two-thirds of driver owners using ADAS technologies frequently, sometimes, or rarely reported they would *not* be more likely to undertake any non-driving task while using the technologies.

- The non-driving tasks most commonly reported as more likely were talking with passengers (10% to 15% depending on the technology) and talking on a hands-free phone (11% to 15% depending on the technology).
- A minority of driver owners and users described issues or ways ADAS technologies did not work as expected, most commonly that technologies were too sensitive or provided unnecessary warnings. This was particularly so for FCW, LDW, and BSM.
- An analysis was undertaken to examine whether attitudes to automated vehicles and knowledge of the ADAS technologies correctly predicted how frequently ('sometimes', 'frequently') technologies were used. The analysis showed a weak relationship between the variables. This result may in part be due to weaknesses in the knowledge question used in the survey (see previous discussion in section 4.2.9).

4.4.2 Frequency of use

Driver owners and driver users of each technology were asked how often they do or did use each technology. These respondents were simply asked how often they 'used' each technology; however, this study shows that the concept of 'using' ADAS technologies requires further consideration. This issue is discussed in depth in section 5.4. For current purposes, the reader should recognise that the findings on use will in large part reflect how each respondent interpreted the meaning of 'using' ADAS technologies.

Table 4.17 shows the frequency of use reported by driver owners and driver users respectively. The ADAS technologies most commonly used frequently by driver owners were BSM (52%), ESC (40%), FCW (38%) and LKA (38%). Those used most frequently by driver users were BSM (26%), followed by LDW (23%) and FCW (19%).

For all technologies, a greater proportion of driver owners reported using each technology frequently compared to driver users. Differences were greatest for BSM (52% vs 26%), ESC (40% vs 15%), and LKA (38% vs 17%).

The number of drivers turning any of the ADAS technologies off are small for both user groups. The technologies most likely to be turned off by driver owners were AEB (8%), LDW (8%), and LKA (8%).

Driver users are likely to have a greater range of experiences with ADAS technologies than driver owners. Driver users are more likely to have fleeting experiences, such as through a rental vehicle, or more long-term, yet still potentially sporadic, experience through a work vehicle. Therefore, the context of use for driver users may provide more limited opportunities to learn about technologies prior to use. The more sporadic nature of use by driver users may also mean they are less likely to build the experience and confidence with technologies that might predict more regular use. Both factors could help to explain why driver owners are more likely than driver users to use ADAS technologies frequently.

It should also be noted that AEB is likely to be activated less frequently than other technologies, and this may influence drivers' perceptions of how frequently this technology is used.

Table 4.17 Frequency with which each ADAS technology is used

	AEB (*n* = 231)		FCW (*n* = 215)		ACC (*n* = 270)		LDW (*n* = 234)		LKA (*n* = 181)		BSM (*n* = 227)		ESC (*n* = 300)	
	Driver owners (*n* = 170)	Driver users (*n* = 61)	Driver owners (*n* = 167)	Driver users (*n* = 48)	Driver owners (*n* = 190)	Driver users (*n* = 80)	Driver owners (*n* = 173)	Driver users (*n* = 61)	Driver owners (*n* = 134)	Driver users (*n* = 47)	Driver owners (*n* = 159)	Driver users (*n* = 68)	Driver owners (*n* = 219)	Driver users (*n* = 81)
Frequently	26%	11%	38%	19%	25%	16%	34%	23%	38%	17%	52%	26%	40%	15%
Sometimes	15%	15%	23%	13%	28%	35%	23%	16%	20%	26%	25%	30%	18%	18%
Rarely	28%	18%	18%	27%	23%	14%	17%	25%	18%	23%	9%	13%	17%	22%
Never	15%	20%	9%	13%	14%	11%	9%	7%	10%	9%	6%	9%	8%	9%
Turned off	8%	7%	5%	4%	6%	8%	8%	3%	8%	2%	3%	0%	5%	6%
NA/not sure	8%	29%	7%	24%	4%	16%	9%	26%	6%	23%	5%	22%	12%	30%

Note. The bases are driver owners and driver users of each technology in the main and boost survey.

The frequency of use by driver owners was examined by gender (Table 4.18). Users were grouped into two categories: ‘frequently/sometimes’ and ‘rarely/never/turned-off’. Respondents answering ‘Not applicable’ or ‘Not sure’ to the use question were excluded from the analysis.

Males were more likely than females to report using most ADAS technologies sometimes or frequently. The gender difference was greatest for AEB (50% male sometimes/frequently vs 37% female sometimes/frequently), ACC (60% vs 47%), and ESC (74% vs 43%).

Table 4.18 Frequency of ADAS technology use, by gender

	Sometimes/ frequently		Rarely/never/ turned-off	
	Female	Male	Female	Male
AEB (*n* = 117)	37%	50%	63%	50%
FCW (*n* = 128)	65%	69%	35%	31%
ACC (*n* = 140)	47%	60%	53%	40%
LDW (*n* = 115)	62%	64%	38%	36%
LKA (*n* = 96)	77%	85%	23%	15%
BSM (*n* = 116)	58%	64%	42%	36%
ESC (*n* = 161)	43%	74%	57%	26%

Note. The bases are the total number of driver owners and driver users of each technology from the main and boost surveys who responded ‘Frequently’, ‘Sometimes’, ‘Rarely’, ‘Never’, or ‘Turned Off’ to the use question.

4.4.3 Reasons for non-use

Table 4.19 shows the reasons that driver owners and driver users of each ADAS technology gave for using the technology sometimes, rarely, never, or for turning it off. Respondents were presented with a list of reasons and could also identify other reasons through an open-text response.

The most common reason for less than always or non-use of each technology was ‘my driving is good/not needed’ (Table 4.19). As mentioned in the previous section, respondents were most likely to select ‘don’t drive on the open road a lot’ as the reason for not using ACC, suggesting that the road environment influences the potential to use some technologies more frequently.

Other reasons for low or non-use varied by technology. Most notably, ‘it is annoying’ and ‘it is distracting’ was highest for LDW (26% and 25% of respondents, respectively) and LKA (28% and 22% of respondents, respectively).

Table 4.19 Reasons for using ADAS technologies sometimes, rarely, never, or turning-off

	AEB (*n* = 113)	FCW (*n* = 90)	ACC (*n* = 133)	LDW (*n* = 97)	LKA (*n* = 74)	BSM (*n* = 68)	ESC (*n* = 105)
My driving is good/not needed	38%	32%	28%	31%	38%	31%	44%
I don’t know how to use it	13%	11%	11%	6%	4%	10%	15%
Don’t drive on the open road a lot	9%	3%	26%	10%	9%	6%	4%
It is annoying	6%	14%	16%	26%	28%	16%	13%
It is distracting	12%	12%	10%	25%	22%	18%	10%
It doesn’t work	4%	6%	3%	5%	1%	4%	5%
Other	7%	7%	10%	7%	8%	4%	6%
Not applicable	13%	13%	9%	11%	5%	16%	9%
Not sure	5%	14%	5%	3%	5%	6%	10%

Note. The bases are driver owners and driver users of each technology from the main and boost survey who responded ‘Sometimes’, ‘Rarely’, ‘Never’, or ‘Turned Off’ to the use question.

On all technologies except LDW and LKA, about 1 in 10 users who were using each technology less than all the time were doing so because they did not know how to use the technology. Table 4.20 shows the number of respondents who reported they did not know how to use the technology by how often they used the technology. Due to the very small number of respondents who comprised these categories, these results are reported as the number of respondents rather than percentages.

The analysis shows that depending on the technology, between one and six respondents had turned off each technology because they did not know how to use it. While this represents a very small proportion of overall users (less than 1% for all technologies except AEB), it shows that drivers do turn off ADAS features because they don’t know how to operate them correctly.

Further, between 2 and 11 respondents used each technology sometimes or rarely, despite not knowing how to use it. This shows a very small minority of drivers still use technologies, albeit infrequently, despite a lack of understanding.

Table 4.20 Not knowing how to use the ADAS technology as a reason for low or non-use

	AEB (*n* = 19)	FCW (*n* = 14)	ACC (*n* = 17)	LDW (*n* = 13)	LKA (*n* = 5)	BSM (*n* = 10)	ESC (*n* = 21)
Sometimes	3	4	1	3	1	2	5
Rarely	3	4	3	7	1	4	6
Never	7	5	11	2	2	3	7
Turned off	6	1	2	1	1	1	3

Note. The bases are driver owners and driver users of each technology from the main and boost survey who responded ‘I don’t know how to use it’ to the reasons for low or non-use question.

4.4.4 Driver responsibilities

Driver owners of each ADAS technology were asked: ‘While using this feature, are you still responsible for monitoring the vehicle’s driving functions?’ (Table 4.21). While the majority response for all technologies was ‘all of the time’, a considerable proportion of respondents reported less than all the time (ie, most, some, only when needed) or were unsure. These proportions ranged from 28% to 37% depending on the technology. Considering ADAS is designed for full driver responsibility all of the time, this result is of concern when considering the potential for adverse consequences.

Table 4.21 Perceived responsibility while using ADAS features

	AEB (*n* = 170)	FCW (*n* = 167)	ACC (*n* = 190)	LDW (*n* = 173)	LKA (*n* = 134)	BSM (*n* = 159)	ESC (*n* = 219)
All of the time	66%	72%	63%	68%	68%	72%	70%
Most of the time	12%	9%	12%	12%	14%	14%	12%
Some of the time	9%	11%	12%	11%	7%	7%	6%
Only when needed	5%	3%	7%	3%	4%	3%	4%
Don’t know/Not sure	7%	5%	6%	6%	7%	4%	8%
Total less than ‘all the time’	33%	28%	37%	32%	32%	28%	30%

Note. The bases are driver owners of each ADAS technology from the main and boost surveys.

4.4.5 Undertaking non-driving tasks

Driver owners who used ADAS features frequently, sometimes, or rarely were asked whether they were *more* likely to undertake any non-driving tasks while using the feature (Table 4.22). These respondents were provided a list of common non-driving tasks and could also identify any other tasks through an open text response. Respondents could select multiple tasks.

Approximately one-third of respondents indicated they would be more likely to engage in at least one non-driving task while using the technology. The non-driving tasks most commonly reported as more likely across the technologies were talking with passengers (ranging from 10% to 15%) and talking on a hands-free phone (ranging from 11% to 15%).

Table 4.22 Non-driving tasks more likely to be undertaken, by driver owners

	AEB (*n* = 118)	FCW (*n* = 133)	ACC (*n* = 143)	LDW (*n* = 127)	LKA (*n* = 102)	BSM (*n* = 136)	ESC (*n* = 165)
Talking on a handheld phone	4%	3%	4%	6%	5%	4%	6%
Talking on a hands-free phone	11%	15%	14%	12%	11%	15%	12%
Reading or sending text messages	5%	5%	6%	7%	8%	3%	7%
Changing the audio entertainment system	11%	9%	15%	5%	10%	4%	7%
Changing the GPS	8%	9%	9%	6%	8%	9%	8%
Eating or drinking	7%	11%	11%	9%	14%	7%	9%
Smoking	7%	2%	4%	6%	2%	1%	4%
Talking with passengers	10%	13%	15%	11%	11%	12%	11%
Attending to children or pets	1%	3%	5%	2%	2%	6%	5%
Looking for, reaching for, or tidying up an object	2%	2%	3%	6%	5%	5%	2%
Looking at something outside the vehicle	5%	6%	5%	2%	8%	7%	4%
Thinking about things unrelated to the driving task	3%	2%	5%	2%	3%	1%	2%
Other	0%	0%	1%	0%	0%	1%	0%
None of the above	61%	62%	58%	65%	62%	65%	67%

Note. The bases are driver owners using each ADAS technology frequently, sometimes, or rarely, from the main and boost survey.

4.4.6 Issues using ADAS features

Driver owners and driver users of each technology were asked ‘Have you experienced any issues using each feature (for example, the feature not working in the way you expected it to)?’ Respondents were able to provide no response to this question if they wished.

Across the technologies, the proportion of respondents who provided a response and reported no issues ranged between 78% and 87%. Of respondents who reported an issue of some kind, these most commonly related to the technology being too sensitive and/or providing unnecessary warnings. This was particularly so for FCW, LDW, and BSM.

Qualitative description of the issues identified are provided below. The full results of the issues identified for each technology can be found in Appendix B, Tables B.12 to B.18.

One survey respondent reported the issue they have experienced with LDW:

> *…lots of beeping when the vehicle detects markings on the road where lines have been repainted and updated, as it cannot distinguish between old and current.*

While most issues related to systems perceived as too sensitive, some survey respondents described features operating in unexpected ways. For instance, one respondent described their experience using LKA:

> *It can be a little unnerving when the car does make a correction for you when you are not expecting it as the automatic response is to then over correct manually.*

Similarly, another respondent described their experience with AEB operating when they had not anticipated:

> *It braked when I entered a narrow dark corner on a country road where there was no vehicle in front of me … it was a work vehicle and started beeping and braking. It gave me a hell of a fright.*

Another respondent described their experience using ACC, alluding to variations in the way this feature is designed by different manufacturers:

> *Car can speed up going round corners due to losing sight of car in front. Some models do not keep the speed at the set speed going down-hill – next thing you are doing 130 kph.*

4.4.7 Relationship between attitudes, knowledge, and use

A binomial logistic regression was conducted exploring the extent that attitudes to automated vehicles and knowledge of the ADAS technologies correctly predicted use of each technology. The results from this analysis are presented in Appendix B, Tables B.19 to B.25. For each technology, driver owners who used each technology either sometimes or frequently were categorised as 'users' of the technology. The knowledge variable was created from the question that tested respondents' knowledge of each technology. The attitude variable was a composite variable that combined respondent scores to five strongly correlated attitudinal statements regarding attitudes to automated and fully autonomous vehicles.

Overall, the models explained only a very small variance in use of each technology. The models for BSM ($x^2(2) = 0.456$, $p < 0.796$) and ESC ($x^2(2) = 1.299$, $p < 0.522$) were not statistically significant. The remaining models explained between 5% and 16% of use in each technology. This suggests there was not a strong correlation between these variables, at least for this study. Attitudes tended to have a more pronounced effect on use than knowledge, in each of the models. However, it should be noted, as discussed earlier in the report, that there are some limitations to the knowledge question, given that the names of some technologies are more descriptive than others, making it relatively easy for respondents to 'guess' the correct answer.

5 Interview findings

This chapter presents the findings from the interviews conducted with driver owners of vehicles with ADAS technologies. The findings are again structured by the pre-consumer, consumer, and user stages of the consumer journey. Note that the findings from the in-depth and ride-along interviews, respectively, are not distinguished in the analysis and reporting.

5.1 ADAS user types

All the survey respondents who took part in an in-depth or ride-along interview were a driver owner of at least one of the seven ADAS technologies examined in the research. Of the 17 interviewees, one drove a leased vehicle, while the remainder had purchased their vehicle through a dealership.

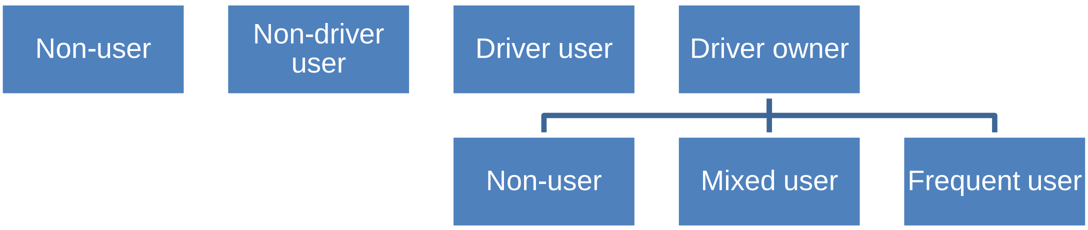
Through the interviews subsequently conducted with these driver owners, we identified three distinct user 'types' within the user group:

- **Non-user**: uses ADAS technologies very occasionally or does not *intentionally* use any ADAS technologies
- **Mixed user**: selectively uses *some* ADAS technologies
- **Frequent user**: uses all ADAS technologies their vehicle is equipped with, although use may vary depending on the road and speed environment.

From the interviews we identified similarities and differences across the user types in the pre-consumer, consumer, and user stages. These are identified and discussed throughout this findings chapter.

Figure 5.1 shows how the three user types were conceptualised in relation to the ADAS user groups from the survey.

Figure 5.1 Relationship between ADAS user groups (survey) and ADAS user types (interviews)



5.2 Pre-consumer stage

Pre-consumer stage findings address Research Objectives A and C.

5.2.1 Key findings

- Interview participants illuminated the diversity of consumers by awareness, perceptions, knowledge, purchasing decisions, and use of ADAS technologies.
- Frequent users were more likely to have undertaken comprehensive pre-purchase information gathering. Members of this group were more likely to see ADAS as useful prior to their vehicle purchase.
- Mixed users were generally aware of the safety benefits of some or all the ADAS technologies. Some assumed that technologies would increasingly be present in all new vehicles. Often, the technologies were learnt about in a less deliberate fashion than the frequent user group.

- Non-users had varying purchasing experiences and reasons for not using ADAS technologies. Two interviewees were highly motivated to use ADAS prior to purchasing their vehicle. However, their lack of understanding about when and why technologies activated and the meaning of alerts created a negative experience. This led them to turn technologies off. For another two interviewees, the lack of perceived usefulness of technologies meant they lacked the motivation to learn about how to use them and their potential benefits.

5.2.2 Influence on purchasing decision

Perhaps unsurprisingly, interviewees who were specifically looking for a vehicle with ADAS technologies were more likely to be currently using these technologies. Typically, these interviewees were more likely to undertake extensive research, often over several months, including multiple test-drives of different vehicles.

> *I did quite a bit of research – I read car reviews and that sort of thing, I was looking for a hatchback and there’s not a whole lot in that segment that tend to have those safety features, they tend to be in more of the high-end cars, so this was one of the few that had all those features.* (Frequent user 16)

Among these participants, ADAS technologies were generally perceived as useful, mostly commonly because of the added safety benefit.

> *You start seeing what they’ve got, you compare them, and you compare different models and different vehicles and what they’ve got, you know, what’s value for money, what it’s going to be like, which is the safest vehicle to buy.* (Frequent user 2)

Alongside this, several participants also mentioned that ACC provided for a more comfortable driving experience, particularly when travelling longer distances:

> *It makes driving so much easier, you just put it in it, and then you basically just steer. And I’m getting old, it makes it handy because I used to start cramping up in my leg when I was using the acceleration.* (Frequent user 2)

In contrast, several interviewees reported that other vehicle technologies were more influential in their vehicle purchase decision (eg, reliability, vehicle size, electric or hybrid). For these interviewees, ADAS technologies were of secondary or no importance in their decision making. As one interviewee describes:

> *None of those features we discussed [earlier in the interview] were any sort of rocket for me buying it. No, I didn’t care about them at all.* (Non-user 1)

Several participants, typically mixed users, assumed that ADAS technologies would increasingly become standard features in new vehicles. This expectation meant that limited attention was given to ADAS technologies when determining which vehicle to purchase.

> *[The car] just happened to have it. We were going to buy one and [my partner] decided she wanted an electric car. So that was it ... So, I didn’t think about those things, mainly because I figured that most of the new cars these days have got them anyway.* (Frequent user 12)

5.2.3 Prior experience of ADAS

Approximately half of respondents had some experience with ADAS technologies in a previous vehicle, hire vehicle, or work vehicle. Interestingly, the influence of this prior experience seemed to vary somewhat. One interviewee who hired a vehicle equipped with multiple ADAS technologies during a European holiday found the ADAS technologies extremely useful in an unfamiliar road environment. In turn, this experience influenced their decision to purchase a vehicle equipped with these technologies. In contrast, another interviewee who had hired a car with ADAS technologies had been reluctant to learn how to use them, given the short duration of the hire period:

> *I mean I was aware they had them, but I just wanted to get from a to b, I wasn't prepared to start fiddling with anything I wasn't familiar with.* (Frequent user 4)

Other respondents had prior experience with one or more ADAS technologies through a work vehicle or through a partner's or friend's vehicle. For one interviewee, the presence of a wider selection of ADAS technologies on her partner's vehicle was a prompt for her to begin looking for a replacement vehicle.

> *Once I drove my husband's car, then I felt like I want to get the latest features … [I find the] most helpful feature [on his vehicle] is the lane watch camera. That is incredibly helpful to me when crossing, you know, lanes. Crossing cycle lanes, those kind of things, and when we are moving over on a congested motorway.* (Mixed user 10)

Several interviewees reported having experience with ADAS technologies on a work vehicle. One noted that ADAS technologies had been disabled due to the majority of staff disliking the feature:

> *There's a whole lot of roadworks around at the moment. When we have that on in our work car, we go through road works where we have a little diversion, and you drive off the road a little bit. It's dangerous there because it doesn't recognize the new road layout and it tries to drive you into the cones … everyone tries to avoid using those two cars ... because of the features.* (Mixed user 7)

Interestingly, some interviewees who had prior positive experience with ADAS technology (commonly cruise control or reversing cameras), began their vehicle search specifically looking for the feature they were familiar with. During this process, they were exposed to the range of technologies commonly available and developed new appreciation of the value of other technologies.

5.3 Consumer stage

Consumer stage findings address Research Objectives B and C.

5.3.1 Key findings

- Interviewees most commonly specified ACC and BSM as the ADAS technologies that would be most important in their next vehicle. Technologies that interviewees had had little direct interaction with (such as AEB or ESC) were sometimes overlooked in favour of technologies that interviewees experienced more regularly.
- Buyer/seller discussions were typically influenced by the needs and interests articulated by the consumer. The dealer or seller tended to focus on the consumer's needs and motivations – and were less likely to raise ADAS technologies if the consumer did not identify these as important.
- Interviewees tended to place the lowest level of trust in AEB, attributed to the fact that this technology was rarely activated. This suggests that more frequent (appropriate) activation builds trust as well as the importance consumers place on the technology.
- Some interviewees expected or assumed that ADAS technologies would now be largely standard technologies in most new vehicles.
- There was some awareness that performance of ADAS technologies varied by manufacturer. One interviewee was deterred from purchasing a vehicle due to how the LKA feature performed during a test drive.
- Once having purchased a vehicle, frequent users were more likely to engage in a concerted effort to learn about the technologies in their vehicles. Learning by trial and error was again commonly used.

- One interviewee who purchased a vehicle through a private sale illuminated the challenge of imparting knowledge about the presence of the technologies on vehicles, as well as the safe and correct use of these technologies to potential buyers. Private sellers are, perhaps, less likely to be informed about these technologies than dealers. As ADAS technologies become increasingly standard on vehicles, and more prevalent among private sales, channels to provide information and guidance may need to become more innovative and targeted.

5.3.2 Sales process

Some interviewees reported their dealer had provided comprehensive instruction on how to safely and correctly use ADAS technologies. However, others felt their dealer or salesperson had limited knowledge; indeed, some felt more informed than the seller. As one interviewee described:

> *They might know more now being two years later but at that time it didn't seem much, and I'd done all that research.* (Frequent user 16)

Even if the consumer sought more information, the sales process was often described as brief, as was the time spent discussing ADAS if this occurred. As one interviewee described:

> *I don't think any of the dealers are going to spend an hour with you on the features and show you how to set it and all that, because it's all in the manual, right? It would be preferable if they did but most of them don't know enough about it themselves.* (Frequent user 2)

In some cases, the sales discussion appeared to be largely shaped by the needs and interests articulated by the consumer. Interviewees who were specifically seeking out ADAS technologies typically learned more about these technologies during the sales process. For instance, one interviewee who had previously experienced FCW as being 'too sensitive' asked specific questions about adjusting the setting on the new vehicle:

> *I don't know if I could turn the other one off. If I could, I didn't know I could, whereas this one I know I can turn it off and I was told in the dealership if the other one was annoying me to switch it to near as opposed to far.* (Mixed user 8)

In contrast, other interviewees were more interested in other vehicle characteristics such as vehicle size or performance. These interests, in turn, then shaped the discussion with the salesperson:

> *...they may have mentioned some of the features when we were going over the car when we first looked at it, but they weren't important [to us] at the time so we may have glazed over them, but I honestly don't remember them saying anything about it.* (Mixed user 17)

Some participants reported they had low knowledge of how to use available ADAS technologies at the point of sale. Several had driven the vehicle home with the technologies 'off', and then began their learning process:

> *The night I brought the car home, all I wanted to do was drive it like I knew how to drive a vehicle without any features. And I just wanted to get it home and then take my time reading the book and that kind of thing.* (Frequent user 4)

Reflecting the varied consumer experience, however, some interviewees reported that they felt comfortable driving the vehicle immediately, without any need for further training or information.

5.4 User stage

User stage findings address Research Objectives D and E.

5.4.1 Key findings

- The experiences of drivers in the user stage differed across the user types identified through the interviews. Frequent users were more likely to actively learn about the ADAS technologies on their vehicle and to adapt their driving style to accommodate any ‘quirks’.
- In contrast, non-users were less likely to actively learn about the available ADAS technologies and were more likely to use any perceived problem, weakness, or annoyance as a reason not to use technologies.

5.4.2 Learning through trial and error

The majority of mixed and frequent users described learning about how to use ADAS technologies through trial and error. Typically, interviewees read about technologies in their vehicle manual and then tried them out in appropriate situations. Interestingly, this was generally not perceived to be a risky way to learn; rather, experiencing when and how technologies were activated was considered instrumental to effective learning. As one interview described:

> *When I bought the last car it was a private sale so I had to figure out how to use some of these things ... sometimes I will look up and see what they do ... But generally it’s trial and error and once you work it out and get comfortable with using it you start using it more ... you work out the quirks and benefits of having these systems and then you form your own ideas about when to use them and how to use them as well. So, it’s really about exposure and experience.* (Frequent user 9)

Over time, as experience using technologies in different road environments developed, any ‘quirks’ of the technologies were integrated within the driving task. As one interviewee described:

> *Normally you keep driving along and start catching up with someone and then it would keep a certain distance from them. And then I used to drop its sensor so it would allow you to get closer, so you wouldn’t have such a distance to speed up to get around them. So, things like that you just start learning how to manipulate it.* (Frequent user 2)

Another interviewee, now a frequent user of ACC, described how her partner first showed her how to use the feature. Her partner sat in the vehicle with her when she first used it, but she still found the first experience, while building trust in the feature, uneasy. As she described:

> *I was nervous to use it at the beginning, especially when it would get close to other cars. Oh, my God, is it going to slow down? Is it going to catch up to them and not crash into them?* (Mixed user 7)

Over a period of several months, or even years, several interviewees reported that the integration of ADAS technologies with the driving task became more seamless. They became familiar with the sounds and sensations of alerts and warnings, and these acted to assure them that the technologies were operating as they should. As one interviewee described:

> *It’s kind of set and forget. Okay, this car has got this and this and this and they are all on. So, every time we start the car, we know they’re going to be on and so we are just going to leave them in the background and we don’t give them much thought to be honest...* (Mixed user 17)

5.4.3 Response to issues

Most frequent or mixed users reported some experience of ADAS technologies working or not working in unexpected ways. Most could identify specific road segments or driving conditions when ADAS activations were unexpected. Issues described commonly related to ACC or LKA and rural road environments.

An issue reported by several interviewees related to ACC (or AEB) identifying a stationary object or vehicle in following distance that prompted the brakes to be activated, as described by one interviewee:

> *There is one thing with the adaptive cruise control. And that may also be that emergency braking, I'm not sure which it does but you could be driving along and somebody basically stops your side of the white line to turn right and … the lanes aren't that wide, so you can't take away the sensors from picking it up and it starts ramming on the brakes ... and the closer you get the harder it gets to accelerate. You got to be aware of it, you can drive through it. You just got to be aware that you put your foot on the accelerator and keep it going.* (Frequent user 2)

Unexpected or 'quirky' activations did not tend to deter frequent and mixed users from using ADAS technologies; rather, they adapted their driving to accommodate the issue. For instance, while the interviewee above accelerated through the situation, another interviewee reported simply turning ACC off during a section of the road where this issue repeatedly occurred:

> *I know it's coming, so I make sure I don't have the [adaptive] cruise control on when I'm coming up to that.* (Mixed user 7)

In contrast, non-users were more likely to regard such experiences as a reason not to use the ADAS feature. As one interviewee described:

> *I've had a couple times where the screen's gone red, but I couldn't tell you what it was … Sometimes at first, I'm like, oh, what's that, and then I started looking at my screen when I should have been looking at the road. So, I probably would have been better off not to have the screen to just concentrate on the road.* (Non-user 1)

5.4.4 The driving experience

Frequent or mixed users commonly valued ADAS technologies as a 'back up' in support of their driving. This function made for a more 'relaxing' driving experience. These users were assured that systems were in place and would activate if required:

> *A bit more relaxed about your driving because you know the car's got your back as it were. I don't think I would ever be confident enough to not pay so much attention, but you just get a bit more relaxed about the driving.* (Frequent user 6)

Older interviewees, and one interviewee who had recently gained their licence, valued ADAS as a 'back up' for aspects of their driving requiring additional support. One described the reassurance provided by LKA, when she first gained her driver licence:

> *I think they gave me a bit more confidence knowing that there was a bit of a backup there in the car, that would help to cue me if I'd forgotten to check my blind spot. And when I was learning to drive, you sort of have that fear that you're not on the right place on the road. So that lane departure warning gave me some confidence, sense of security then, when I first started – knowing that it wasn't going off, I knew that I was in my lane.* (Frequent user 16)

However, as discussed below, interviewees did not consider technologies to be failproof – they were a back-up rather than replacement to their driving:

> *I see them as the second level of defence, I am the first level ... I want to be in control of what I'm doing…* (Mixed user 13)

Expanding on this, another interviewee puts the concept of technology fallibility in terms of their responsibilities as a driver:

> *At the end of the day, I am in charge of the vehicle. I have to make sure that I'm operating it safely. So that is part of this. If anything you should be more alert of what's happening around you when the car is driving itself because you don't want to become complacent ... you don't want to fall into that false sense of security that the car will deal with every situation because it won't.* (Frequent user 9)

Several interviewees noted that ACC improved their driving through enabling them to spend more time observing the road environment and less time glancing down to check or adjust their speed.

In contrast, non-users typically perceived ADAS technologies as having had a negative impact on their driving. This was often expressed in terms of the distraction or uncertainty created by warnings, particularly if there was confusion about why an activation had occurred. As one non-user (who was unable to disable the ADAS feature) described:

> *I've adjusted the sensitivity right to the lowest setting because I just thought it was probably more distracting and more dangerous than actually having a warning in place.* (Non-user 3)

5.4.5 Trust in ADAS technologies

Most interviewees did not entirely trust ADAS technologies to work appropriately all the time. This reinforced their understanding of technologies as a support to their driving and tended to motivate full attention on the driving task:

> *I wouldn't 100% trust them. Because they're technology, and because there's a hundred and one different situations that they wouldn't have been tested for. I wouldn't 100% trust them, I just see them as like a back-up and if it goes off, I'm not going to immediately make a decision based on that beeping or whatever, I'm going to look around and see, is there a reason for it and make the decision myself.* (Frequent user 16)

Reflecting a distrust of more advanced automated technologies, one interviewee discussed their reason for not using ACC:

> *I guess for me, I would prefer to be in control, and even thinking ahead about some of the vehicles that are coming in now with the self-driving you know, I'm not comfortable with it, so I know they're becoming more and more prevalent in the marketplace, but I'm a little uneasy with, you know, taking my hands off the wheel. Not even close to being comfortable with it.* (Mixed user 17)

For some interviewees, trust was closely linked to frequency of use. One interviewee had lower trust in AEB, a feature that he hadn't yet experienced:

> *Well, the ones we use. Yes, I do have a lot of trust in. The braking one, I would have trouble with relying on that ... I probably should be thankful that it's there and be thankful if it happened, but I don't think I could rely on that … It's like these cars that have got the self-driving mechanism, and I've always said there's no way I'm going to get into a car to drive me somewhere. I'm going to be driving it. I just couldn't trust that something wouldn't go wrong. And I feel the same with the braking. But as I say, I haven't had to use it, so I don't know.* (Frequent user 12)

A lack of trust in ADAS technologies was more evident among non-users, even for those with some appreciation for the technologies:

> *They do seem to work quite well, but I'd just rather trust my own driving.* (Non-user 3)

One non-user attributed their loss of trust to alerts occurring without any clear explanation:

> *There's nothing on my blind spot and it is suddenly beeping, I don't know why. So, I just switched it off. That's why I lost my confidence and trust.* (Non-user 15)

5.4.6 Reasons for use and non-use

Reasons for non-use of ADAS technologies varied across interviewees. Of the four non-users, two did not use technologies mainly due to a lack of knowledge about how to use them (including how to customise settings):

> *I don't think I am confident enough to use it. I tried using it a few times and then after that it just gets to me, it is really annoying ... makes me flustered all the time … the sudden noise ... only tried using it a couple of days and then I didn't want to use it anymore ... I was not confident enough at the time.* (Non-user 11)

The other non-users saw little of value in ADAS technologies. One felt that technologies simply added unnecessary cost to a vehicle:

> *I would have been happier to have like, a cheaper car without all those things. I wanted the Toyota motor and all the other stuff, but I didn't really care about any of that flash stuff. It probably just added to the cost of the car, and I'll never use them.* (Non-user 1)

This interviewee also struggled to find the time to learn how to use technologies correctly:

> *It would take me time to sort of figure it out and I just don't have the time to figure it out. And I don't think I need it because I can just drive it like a normal car. I don't bother to actually take the time to look into it.* (Non-user 1)

Another non-user did not think technologies improved their driving; they described an inertia about changing their driving style to accommodate technologies:

> *Maybe it's old fashioned, I don't know. I see them as a bit gimmicky without adding too much value to my driving, but maybe there is evidence to say it's safer, but I see them as gimmicks a little bit. They do seem to work quite well, but I'd rather trust my own driving. And I guess it's driver assistance rather than taking over. So, there's no reason why I shouldn't do it, but I guess it's what I'm used to. So, I'm used to driving without it, probably more than anything else.* (Non-user 2)

Non-use of technologies by mixed users was most commonly determined by the driving environment. For example, some would always use LKA, LDW, and ACC (or some combination) for long-distance trips but not for shorter daily trips.

For frequent and mixed users, technologies considered of most importance were generally those used most often. Technologies that would activate relatively infrequently (such as AEB) or which had low salience (such as ESC) tended to be ascribed a lower level of importance:

> *The ones I used the most are the lane keeper assist and the one that guides me. They're quite important. The braking one is very important, but I've never needed it. I would look for ones that I had experience using over something like the braking one.* (Frequent user 6)

5.4.7 Use of adaptive cruise control

Nearly all the interviewees had ACC on their vehicles. Interviewees commonly reported using this feature on motorways or while travelling at higher traffic speeds. The feature was less likely to be used in lower speed environments and in heavy traffic. For some, this was because the feature only activated at higher speeds. It was also noted that in heavy traffic, the system needed to be reset every time braking occurred. One interviewee did not use ACC because they believed their vehicle would run less efficiently when in ACC mode:

> *The only one I refuse to use is the cruise control because I think it's stupid. We don't really have a case to use the cruise control. And I think even when you do use it, you use more petrol than you would just cruising along at the same speed anyway. So I never use cruise control.* (Mixed user 17)

Common reasons for using ACC were a more comfortable driving experience, less straining on leg movements, useful for speed monitoring, and that the feature enabled greater attention to other driving tasks. Perhaps due to the frequency of use, ACC was commonly identified by users as an essential feature in any future vehicle purchased.

Several interviewees reported experiences of ACC not functioning in the way they had anticipated, in certain road situations. Most commonly, as described earlier, ACC radars would pick up stationary objects (such as a pedestrian refuge) or vehicles turning left or right, and in response, AEB would be activated. Another commonly reported situation was the unexpected loss of the lead vehicle (eg, if it goes around a corner) and ACC suddenly accelerating to the maximum cruising spend. This was particularly problematic on corners, with several interviewees reporting that their vehicle suddenly started accelerating into the corner (whereas if they were controlling the speed, they would have been slowing down, in preparation for the corner).

Interestingly, this feature, along with the two lane assistance technologies, appeared to have the greatest variability in performance by manufacturer. One interviewee, who test drove multiple vehicles, preferred his current vehicle due to the more responsive speed adjustments:

> *It [the Mitsubishi] was diabolical ... it would suddenly decide I'm not going quite fast enough and then it would take off, usually the worst thing was, it would do it when you were going up a hill or coming to the corner.* (Frequent user 2)

5.4.8 Use of blind spot monitoring

As with ACC, many interviewees described BSM as an essential feature in any future vehicle. As a complement to reversing cameras, BSM was particularly valuable while reversing:

> *I find that really helpful. Just to be able to see in my mirrors that the light's on. And I know there's something there, even if I haven't seen it.* (Mixed user 8)

5.4.9 Use of lane keep assist and lane departure warning

Interviewees generally only used the two lane keep technologies while travelling longer distances. However, most also reported that the technologies were less useful on rural roads where road markings were less consistent.

A few interviewees found these technologies extremely useful. For one interviewee, newly licensed, the technologies were useful for correct lane positioning. Similarly, another interviewee found the feature useful while becoming accustomed to a larger-sized vehicle and while developing the spatial awareness needed to achieve correct lane positioning.

One interviewee reported issues with using the technologies when encountering a road diversion due to road works. Another interviewee, often driving on rural roads, reported that their vehicle could have difficulty identifying road markings, narrow roads, and one-lane bridges.

5.4.10 Use of forward collision warning

Interviewees were often unclear about whether their vehicle was fitted with the FCW feature. This may be due in part to different terminology being adopted by different manufacturers. While FCW was generally valued by those aware they had the feature, several were using the lowest level of sensitivity because they found the frequency of alerts distracting.

5.4.11 Use of automatic emergency braking

While most interviewees were aware that their vehicle was equipped with AEB, most had yet to experience the feature. However, several noted that the feature worked (perhaps inappropriately, as described above) alongside ACC.

5.4.12 Use of electronic stability control

ESC became mandatory on all new vehicle imports from 2015, and all interviewees in the research drove vehicles manufactured from 2017 onwards. Despite this, many were unsure whether their vehicle was equipped with ESC. A few of those aware of the feature considered it to be very important. Others attributed the feature with lower importance, possibly in part because they were less informed about what the feature did.

Overall, most interviewees had the least experience with AEB and ESC and therefore limited ability to discuss these technologies. This is not surprising given that both technologies operate with a limited level of interaction with the driver.

5.4.13 Incorrect use of ADAS technologies

Most frequent and mixed users reported that they were no more likely to undertake non-driving tasks while using ADAS technologies. A challenge during any interview process is managing social desirably bias – the tendency for interviewees to provide answers that they believe will present more favourably to the interviewer. However, most interviewees appeared to answer in an open, reflective manner. One interviewee described how they were more likely to chat with other passengers. Another indicated that when using the ‘stop and go’ feature (not specifically explored in this research), they would occasionally look at their phone:

> *I think probably from time to time I’ve just popped down to have a look [at my phone]. It’s kind of weird you’re sitting there; you don’t have your foot on the brake or the accelerator. And you’re just sitting at the lights or whatever waiting for traffic to start moving. But you feel like you’ve got more time, and it is very relaxing.* (Non-user 3)

However, most interviewees were adamant they would not undertake non-driving related tasks while using ADAS technologies. As discussed, interviewees understood that they were still ultimately responsible for driving and for maintaining control of their vehicles. As one interviewee observed:

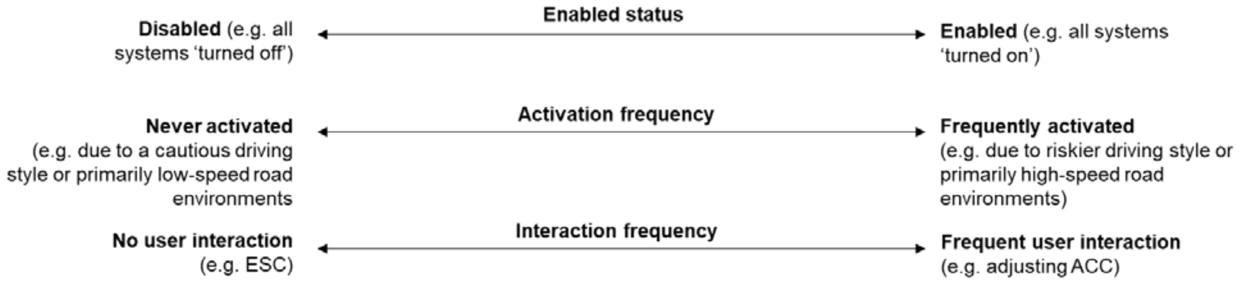
> *No, I don’t, I wouldn’t. Cause it would still be me in trouble, not the car.* (Frequent user 6)

5.4.14 Conceptualising the ‘use’ of ADAS technologies

Perceived and actual use of ADAS technologies varied across the interviewees. While we have broadly categorised users into three groups (frequent, mixed and non-user), the interviews demonstrated that the concept of ‘using’ ADAS technologies is multi-dimensional and not necessarily simply understood as having technologies turned on or off.

As depicted in Figure 5.2, ‘use’ of ADAS could be understood on a spectrum of dimensions including operation (ie, enabling or disenabling systems), activation (ie, frequency an alarm, alert, or intervention is activated), and driver interaction or engagement (ie, level of intervention required). For instance, depending on factors such as driving style, road environment, and traffic conditions, activations and the experience of these may range from frequently, rarely, or never. Similarly, technologies also vary by the extent a driver interacts or engages with the system. Consequently, the extent to which the driver is consciously aware of the feature may also vary. For example, ESC typically involves minimal driver engagement, whereas the driver is more actively engaged and aware of the function and interventions of ACC.

Figure 5.2 Multi-dimensional ADAS use frequency



6 Discussion

The research findings are discussed in this section with the discussion again structured by the pre-consumer, consumer, and user stages.

6.1 Pre-consumer stage

The research findings on perceptions, familiarity, and acceptance of automated vehicles are initially discussed, followed by awareness, knowledge, and experience of specific ADAS technologies. As previously noted, the initial focus on automated vehicles provides understanding of how New Zealanders see the spectrum of automation as well as the concerns they have with fully automated vehicles. Perceptions about full automation may negatively influence perceptions and use of specific ADAS technologies.

6.1.1 Public perceptions, familiarity, and acceptance of automated vehicles

Unprompted, New Zealanders most commonly think of a self-driving or driverless car in response to the term ‘automated vehicle’. Consistent with previous studies (Environics Research, 2019; Smyth et al., 2018; Teoh, 2020), many do not currently think or know about the levels of automation.

Without prompting, we asked New Zealanders how familiar they were with automated vehicles. Responses to this question again provide context for later findings. Note that responses were also likely to have been influenced by how respondents interpreted what was meant by an ‘automated vehicle’. Nonetheless, about a third of respondents described themselves as very or somewhat familiar, with familiarity highest for males and younger age groups. Despite limitations, these findings indicate some level of existing general awareness about the concept of vehicle automation by New Zealanders. Previous studies have found most people have some awareness (Bronson et al., 2019; Robertson et al., 2016; Wolf, 2016), and awareness in Australia and New Zealand has been increasing over time (Ledger et al., 2018; Regan et al., 2017).

Understanding and being able to distinguish the levels of vehicle automation is important, as we found that New Zealanders attribute risks and disadvantages to ‘automated vehicles’ that do not necessarily apply to the levels currently available in New Zealand. The popular imagery may distort or undermine New Zealanders’ responses to and possibly use of these technologies, particularly when more comprehensive and integrated ADAS becomes available. Any intervention to improve public understanding should distinguish what the levels do, and don’t do, and should communicate driver responsibilities at the outset.

A considerable proportion of driver owners did not understand or did not know that regardless of the level of automation, drivers were still responsible for monitoring the functions of their vehicle *all of the time*. Previous studies have also reported this confusion (Smyth et al., 2018; Teoh, 2020). As more advanced SAE Level 2 and Level 3 automation emerges, there may be further confusion regarding driver supervision. This further reinforces the need to clarify driver responsibilities at the outset.

Following the examination of familiarity, this research showed that only 2% of New Zealanders did *not* identify any disadvantages associated with automated vehicles. Higher levels of automation, system security, including risks to data privacy, are of particular concern. A high proportion of New Zealanders would *not* be comfortable travelling in a fully automated vehicle and believed that driving or riding in such a vehicle would be somewhat or very stressful. These concerns are similar to those reported in the recent Canadian survey (Environics Research, 2019).

New Zealanders are particularly concerned that automated vehicles could have a negative rather than positive impact on driver performance, specifically that vehicle automation could lead drivers to becoming over-reliant on technology, less skilled, and less attentive. Nonetheless, our results also show that a significant proportion of New Zealanders understand that automated vehicles can bring benefits and advantages, particularly with respect to enhancing driving performance and road safety.

The risk versus benefit 'tension' identified reinforces the importance of ensuring that New Zealanders understand the levels of automation and ascribed performance and safety benefits. Communicating how a combination of factors – function, benefits, and driver responsibility – can act to eliminate or mitigate risks, will also be useful. For example, the public should understand that vehicle automation requires the driver to become more, not less, skilful, and that *fully* automated vehicles are *not* envisioned in the foreseeable future. Communicating how the government will manage the transition to increasing levels of automation may also help to alleviate concerns.

6.1.2 Public awareness, knowledge, and experience

Our findings showed a reasonably high level of existing general awareness of in-vehicle technologies, with only 5% of New Zealanders having not heard of any technology. Consistent with previous Australasian research (Ledger et al., 2018; Regan et al., 2017) we found differences in familiarity by technology type, ADAS user group, age, and gender. Not surprisingly, we found a relationship between the technologies more likely heard of and those currently more or less commonly available in New Zealand. Males were more likely to have heard of the specific technologies and, perhaps not surprisingly given the higher cost of vehicles equipped with ADAS, awareness tended to increase with age.

In total, close to one-third of the New Zealanders we surveyed had experience with the ADAS technologies examined in our study as either a driver owner, driver user, or non-driver user. However, and not surprisingly, the majority had neither driven nor been a passenger in a vehicle equipped with ADAS, and on each technology, about 1 in 10 were unsure whether they had experience.

Closer examination of driver owners by the number of ADAS technologies in their vehicles also showed that many New Zealanders with experience still only have *limited* experience. Close to half of driver owners only had one technology and about one in five only had two; only 7% had all seven. ESC was shown to be by far the most common technology for driver owners with only one technology. This same technology was also reported by about a quarter of driver owners with two technologies.

Overall, the findings on awareness and experience show that while a reasonable number of New Zealanders have some level of awareness, many only have limited experience, and many do not have any experience.

We asked users[4] and all others who had heard of each technology how familiar they were with each. Overall, about half described themselves as somewhat or very familiar, and under half described the opposite. Examining familiarity by driver owners and driver users showed that about three-quarters or more of these users were somewhat or very familiar with the technologies they used, with driver owners slightly more likely to report this than driver users. These findings also indicated a relationship between frequency of use, the salience of the technology, and reported familiarity. For example, the greatest proportion of driver owners and driver users reported they were somewhat or very familiar with BSM (a regularly used technology) and the lowest proportion reported the same for ESC (a low salience technology).

It was notable, but perhaps not surprising, that while older people were more likely to have heard of different ADAS technologies, younger people were more likely to describe themselves as somewhat or very familiar with them. This result is consistent with a stereotypical view of younger people having more understanding of technology compared to older people.

The conclusions that can be drawn from the 'have heard' and 'how familiar' findings are also not surprising. While many New Zealanders have heard of ADAS technologies, how familiar they are with specific

[4] Driver owners, driver users, and non-driver users.

technologies depends on the type and level of use they have with each. That awareness increases with age is not unexpected, as ADAS technologies are only available in newer vehicles and the average age of the New Zealand vehicle fleet is high.[5] However, while older people may be more likely to be in a position to afford a vehicle equipped with ADAS, our results also suggest they may be less likely to be familiar with the technologies, compared to younger users.

Perhaps *most* important are the proportions of driver owners who described themselves as not very familiar with the ADAS technologies in their vehicles and the proportions of driver owners and driver users who could not correctly identify what the technologies in their vehicles actually did. Previous studies have shown that drivers may not be aware of certain technologies in their vehicle (Eby et al., 2018) and can have limited knowledge at the point of sale (McDonald et al., 2018). Our similar findings, discussed further in section 6.3, suggest that any intervention to increase more detailed understanding of specific ADAS technologies should perhaps *initially* focus on those currently driving or likely to soon be driving vehicles equipped with ADAS, rather than the general population.

6.2 Consumer stage

6.2.1 Information, education, and training at point of sale

This research shows that New Zealanders who drive or ride in vehicles equipped with ADAS technologies are currently largely required to seek out information themselves if they wish to find out more. Similar to previous studies (Abraham et al., 2017; Eby et al., 2018), we found that trial and error was commonly used by many of the driver owners and driver users surveyed; many of the driver owners we interviewed had also used this method. Our survey showed that receipt of information directly from the seller of a vehicle with ADAS was relatively rare. While we didn’t ask our survey respondents about the quality of this information exchange, our interviews with driver owners indicated that quality can be variable, a finding consistent with a previous study (Bronson et al., 2019).

Popular sources of information about ADAS identified in previous studies include training provided by car dealers, vehicle owner’s manuals, and online resources (Bronson et al., 2019; Environics Research, 2019; McDonald et al., 2016; Smyth et al., 2018). We found similar results; current or previous users had most commonly accessed owner’s manuals, web-based information, and friends and family. Sources commonly preferred by New Zealanders without direct experience with ADAS, and by users who had not previously sought information, were predominantly digital – online videos, online searches, and manufacturers’ websites – as well as owner’s manuals. While it was more common for driver users and non-driver users *not* to seek any information compared to driver owners, the overall proportion of all users not seeking information – about one in four – is of particular concern.

The government perhaps has little scope to determine the content of driver manuals. However, requiring owner’s manuals to be provided in English may be important, particularly given the propensity of New Zealanders to seek information through this source.

Our findings suggest a role for government in helping consumers to identify and navigate quality online materials. Note that providing information on standalone government websites may have limited efficacy, as this channel was identified by very few of our respondents. Integration within existing initiatives such as Rightcar and point-of-sale websites such as Trade Me and Auto Trader may be most efficacious.

[5] The average age of New Zealand’s light passenger vehicle fleet is 14.4 years (2017; Ministry of Transport, 2021), compared with 9.7 years in Canada (all vehicles, 2016; Wagner, 2016), 10.6 years in Australia (all vehicles, 2021; Australian Bureau of Statistics, 2021) and 11.9 in the US (all vehicles, 2020; Bureau of Transportation Statistics, 2021).

Our findings also indicate the importance of encouraging consumers to seek information from the seller at the point of sale, at least for those purchasing through a dealership. Increasing the expectation by consumers that information will be provided may encourage dealers to improve their performance in this area, particularly if we are to assume they will be motivated to meet the expressed needs of customers. Our interviews showed that car dealers were more likely to provide information when customers indicated that ADAS technologies were important to them.

6.2.2 Influence on vehicle purchasing decisions

Every technology except LDW was considered by at least half of driver owners to have been somewhat or very important in their decision to purchase or lease their current vehicle. When asked about importance when determining a future purchase or lease decision, at least half the respondents[6] for each technology reported the same. Compared to importance for the current vehicle, greater proportions of driver owners reported that the technologies would be somewhat or very important in a future decision. Previous studies have also reported that perceived value increases with experience (Environics Research, 2019). These findings further support the value of interventions that increase awareness that ADAS technologies are safe and effective.

The lower perceived value of LDW reinforces that it is not only use of the technology that is important, but also that the experience of use is positive. In this research, lane departure technologies were commonly described as not working quite as expected, and it seems likely that these experiences are reflected in the lower perceived value of these technologies.

6.3 User stage

6.3.1 Knowledge of safe and correct use

We examined New Zealanders' understanding of the correct and safe use of ADAS by asking users and those aware of each technology about what each technology did. While the findings for the latter group do not strictly belong in the user stage findings, they are discussed here for simplicity. As previously noted, some caution is required when interpreting these results as the names of some technologies are more descriptive of purpose than others. Of most concern, and despite the possibility of correct guesses, is the proportion of driver owners and driver users who did *not* correctly identify what each feature did. This was particularly notable for ACC and FCW respectively.

We found that understanding varies by ADAS technology type, as well as by gender and age. Similar to the Transport Canada study (Environics Research, 2019), differences across the technologies ranged from almost three-quarters (72%) of respondents correct for BSM to only 16% for ACC. Differences by technology are not unexpected given the range of factors that are likely to shape understanding (eg, exposure, frequency of activation, interest, perceived value). Differences by gender and age were minimal for some technologies and more pronounced for others; overall, male and older respondents tended to be more likely correct.

Not surprisingly, we found that driver owners were more likely to be correct on some technologies compared to other user groups. It makes sense that driver owners had a better understanding on some technologies as this is likely to be a function of exposure, experience, and access to information sources. However, that differences were not greater on some technologies is also not surprising, given the previous finding that

[6] Driver owners, driver users, and non-driver users of each technology and all other respondents who had heard of each technology

many driver owners had not sought any information. Correct guesses may have also reduced differences on some technologies.

6.3.2 User interactions with ADAS

As mentioned earlier, drivers commonly learnt about ADAS features through trial and error. While this may have risks, many of the driver owners we interviewed did not see this; rather, the approach was commonly seen as an effective learning method, and one often used in other learning contexts.

Our findings suggest the degree of risk from trial and error may vary by ADAS user type. For example, we identified that driver owners who were more frequent users were likely to have had previous experience of ADAS and were often motivated to learn about ADAS. They may have engaged in pre-purchase research and may have initiated discussion with the seller. For these users, trial and error therefore often builds upon a base of understanding and experience and may therefore be a relatively low-risk strategy. Certainly, we saw how experiencing when different features activated or not helped these users to understand how they should interact with the technology and the extent to which a feature in a new vehicle may be similar or different to an equivalent feature in a previous vehicle.

Of more concern perhaps are the driver owners we interviewed who used ADAS occasionally and who may have turned technologies off. These users were more likely to bring limited existing knowledge and experience to the sales process. They may not have been specifically seeking ADAS and might therefore acquire limited further understanding through the sales process itself. These users described trial and error experiences that were alarming, confusing, and potentially dangerous; for example, unexpected activations of AEB. Such experiences had led some to turn technologies off, with the potential performance and safety benefits of these thus unrealised.

This research also showed there can be differences in how ADAS users and non-users respond to the experience of technologies activating or not activating as one might expect. Depending on the driver’s response to them, these experiences during trial-and-error learning could also be instrumental in determining whether or not the use of technologies became embedded within driving behaviour.

Most of the drivers we interviewed described some experience of unexpected activations – ranging from minor irritants to more significant events such as the unexpected activation of AEB, lane keep features incorrectly interpreting the driver’s intent, and erratic acceleration under ACC. We saw that drivers’ responses to these experiences often reflected their level of existing knowledge and experience as well as their level of comfort with trial and error. For example, driver owners who used technologies more frequently generally accepted these experiences as part of the process of understanding how technologies behaved. Their response was often some degree of relatively minor behavioural or cognitive accommodation (eg, specific features turned off in certain road conditions). Similarly, warnings commonly activated in low-risk situations were often accepted as a reminder that technologies were in operation and were working. These experiences therefore gave assurance that activations would also occur in higher-risk situations. This tended to outweigh any concern that warnings were an irritant or distraction and any tendency to deactivate the system. These findings are consistent with previous research showing that even if annoying, features will be left on if the perceived safety benefit is high (Abraham et al., 2017). It has also been shown that use or non-use will be influenced by a range of driver characteristics, including level of tolerance and driving style (Wang et al., 2020).

6.3.3 Frequency of use

Interpreting the frequency with which New Zealanders use ADAS technologies requires some initial consideration of what is meant by ‘use’ as well as how the respondents to the survey interpreted the meaning of use. In the first instance, a feature can be considered to be ‘used’ when it is turned on. However, a feature then only activates under certain conditions and circumstances, with different technologies therefore activating more or less frequently. For example, when driving on busy, multi-lane roads, BSM is frequently activated and could thus be considered to have a high frequency of use. By comparison, AEB activations are relatively rare; a number of the drivers we interviewed had never experienced AEB, even though the technology was turned on. Finally, the extent to which a technology 'intervenes' in the driving task, and the salience of the intervention, may also impact at least the perceived frequency of use. For example, AEB, LKA, and ACC all intervene directly, while FCW and LDW provide visual and auditory warnings only. ESC adjusts braking to improve stability when specific thresholds are reached, with the driver potentially relatively unaware of the intervention; the likelihood of this was indicated in this study through the high proportion of users of ESC unaware their vehicles had this technology.

Notwithstanding the above, we found that ESC was more commonly used 'frequently' by driver owners and that BSM and FCW were more commonly used frequently by driver owners and driver users alike. Perhaps not surprisingly, a greater proportion of driver owners used each technology frequently compared to driver users. Driver users are likely to have more fleeting, sporadic experiences with technologies compared to driver owners, and we suggested this as a reason for different frequencies of use. Consistent with previous research (Bronson et al., 2019), we found males were more likely than females to report using most ADAS technologies sometimes or frequently.

Overall, the number of drivers turning any of the ADAS technologies off was small for both user groups. The most common reason that driver owners and driver users gave for not using ADAS technologies or not using them more frequently was the belief that their driving was good enough. Consistent with previous research (Kidd et al., 2017; Reagan et al., 2018), as well as earlier findings in this study, LKA functions were often underutilised because warnings were considered annoying or distracting.

6.3.4 Engaging in non-driving tasks

As discussed earlier, an alarming proportion of driver owners did not believe or did not know that regardless of ADAS technology, they were responsible for monitoring vehicle functions *all of the time*. However, despite this, a majority of driver owners and driver users said they would not be *more* likely to undertake secondary tasks while using ADAS technologies. While some degree of social acceptance bias may be at play here, these findings are consistent with the common view of the drivers we interviewed that ADAS features were a 'back-up' and additional layer of safety to their driving. They continued to see themselves as fully responsible and accountable for any errors. Moreover, partial distrust of the features appeared to further motivate the maintenance of full awareness and control of the driving task.

Previous research has shown that ADAS can increase the propensity of drivers to pay less attention to the driving task and to undertake secondary activities (Robertson et al., 2016; State Farm, 2016). In this study, talking with passengers and talking on a hands-free phone were the two secondary activities identified most frequently as more likely when using ADAS. Whether these findings represent a significant safety risk may need further consideration.

6.3.5 Unexpected performance/issues

Across all the ADAS technologies, the majority of driver owners and driver users surveyed had *not* experienced any performance issues or problems with the technology. Problems that were identified generally related to unnecessary or over-sensitive warnings, unexpected braking, and responses due to the system misinterpreting the situation, particularly LDW. The driver owners we interviewed described similar issues and experiences; however, these were of relatively minor concern to many. As discussed, driver owners who used technologies more frequently tended to adapt to or accommodate issues without any obvious enhanced risk. However, as discussed, we did talk to some non-users whose experiences had led them to turn features off.

Although we have little data, potential consequences from unexpected activations may be more significant for driver users, particularly those driving hire or fleet vehicles. In this context, a range of factors may increase risk; for example, potentially a lack of previous experience with ADAS, an unfamiliar vehicle, and high need to continue the journey. The importance of addressing this context of use seems clear, but further targeted research may be needed.

7 Conclusion, recommendations, and further questions

7.1 Conclusion

This research explored New Zealanders' awareness, perceptions, knowledge, use, and experience of ADAS technologies up to and including SAE Level 2 (partial driving automation). The research objectives were nested within the consumer journey stages of pre-consumer, consumer, and user.

We found many New Zealanders have awareness of the concept of vehicle automation; however, the concept is often equated with a fully autonomous vehicle. Many New Zealanders do not understand or think about different levels of automation. For ADAS, there exists a high degree of generalised understanding, but the understanding and use of specific technologies is highly variable. Some users are not familiar with the technologies in their vehicle or cannot correctly identify what they do.

The experience of using ADAS technologies can increase perceived value and future use, so long as experience is affirming and assuring. This indicates the value of interventions to enhance the extent to which consumers are equipped to embrace their use of these technologies once in a position to do so. Quality ADAS information at the point of sale or, for hire or fleet vehicle users, the first point of use is likely to be limited, and a range of contextually relevant information and education 'touchpoints' would help fill information gaps.

Trial and error appears to be a common strategy for learning, but this may be safer for someone who is confident and engaged, compared with a user who has little awareness or interest in the technologies. This emphasises the importance of meeting the different needs of different consumer segments, and not treating all consumers as the same. This research has also guided the targeting of information by stage of the consumer journey.

The frequency of use of ADAS is difficult to determine as there are varying levels of activation and interaction required depending on the technology. Nevertheless, the most commonly used technologies appear to be those activated more routinely, such as BSM, FCW, and ESC. While the number of respondents who turned off the technologies is small, those most likely to be turned off include AEB, LDW, and LKA; this is supported by accounts of some technologies not performing correctly in some circumstances.

Given the older age of the New Zealand vehicle fleet, there is a long way to go before the benefits of ADAS technologies are experienced at scale. Further, there is some uncertainty regarding the way in which manufacturers may design the consumer interface of these technologies so that they are more intuitive and may better support their safe and correct use in future. However, the issues raised in this research can be used to guide initiatives to improve current driver engagement with and uptake of ADAS technologies. This is also important for more sophisticated vehicles in future where driver responsibility is ultimately still required for safe vehicle operation.

7.2 Recommendations

Our recommendations follow logically from the research findings and discussion and are again organised by the pre-consumer, consumer, and user framework. As far as possible, the recommendations are also differentiated by the consumer segments discussed throughout.

7.2.1 Pre-consumer stage

For the general driving population, the popular imagery of automated vehicles *may* undermine perceptions, acceptance, and use of lower levels of automation. More pragmatically, while there is a reasonable degree of general awareness, many drivers may simply be unaware of the benefits of ADAS and how they fit within the future evolution of vehicles. There is a need to ensure that New Zealanders understand:

- the differences between lower levels of ADAS (ie, SAE Levels 0 to 2) and higher levels up to fully automated driving, including driver responsibilities
- the differences between currently available ADAS technologies and fully automated vehicles (ie, SAE Level 5)
- what levels of vehicle automation currently exist in New Zealand vehicles, and expectations and timeframes for higher levels of automation
- the benefits and value provided by ADAS technologies, specifically in respect to driver performance and road safety
- the actions government is taking as New Zealand proceeds towards automated vehicles in future.

Consideration should be given to the timing of these interventions to ensure it matches with sufficient levels of market penetration of ADAS technologies. At this stage, the focus should be on mass awareness for the driving population, possibly targeting those who are most unsure about safety and driver performance benefits. A considerable amount of effort goes into road safety advertising, including how to choose safe vehicles; existing channels could be used to communicate and raise awareness about safety benefits.

7.2.2 Consumer stage

Accurate and easy-to-understand information about ADAS technologies, what they do, and how to use them are important for those in the consumer stage. This is also relevant for those who come to drive vehicles equipped with ADAS technologies through other channels; for example, hire and fleet vehicles, and increasingly through the second-hand market. In the latter cases, information may currently be less readily available to the driver when they come to operate the vehicle.

This research suggests that without prior experience, there is variable understanding of the specific functions and operation of the various ADAS technologies. While drivers seem to understand the technologies are aids to driving, we also found a minority misinterpret the respective roles of the driver and the vehicle.

Given the different consumer segments, there is a need for ‘demand’ and ‘supply’ side interventions. Demand-side interventions will increase the extent to which consumers seek out information, while supply-side interventions will make information more readily available and accessible.

Based on our research, we make the following recommendations.

- Strategies should be developed for reinforcing the need to be an informed consumer and increasing consumer expectations that quality information and training will be provided by the seller at the point of sale. Such provision is an important yet currently underutilised opportunity to enhance consumer knowledge. Given some variability in the quality of information provided at point of sale, some other government intervention may be required.
- Elevated importance should be given to ADAS features on specification sheets, sales websites, and commonly used websites such as Rightcar, including clarity on how ADAS technologies contribute (or not) to Star ratings.
- Sellers of vehicles should be required to provide an English version of instructions for ADAS features in vehicles.

- Online, printed, and spoken information about specific ADAS technologies should be available at the point of sale or, for hire and fleet car drivers, the point of first use. Any information provided must be intuitive and obvious at key ‘touchpoints’ in the consumer process (eg, links from online search websites, information provided at dealerships both during the sales process and in ongoing customer support).
- Table 7.1 summarises the information that should be provided for each technology, as indicated by the findings of this research. The literature suggests that in the future, consideration should also be given to providing information about the benefits and limitations of ADAS technologies with a higher level of automation or user interaction as these pose the greatest risk for misuse yet deliver high road safety benefits. For all technologies, messaging should be clear that while the technology aids driving performance and safety, the driver must always be in control.

Table 7.1 Information needs for specific ADAS technologies

Technology	SAE Level	Information needs	Relative priority	Rationale
AEB	0	Safety benefits	Low	Minimal user interaction; comparatively high awareness among general population.
FCW	0	Safety benefits; information about what the technology does	Medium	Interviewees’ experiences with this technology were variable, with some deterred from using due to perceived oversensitivity of alerts. Reinforcing safety benefits may encourage users to continue to use this technology. Knowledge about what FCW does among current driver owners is relatively low.
ACC	1	Usefulness to particular road environments/conditions (eg, speed maintenance and comfort at higher speeds) Limitations (eg, loss of lead vehicle will cause vehicle to accelerate to maximum cruising speed; performance can vary across different vehicle makes/models)	High	Findings from interviews and the literature suggest that setting user expectations about the road environments/conditions that ACC is designed for may prevent frustration and support increased use. Survey findings indicated low knowledge about ACC among current driver owners and users, particularly regarding reliance on lead vehicle to maintain speed.
LDW	0	Usefulness to particular road environments (eg, urban roads) Limitations (eg, may experience performance issues on rural roads with poor road markings; performance can vary across different vehicle makes/models)	Medium	Interviewees’ experiences with this technology were variable on rural roads and locations with poor road marking. Performance also varied by vehicle make/model. Informing drivers about the optimal road environment/conditions for using LDW may reduce negative experiences with this technology and, in turn, support increased use. Knowledge and self-reported familiarity among driver owners and users of the technology were relatively high.
LKA	1	Usefulness to particular road environments (eg, urban roads) Limitations (eg, may experience performance issues on rural roads with poor road markings; performance can vary across different vehicle makes/models)	High	Similar rationale to LDW; however, as LKA automates a component of the driving task (steering), this elevates the relative priority for information.
BSM	0	Safety benefits	Low	Some user interaction; comparatively high levels of awareness among general population and levels of knowledge among current driver owners.
ESC	0	Safety benefits	Low	Minimal user interaction; low awareness among general population.

There are inconsistencies in the names of ADAS technologies and variations in how similar technologies perform across different manufacturers (Kidd et al., 2017; Reagan et al., 2018). Proactive consumers may actively compare performance across vehicles and manufactures; manufacturers are unlikely to cooperate in providing consistent language and performance. There is a need to:

- better promote existing material (such as what is currently available on the Rightcar website) about the kinds of ADAS technologies, what they do, and common names
- encourage third parties (such as car review columns and consumer review websites) to compare the performance of specific technologies, thus aiding consumer decision making.

7.2.3 User stage

At the point that ADAS-equipped vehicles are being driven, there is a learning and familiarity process, along with eventual mastery of the driver working in partnership with ADAS technologies.

Learning by doing makes sense for many users of existing ADAS technologies, as evidenced by this research and previous studies. Our findings indicate there is a need to support this natural experiential learning with targeted interventions within driver training pathways.

Knowledge, skills, and attitudes are all important for competent driving. Ideally, the correct understanding and safe use of ADAS should be addressed within driver licensing and training pathways. There is a need to:

- consider how information around ADAS technologies can be included in the driver training and possibly licensing process
- consider how ongoing driver support might be designed considering the relationship between the vehicle user, the seller, and the land transport regulator.

Regarding the above two points, it is interesting that as vehicles become more complex with their various safety and other features, there remains very little training and support for how to confidently and safely use them. As vehicles become more complex there should be increased emphasis on training and competency should be considered, including reinforcement of how the human should interact with increasingly automated driving systems. This is important for addressing misunderstanding, non-use, and misuse of ADAS technologies, and at the extreme end may help to prevent situations where drivers mistakenly think the vehicle can drive itself without driver input.

Finally, within the wider context of using ADAS-equipped vehicles, the literature suggests that there is a gap in regulation and minimum standard setting to ensure safe and educated use of ADAS, and that more regulatory oversight will be needed in future. However, regulatory bodies are likely to favour an education and training emphasis ahead of regulatory interventions. As suggested earlier, a well communicated regulatory pathway that accompanies emerging ADAS technologies would be helpful for government planning, stakeholders, and consumers that may be apprehensive about increasing automation. The research suggests that activities related to regulation within a New Zealand context could be:

- engagement with industry bodies regarding their perceived role in educating and training consumers about ADAS technologies
- determining what regulation might be needed in the absence of sufficient industry information and education around ADAS technologies
- as suggested by AAA (2019), developing a set of standardised technology names for use in describing ADAS systems to ensure consumers are knowledgeable about what they are operating and to avoid misuse
- determining what levels of automation are allowed on public roads, including variations of technologies, which have the potential to be misleading, ineffective, or unsafe.

7.3 Further questions and next steps

As with any research, this study has limitations, and further questions and implications for next steps have arisen outside the scope of this research. These are briefly presented below.

7.3.1 Influences of ADAS technologies on road safety

While it is generally understood that ADAS technologies lead to improved safety overall, there is limited understanding of the actual road safety effect of the technologies within the New Zealand context. The existence of a unique road environment is often mentioned as grounds for some doubt regarding the applicability of international research to a New Zealand context, and there may be unique ways in which ADAS technologies are performing in New Zealand.

Further New Zealand-specific research would be useful to better understand the influence of ADAS misuse or failures in vehicle crashes and the risk reduction factor associated with different ADAS technologies. In addition, further research examining vehicle crashes that could have been prevented or moderated through use of ADAS technologies would be beneficial. For instance, research could be undertaken examining crashes that result in death or serious injury by road movement type to understand which, if any, ADAS technologies would have been effective in preventing or minimising the crash.

7.3.2 More in-depth understanding of ADAS user segments

This research has identified different profiles for people considering and using vehicles with ADAS technologies, and the interviews provided some context to everyday users' experiences. However, in order to more accurately design interventions to meet these diverse situations, a more detailed understanding of typical profiles could be developed, including people's contextual situations, their knowledge, experience, motivations, and attitudes. This would help to further tailor interventions to real-life contexts.

7.3.3 New Zealanders' experiences with advanced SAE Level 2 functionality

None of the interviewees owned or leased a vehicle with 'Level 2+' functionality. This functionality is designed to enable the driver to disengage from physically operating the vehicle (ie, hands off the steering wheel and the foot off the pedal at the same time; eg, ACC and LKA). This is unsurprising as only a small number of such vehicles (such as the Tesla Model 3) are available on the New Zealand market and, currently, there are legal limits on the full use of their functionality on New Zealand roads.

In the future, qualitative research exploring New Zealanders' experience with these advanced Level 2+ technologies may be warranted ahead of any significant prevalence of this functionality in New Zealand. Such research may provide further insight regarding the potential for misuse and safety risk as well as the ways in which New Zealanders' driving behaviours change in response to a more pronounced increase in driving automation.

7.3.4 Human factors considerations

The interviews highlighted a range of scenarios in which users had experiences with ADAS technologies not working in the ways they had expected; for instance, AEB activating in response to street furniture. Learning how ADAS technologies perform in different road environments (for different vehicles) and the mental models and strategies for how the driver interacts with the technology to drive effectively and safely would be advantageous. Further research examining the ways in which users engage with the technology may be beneficial.

7.3.5 Awareness, knowledge and use of other ADAS technologies

The technologies examined in this research were primarily selected because of their current prevalence in New Zealand. However, other technologies will become more common in the future, and given this, there may also be value in exploring awareness, knowledge, and use of these. For example, ‘stop and go’ (or ‘auto stop/start’) was discussed favourably by several interviewees, including one who indicated they were more likely to undertake non-driving tasks while using it.

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Appendix A: Stage One report

CONSUMER AWARENESS, UNDERSTANDING, AND USE OF ADAS

STAGE ONE FINDINGS AND DIRECTION

Laura McCarthy | Michael Blewden | Hamish Mackie

23 APRIL 2021

MACKIE RESEARCH
OPTIMISING HUMAN SYSTEMS

EXECUTIVE SUMMARY

This document outlines the preliminary research findings and proposed survey methodology and questionnaire for the Waka Kotahi research project exploring consumer awareness, knowledge, and use of advanced driver-assistance systems (ADAS).

The research will clarify the understanding and perceptions that New Zealand drivers have of selected Level 0 to 2 ADAS technologies and of the correct and safe use of Level 2 ADAS functions. For drivers of vehicles with Level 0 to 2 ADAS capability, the research will build an understanding of their engagement, use, and misuse of the technology and their experience of unintended events or consequences. The research findings will inform the development of policy and programmes needed to develop necessary understanding, desired behaviours, and the safe use of Level 0 to 2 ADAS technologies.

Through a mixed-methodology research approach, the research will explore the following objectives:

a. To improve our understanding of the level of awareness and understanding of New Zealanders around ADAS, including knowledge of how they work [what they do] and how people should properly interact with them.

b. To understand what training [and information] on the different functionalities people are given when they buy a vehicle with ADAS features.

c. What is the public acceptance and perceptions of these different technologies, and does a vehicle having or not having them influence vehicle purchasing decisions?

d. For people who own vehicles with these technologies, how often are they using them (applies only to technologies where people can turn them on and off)? If they turn them off, what are their reasons for turning them off?

e. Are there ways that people are using these systems that differ from how or when they were designed to be used (eg, performing non-driving tasks such as texting whilst using lane keep assist)?

ENVIRONMENTAL SCAN

An environmental scan was undertaken to build an understanding of current relevant context, which was used to inform the final design of the online survey. The scan comprised the following research activities.

1. **International literature review:** Brief scan of the literature to identify current relevant knowledge and to identify regulatory/non-regulatory interventions employed in other countries. [Underway]
2. **Market definition:** Analysis of available secondary data to understand the size and shape of the current ADAS market (ie, proportion of the light vehicle fleet currently with at least Level 1 ADAS, proportion of private and fleet vehicles that make up the total Level 1 ADAS fleet) and volume and type of sales (ie, new, second hand, dealers, private sales). [Underway]
3. **Key informant interviews (×3 interviews):** Interviews with motor industry sector experts to build further understanding of the current context (eg, current education/information dissemination at point of sale, insights into consumer knowledge/questions, influence on consumer decision making). [Complete]
4. **Content analysis of online discussion boards:** Content analysis of relevant consumer and manufacturer online discussion boards to examine current issues, experiences, and questions as well as language and terms used in relation to ADAS technologies. [Complete]

This section presents the preliminary results from these activities that have been completed (key informant interviews), focusing on the findings that are relevant for the research design.

KEY INFORMANT INTERVIEWS

Approach

Sector experts from the Automobile Association, Motor Industry Association, and the Motor Trade Association were invited to participate in an interview about ADAS technologies within the New Zealand market. Participation in the interview was voluntary, and participants were not renumerated for their time. Interviews were conducted online and ranged in length from 45 minutes to one hour. All interviews were recorded and transcribed. A thematic analysis of the material was then conducted.

Key themes

Several themes relating the New Zealand ADAS consumer market emerged during the interviews, discussed below. There was a general recognition that market penetration of many higher-level automation features is low. As such, the themes primarily focused on the pre-purchasing stage of the consumer journey.

Consumer knowledge

Multiple terms are used to describe the same technology, creating confusion for consumers.

Terminology of ADAS features varies by manufacture. In the short term, this makes it difficult for consumers to understand, compare and build knowledge about these technologies. In the long term, comparisons were made with the multiple names given to anti-lock braking systems (ABS) and a similar trajectory was envisioned: during the initial introduction to the market, multiple names will be used, but as customers increasingly request these technologies, one term will begin to dominate.

Alongside multiple names being used to describe the same features, each manufacturer will design and build ADAS features differently. While there is an ADAS ratings system under development (to work alongside the existing ANZCAP/ECAP framework), currently there is little information for consumers to compare differences between manufacturers of the same technologies.

Consumers will typically prioritise ‘infotainment’ features over safety features.

Consumers of new vehicles are presented with an extensive list of customisable specifications. It makes it difficult for some consumers to determine the value of these individual features. If consumers are unsure, there is a perception they will prioritise ‘infotainment’ over safety features. As one interviewee describes:

> *They’re not asking about lane departure, AEB, that sort of thing. They don’t know much about it, and they’re not asking about it, but they are asking about the entertainment infotainment.* (Key informant interview 1)

Public knowledge of ADAS is low.

Consumer knowledge of ADAS, in terms of awareness, how to use it, and what it can do, is perceived as low. Consumers (and dealers) do not think in terms of automation levels – instead, they see the various safety features but generally do not correlate that these features are part-way to vehicle automation (autonomous vehicles are perceived as something different). As one interviewee expressed:

> *The dealer community at this point is driven around the feature, not around a nought to five scale.* (Key informant interview 2)

Consumers are more knowledgeable about general vehicle features.

While consumers may have limited knowledge about ADAS features, they generally have more knowledge about the type of vehicle they would like.

> *…many consumers now read about the car before they approach the dealership. So they're already well down the selection process … And a common catch line in the industry is that customers know more about the car they're going to buy than the car salesman who's selling it, because they're so information loaded.* (Key informant interview 2)

Comparisons are made with limited uptake and knowledge of cruise control, ABS and ESC.

All interviewees made comparisons between ADAS and the pathway of vehicle technologies that had been in the market for a much longer period. In particular, ABS was often mentioned as an example of a technology that had been present in vehicles for decades, but understanding of its correct use among consumers remains low. Similarly, while cruise control has had relatively high market uptake (anecdotally), interviewees reported use remains low.

Training at point of sale

Dealer training is limited, but new vehicle features are something that dealers will typically promote.

Distributors undertake training about new vehicles in the fleet for either their own dealers or franchisees. This will cover vehicle servicing and maintenance as well as training about new in-vehicle technologies. However, how this is passed on to consumers will likely vary considerably, and it is likely to reflect consumers' own interests. For instance, if a consumer expresses interest in vehicle safety features, such as blind spot monitoring, this will likely be emphasised during the sale process. However, if a consumer only expresses interest in the vehicle performance, safety features may not be discussed at all.

It is perceived that dealers use any new vehicle features as a 'hook' to persuade customers to upgrade their current vehicle:

> *In the motor vehicle space … they're always looking for a reason to change, a reason to draw the customer in, and that this vehicle does this better than the one you own, trying to create a reason for upgrading the car.* (Key informant interview 2)

Market penetration

Surveying consumers about use of ADAS is difficult, given low market penetration.

As market penetration of ADAS features was low, one interviewee had experienced difficulties recruiting sufficient survey participants to allow for meaningful analysis of results regarding use of these features. This was as part of a general population survey, without adopting additional measures to target participants who may drive vehicles with this technology.

Overall market penetration of ADAS is low, but higher in commercial fleets.

While ADAS features are becoming more common in late model vehicles, overall penetration of the New Zealand vehicle fleet is low. Moreover, light passenger vehicles imported for commercial fleets generally have a higher level of optional features added than those vehicles for the private market.

Emerging issues

Maintaining ADAS technologies is challenging, particularly following crashes.

ADAS car repairs are more complex and, as such, more costly. There is perceived to be a limited capacity in the industry to undertake the repairs, and this expertise is generally located in urban areas. In turn, this creates an access issue for vehicle owners in non-urban areas. At this stage, windscreen repairs are proving complex, and there is concern as to whether re-fitted windscreens have been calibrated properly to ensure that the safety features are operating correctly. In response, a voluntary code has been developed among the three major windscreen repairers, but the industry is advocating for the vehicle repair rules to be updated to reflect this new technology.

Overall, the findings from the key informant interviews suggest that consumers are generally likely to have limited knowledge about ADAS features, in terms of their awareness, knowledge of their correct use, and what the features can do. Nonetheless, it suggests that ADAS features are being promoted to consumers through the sale purchase, although the extent of training is likely to be variable.

Further, the interviews reinforced initial preconceptions that while market penetration of ADAS technologies is becoming more prevalent among late model vehicles, overall, it remains low. This presents implications for the approach adopted to survey consumers about the use, non-use, and misuse of these technologies, discussed later in this report.

Finally, the findings also highlighted an emerging issue about the ongoing maintenance of vehicles with this technology. This issue, if it garners more prominence over time, may influence consumer purchasing decisions about vehicles with this technology.

SURVEY METHODOLOGY

An online survey will be conducted of approximately 1,000 New Zealanders. The survey will determine awareness, understanding, and perceptions of six Level 0 to 2 ADAS technologies, influence on vehicle purchase decisions, education/information at point of sale, use/misuse, and experiences of unintended events or consequences. The ADAS technologies to be tested in the survey are yet to be finalised.

Participants will be recruited from Dynata’s market research panel of 300,000 New Zealanders. Dynata recruits panel members from multiple sources to ensure that the panel is broadly representative of the New Zealand population.

User definitions

The definition of what constitutes a ‘user’ of ADAS technology will affect the way in which this sample is recruited. It is proposed to mirror the definitions adopted as part of the Transport Canada study (Environics Research, 2019) but broadening the definition of ‘driver user’ to include respondents currently driving a work vehicle equipped with an ADAS feature. This reflects that in the New Zealand market, vehicles equipped with ADAS features are more likely to appear on commercial fleets than the private market fleet.

Table A.1 User definitions

Canadian segments		New Zealand segments	
Description	**Segment**	**Description**	**Segment**
Respondents neither driven nor been a passenger in a vehicle equipped with any of the six ADAS features tested	**Non-users (includes 'not sures')**	**No change**	**Non-users (includes 'not sures')**
Respondents owning or leasing a vehicle equipped with at least one ADAS feature tested	**Driver owners**	Respondents currently driving a vehicle equipped with an ADAS features (eg, owning or leasing, **or work vehicle**)	**Driver user**
Respondents previously having driven a vehicle equipped with an ADAS feature (ie, as owner, drove as rental, lease, car share) but not current owning or leasing	**Driver user**	Respondents previously having driven a vehicle equipped with an ADAS feature (ie, as owner, drove as rental, lease, car share, work vehicle)	**Former driver user**
Respondents being a passenger in a vehicle equipped with ADAS features but not driving one personally	**Non-driver user**	**No change**	**Non-driver user**

Survey waves

It is proposed the survey is conducted over two waves. The first wave (*N* = 500) will be used to determine the natural fall-out rate of 'driver users' among the general population. If less than 15% of respondents fall into the 'driver user' category (*N* = 75), the second wave of the survey will oversample panel members that are more likely to fall into this category.

Quotas and weighting

Quotas will be set for the following characteristics: licence, gender, urban/non-urban area, age, and 'driver users'. The data will then be weighted based on 2018 Census data for age, gender, and urban/non-urban residence to ensure that the results are broadly representative of the New Zealand population.

Questionnaire design

The questionnaire has been based on the survey used in the Transport Canada study (Environics Research, 2019). To allow for comparability between the New Zealand and Canadian results, the questionnaire has been left substantially the same. However, several changes have been proposed, outlined below, to address Waka Kotahi research objectives. In addition, some alternate phrasing has been suggested to adapt the survey for the New Zealand population.

The Transport Canada questionnaire was designed to take respondents approximately 15 minutes to complete. If additional questions are added, as suggested below, some questions will need to be removed to ensure completion time remains at a maximum of 15 minutes in length.

Please note: For ease of reference, the numbering in Table A.2 follows the original Transport Canada study. This, along with the survey logic, will be updated once the number of ADAS features to be tested has been finalised.

Table A.2 Summary of proposed changes

Change	Q/s	Transport Canada study	Recommended approach Waka Kotahi study
ADAS features		ADAS features included in Transport Canada study: • automatic emergency braking (AEB) • forward collision warning (FCW) • adaptive cruise control (ACC) • lane departure warning (LDW) • lane keep assist (LKA) • blind spot monitoring (BSM).	Suggest focusing on Level 0–2 features with greatest market prevalence. Note: 2016 Transport Futures survey explored awareness/use of: • adaptive cruise control • automatic lane keeper • intelligent parking assist.
Sample			
Age of participants		Transport Canada study included participants aged 16–17 by obtaining consent through parents. Capped participation at age 80.	Given additional complexity in recruiting participants aged 16–17 and limited time frames, recruit participants aged 18–80 only.
Quotas		Set quotas in sample by age, gender, region, and Environics Analytics PRIZM5 segments.	Suggest quotas for age, gender, urban/non-urban, non-licensed 18+ population.
• Non-licensed drivers		10% of sample non-licensed.	No change to proportion (N = 100).
• Driver users		N/A – did not set out to oversample.	
Driving distance	Q10–11	Typical driving distance per weekday and weekend day.	May need to delete, depending on overall survey length.
Segmentation analysis/ Attitudes to automated vehicles	Q12–21	Broader attitudes to autonomous and partially autonomous vehicles explored. This was used as part of a segmentation analysis.	Retain, as provides a useful baseline regarding attitudes to autonomous/ partially autonomous vehicles.
NZ terminology	Q15	Question set heading described as ‘Public opinions of ADAS’.	Change to ‘Public perceptions of ADAS’.
NZ context	Q15–16		Additional response option for Q15: • ‘Help to manage NZ road/driving conditions’ Additional response option for Q16: • ‘Not safe/suitable for NZ road/driving conditions’
ADAS features – use, perception questions	Q27–37	All respondents were asked about three of six selected ADAS features – the three asked were randomly selected for each respondent – ensured each was presented to half the sample and that common features were not over-sampled (ie, if left to self-selection).	Propose to ask ‘driver users’ about **all** selected ADAS features (that they have in their vehicle). Given the smaller sample size compared with Transport Canada study, this will minimise risks that there is insufficient data collected on each feature.
Familiarity vs confidence	Q31	Question asks about **familiarity** with using feature. No question regarding confidence in ability to use feature (instead, captures familiarity).	Replace with question about **confidence** using feature.

Change	Q/s	Transport Canada study	Recommended approach Waka Kotahi study
Usefulness of feature vs importance in future purchasing decision	Q32	Question asks about **importance** of feature in future purchase decision. No question regarding usefulness of feature (instead, asks about importance of feature in future purchase decision).	Retain, will be used as a proxy to also understand the usefulness of the feature along with reasons for turning off. [Or, additional question: 'How useful is this feature for you as a driver?']
Additional question – roles/responsibilities	New	No questions regarding understanding of roles/responsibilities when using feature.	Additional question explored for each ADAS feature: • 'To what extent are you required to maintain attention on the driving task while using this feature?' [slider scale 1: No attention; 10: Full attention]
Additional question – misuse	New	No questions regarding misuse.	Additional question explored for each ADAS feature: • 'Compared to when you don't use this feature, are you more or less likely to do the following: – talking on a handheld phone – talking on a hands-free phone – reading or sending text messages – manipulating the audio entertainment system – manipulating the GPS – eating or drinking – smoking – being absorbed by talking with passengers – dealing with children or pets – looking for, reaching for or tidying up an object – looking at something outside the vehicle – thinking about things unrelated to the driving task.'
Additional question – roles/responsibilities	New	No questions regarding **unintended consequences.**	Additional question explored for each ADAS feature: • 'Have you experienced any issues using this feature (for example, the feature not working in the way you expected it to)?' [Open text question]
Research objectives – understanding	Q38–39	Explored understanding of what certain ADAS features 'do' rather than [mechanically] 'how they work'.	To improve our understanding of the level of awareness and understanding of New Zealanders around ADAS, including knowledge of ~~how they work~~ **what they do** and how people should properly interact with them.
Research objectives – training at point of sale	Q38–39	Explored all sources of information about ADAS use – not just training.	Explore broader information provided to consumers at point of sale, including training [broader than scope of Research Objective B, which just explores 'training'].

Change	Q/s	Transport Canada study	Recommended approach Waka Kotahi study
Questions of scope – useful methods to learn about ADAS	Q40–44	Explored perceived usefulness of methods to learn about ADAS.	Out of scope but retain if time permits.
Demographics	Q45–48	Captured: • education • employment status • community size • income • age • gender	Include ethnicity; delete education, employment status and community size.
Participate in further research	New		Additional question regarding willingness to participate in further research (interviews).

SCHEDULE

Key dates for the survey design, administration, and major project deliverables are set out below.

Activity	Date
Feedback on survey approach and questionnaire from steering group	Wed 5 May 2021
Survey programming and testing [Dynata Market Research]	Thu 6 May 2021
Survey launched	
• First wave	Mon 10 May 2021
• Second wave	Mon 17 May 2021
Provide interview topic guide and methodology to steering group for feedback	Mon 17 May 2021
Interview topic guide and methodology finalised/commence interviews	Mon 24 May 2021
Draft final report	Mon 28 June 2021
Final report	Early July 2021

Appendix B: Additional survey data tables

B.1 Responses to the term ‘automated vehicle’

Table B.1 Responses to the term ‘automated vehicles’

	%
A car that drives itself/autonomous/self-driving	28%
Automatic (not standard) transmission cars/everything automated	14%
A driverless vehicle	12%
Electric/hybrid/battery operated	10%
A car driven by a computer/robotic	7%
Tesla/Google/other makes of cars	5%
AI/artificial intelligence built in car	4%
Collision avoidance sensors/lane changing warning	4%
Advanced electronic features/innovative technology for safety	3%
Vehicle parks itself/automatic parallel parking	3%
Cars/trucks/vehicles	3%
Unsure	8%
Nothing	4%

Note. The base is total survey respondents to this question (*n* = 1,041). Responses identified by 3% or more of respondents are shown.

B.2 Familiarity with automated vehicles by age and gender

Those aged 18–24 stood out as the group most familiar with automated vehicles. Over half of respondents aged 18–24 reported familiarity with automated vehicles (53%). This is 16 percentage points higher than the next highest age group (25–34) and 29 percentage points higher than the age groups 45–54 and 55–64. While those aged 18–24 had similar ‘very familiar’ response rates to other age groups, they reported being ‘somewhat familiar’ at a much higher rate than other age groups. Three-quarters of respondents aged 45–54 reported being ‘not familiar’ with automated vehicles, and these were similar response rates to those aged 55–64 (72%) and 65–80 (70%).

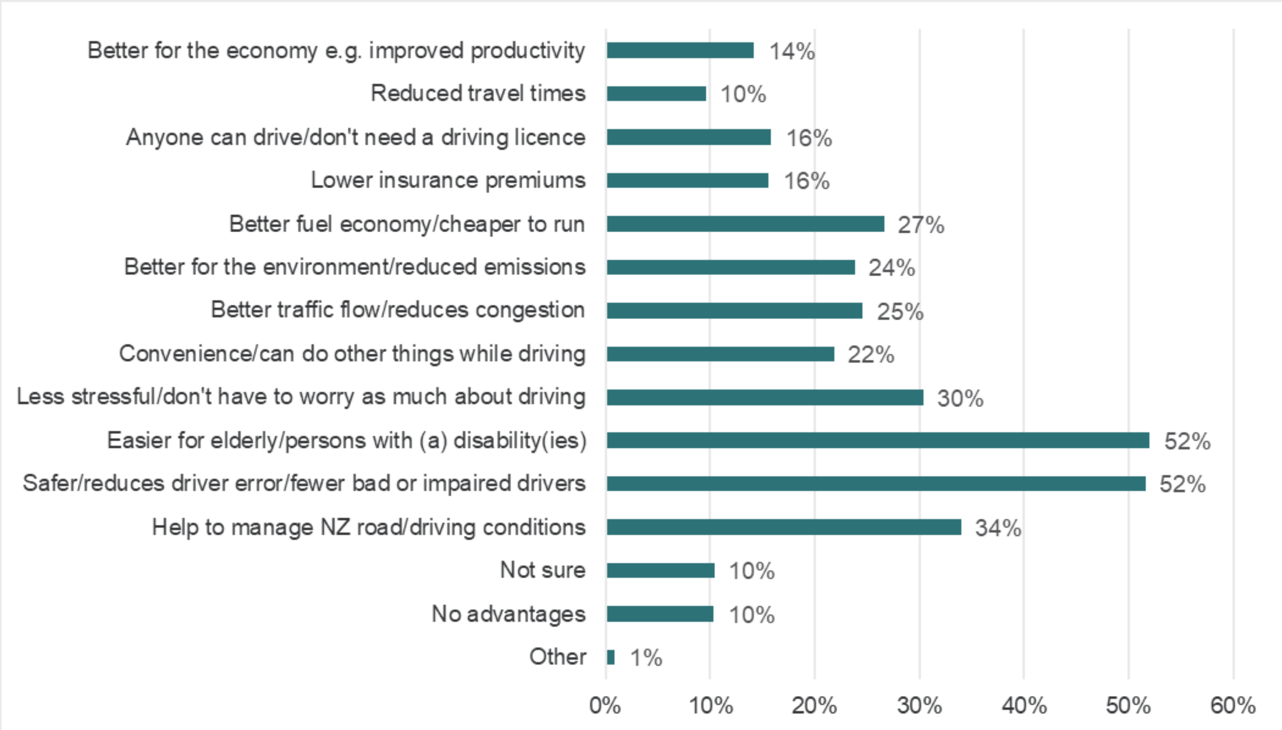
Table B.2 Familiarity with automated vehicles, by age and gender

	Total % (*n* = 1,051)	Gender		Age group					
		Females (*n* = 539)	Males (*n* = 510)	18–24 (*n* = 141)	25–34 (*n* = 176)	35–44 (*n* = 197)	45–54 (*n* = 206)	55–64 (*n* = 169)	65–80 (*n* = 162)
Net: familiar	32%	28%	37%	53%	37%	36%	22%	22%	28%
Very familiar	9%	6%	11%	10%	12%	10%	6%	4%	9%
Somewhat familiar	23%	22%	26%	43%	25%	26%	16%	18%	19%
Net: not familiar	63%	66%	60%	39%	57%	60%	75%	72%	70%
Not very familiar	36%	33%	39%	26%	37%	35%	41%	40%	32%
Not at all familiar	27%	33%	21%	13%	19%	25%	34%	32%	38%
Not sure	5%	6%	3%	8%	6%	4%	3%	6%	2%

Note. The bases are the total number of respondents to the main survey in each female, male and age category.

B.3 Advantages of automated vehicles

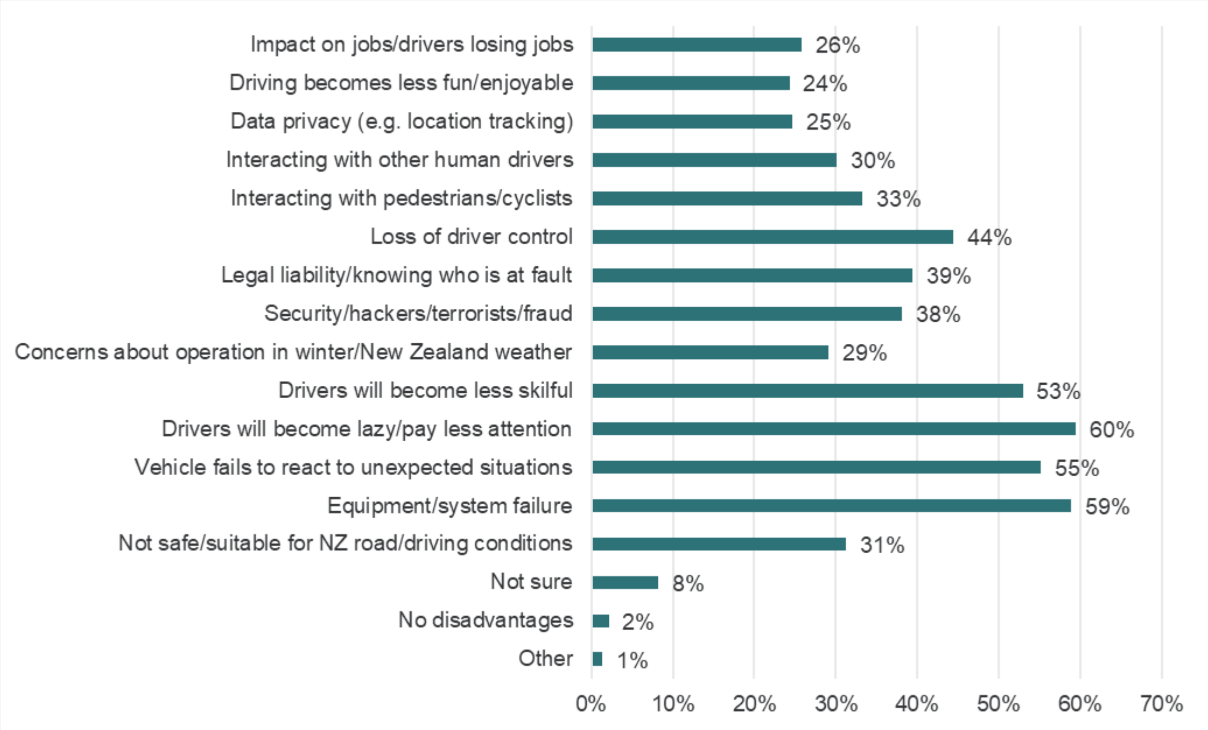
Figure B.1 Advantages of automated vehicles



Note. The base is all respondents to the main survey (*n* = 1,051).

B.4 Disadvantages of automated vehicles

Figure B.2 Disadvantages of automated vehicles



Note. The base is all respondents to the main survey (*n* = 1,051).

B.5 Acceptability of automated vehicles

All respondents were shown five statements about automated vehicles and asked to select their level of agreement with each statement. As shown in Table B.3, over two-thirds of respondents agreed with statements indicating some concern or pessimism about automated vehicles, such as system security and data privacy issues (71%) and concern with the idea of fully automated vehicles (64%). One-third of respondents agreed that they would feel comfortable riding in a fully automated vehicle (36%), and 38% agreed that automated vehicles perform better than human drivers in routine driving conditions.

Statements describing pessimism about automated vehicles and fully autonomous vehicles tended to elicit stronger responses. For example, respondents strongly agreed with the two statements pessimistic about automated vehicles (24% and 22%) at a higher rate than the three statements positive about automated vehicles (8%, 7% and 9%), and one-quarter of respondents strongly disagreed that they would feel comfortable riding in a fully automated vehicle.

Table B.3 Agreement with statements about automated vehicles

	Level of agreement					
	Net agree (strongly + somewhat)	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	Not sure
When vehicles become more automated, system security and data privacy will become more of a concern	**71%**	24%	47%	12%	4%	13%
The idea of fully automated delivery vehicles concerns me	**64%**	22%	42%	19%	9%	8%
Automated vehicles perform better than human drivers in routine driving conditions	**38%**	8%	30%	22%	11%	29%
Automated vehicles will help keep the roads safer for everyone	**43%**	7%	36%	26%	12%	19%
I would be comfortable riding in a fully automated vehicle	**36%**	9%	27%	27%	25%	12%

Note. The base is all respondents to the main survey (*n* = 1,051).

B.6 Driving or riding in an automated vehicle

All respondents were asked how relaxing or stressful driving (licensed respondents) or being a passenger (non-licensed respondents) in an automated vehicle would be to them (Table B.4). A scale was used where 1 equalled ‘relaxing’ and 10 equalled ‘stressful’. Overall, 18% of respondents thought it would be relaxing (0–3), just under half thought it would be somewhat stressful (47%, 4–7), and 22% thought it would be stressful (8–10). Males tended to think driving or riding in an automated vehicle would be more relaxing than did females. Younger age groups (below 45 years old) generally thought it would be less stressful than older age groups (above 45 years old). There was little difference between the younger and older age groups in the proportion who thought the experience would be relaxing (between 17% and 19%).

Table B.4 How relaxing or stressful would it be to drive/ride in a fully automated vehicle?

	Total %	Gender		Age group					
		Females (*n* = 539)	Males (*n* = 510)	18–24 (*n* = 141)	25–34 (*n* = 176)	35–44 (*n* = 197)	45–54 (*n* = 206)	55–64 (*n* = 169)	65–80 (*n* = 162)
Net: Relaxing (score 1–3)	**18%**	**14%**	**22%**	**18%**	**19%**	**18%**	**18%**	**17%**	**17%**
Relaxing (1)	5%	5%	6%	4%	5%	5%	7%	7%	5%
2	4%	3%	5%	6%	5%	3%	5%	0%	3%
3	9%	6%	11%	7%	9%	10%	6%	10%	9%
Net: Neutral (score 4–7)	**47%**	**48%**	**47%**	**60%**	**57%**	**50%**	**37%**	**41%**	**41%**
4	8%	8%	9%	13%	10%	10%	6%	5%	8%
5	16%	18%	14%	21%	16%	15%	12%	21%	9%
6	11%	11%	11%	16%	16%	12%	8%	7%	10%
7	12%	11%	13%	10%	15%	13%	11%	8%	14%
Net: Stressful (score 8–10)	**22%**	**24%**	**20%**	**16%**	**15%**	**18%**	**28%**	**27%**	**28%**
8	8%	9%	7%	10%	6%	5%	10%	9%	9%
9	3%	3%	3%	2%	2%	5%	1%	4%	5%
10	11%	12%	10%	4%	7%	8%	17%	14%	14%
Not sure	13%	15%	11%	6%	9%	14%	17%	15%	14%

Note. The base is all respondents to the main survey (*n* = 1,051).

B.7 Knowledge of ADAS technologies by ADAS user group

Tables B.5 to B.11 show the proportion of each ADAS user group of each technology, and proportion of non-users of each technology who had heard of each technology, who correctly identified the purpose of each technology.

Table B.5 Correct identification of automatic emergency braking

	Total respondents with AEB (*n* = 520)	Driver owners of AEB (*n* = 79)	Driver users of AEB (*n* = 79)	Non-driver users of AEB (*n* = 143)	Non-users who had heard of AEB (*n* = 219)
Avoid collisions from the front, rear, and/or sides of the vehicle	12%	13%	14%	13%	10%
Alert the driver of an imminent collision in the rear of the vehicle	10%	10%	25%	13%	4%
Automatically applies the brakes if a collision is imminent in front of the vehicle [CORRECT RESPONSE]	**63%**	**68%**	**55%**	**61%**	**65%**
I am unsure of the correct response	14%	6%	6%	13%	20%
Prefer not to answer	1%	3%	0%	0%	1%

Note. The bases are the total driver owners, driver users, and non-driver users of AEB and the total non-users of AEB who had heard of AEB.

Table B.6 Correct identification of forward collision warning

	Total respondents with FCW (*n* = 471)	Driver owners of FCW (*n* = 92)	Driver users of FCW (*n* = 61)	Non-driver users of FCW (*n* = 129)	Non-users who had heard of FCW (*n* = 189)
Detect a collision, and automatically apply the brakes if a collision is imminent	37%	34%	31%	33%	42%
Detect and warn the driver of an imminent collision [CORRECT RESPONSE]	**40%**	**51%**	**51%**	**38%**	**33%**
Detect when a collision is imminent, from the front, sides, and/or rear of the vehicle	11%	10%	13%	16%	7%
I am unsure of the correct response	12%	4%	3%	13%	18%
Prefer not to answer	0%	1%	2%	0%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of FCW and the total non-users of FCW who had heard of FCW.

Table B.7 Correct identification of adaptive cruise control

	Total respondents with ACC (*n* = 546)	Driver owners of ACC (*n* = 97)	Driver users of ACC (*n* = 95)	Non-driver users of ACC (*n* = 186)	Non-users who had heard of ACC (*n* = 168)
It may accelerate if the vehicle ahead moves out of the detection zone [CORRECT RESPONSE]	**17%**	**33%**	**17%**	**14%**	**10%**
It works well in thick fog or heavy precipitation because it relies on radar	10%	11%	18%	9%	5%
It is able to successfully brake the vehicle in any situation, as long as the system has detected a vehicle ahead	30%	27%	35%	31%	30%
I am unsure of the correct response	42%	25%	30%	44%	55%
Prefer not to answer	1%	4%	0%	2%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of ACC and the total non-users of ACC who had heard of ACC.

Table B.8 Correct identification of lane departure warning

	Total respondents with LDW (*n* = 538)	Driver owners of LDW (*n* = 87)	Driver users of LDW (*n* = 81)	Non-driver users of LDW (*n* = 147)	Non-users who had heard of LDW (*n* = 223)
Provide an alert if another vehicle is entering your lane	6%	5%	9%	9%	3%
Provide an alert if your vehicle is departing its lane [CORRECT RESPONSE]	**58%**	**67%**	**48%**	**62%**	**57%**
Gently steer your vehicle back into the lane if it begins to depart from the lane	24%	24%	36%	20%	24%
I am unsure of the correct response	11%	2%	6%	9%	16%
Prefer not to answer	1%	2%	1%	0%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of LDW and the total non-users of LDW who had heard of LDW.

Table B.9 Correct identification of lane keep assist

	Total respondents with LKA (*n* = 485)	Driver owners of LKA (*n* = 73)	Driver users of LKA (*n* = 58)	Non-driver users of LKA (*n* = 133)	Non-users who had heard of LKA (*n* = 221)
Prevent collisions caused by your vehicle unintentionally drifting out of its lane [CORRECT RESPONSE]	**68%**	**67%**	**71%**	**58%**	**73%**
Prevent collisions caused by other vehicles that drift out of their lane	11%	18%	15%	16%	4%
Avoid collisions from the front, rear, and/or sides of the vehicle	10%	11%	9%	15%	8%
I am unsure of the correct response	11%	3%	5%	11%	15%
Prefer not to answer	0%	1%	0%	0%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of LKA and total non-users of LKA who had heard of LKA.

Table B.10 Correct identification of blind spot monitoring

	Total respondents with BSM (*n* = 534)	Driver owners of BSM (*n* = 75)	Driver users of BSM (*n* = 90)	Non-driver users of BSM (*n* = 139)	Non-users who had heard of BSM (*n* = 230)
Detect when my vehicle is located in another vehicle's blind spot	6%	11%	9%	7%	3%
Detect when another vehicle is located in my vehicle's blind spot [CORRECT RESPONSE]	**73%**	**78%**	**73%**	**78%**	**69%**
Detect when my vehicle is located in another vehicle's blind spot and will sound my vehicle's horn if the other vehicle begins to move into my lane	8%	3%	12%	10%	6%
I am unsure of the correct response	13%	8%	5%	5%	22%
Prefer not to answer	0%	0%	1%	0%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of BSM and the total non-users of BSM who had heard of BSM.

Table B.11 Correct identification of electronic stability control

	Total respondents with ESC (*n* = 440)	Driver owners of ESC (*n* = 136)	Driver users of ESC (*n* = 73)	Non-driver users of ESC (*n* = 128)	Non-users who had heard of ESC (*n* = 103)
Provide an alert when my vehicle may lose traction with the road	11%	12%	7%	12%	11%
Provide an alert when another vehicle located in range may lose control	11%	7%	20%	15%	2%
Detect when my vehicle may lose control, such as when going around corners too fast, and stabilises my vehicle [CORRECT RESPONSE]	**61%**	**73%**	**62%**	**54%**	**54%**
I am unsure of the correct response	17%	7%	11%	19%	33%
Prefer not to answer	0%	1%	0%	0%	0%

Note. The bases are the total driver owners, driver users, and non-driver users of ESC and the total non-users of ESC who had heard of ESC.

B.8 Issues or problems with ADAS technologies

Tables B.12 to B.18 show the issues reported by driver owners and driver users of each ADAS technology. On all technologies, less than 10% of respondents who provided a response to this question reported an issue, mostly related to over sensitivity and/or unnecessary warnings. This was particularly so for FCW, LDW, and BSM.

Table B.12 Reported issues with automatic emergency braking

	%
No issues/works fine	80%
Unexpected braking/sensitive braking	8%
Experience issues (unspecified)	3%
Difficult to use/takes getting used to	2%
Other	2%
N/A (never used)	5%

Note. The base is total driver owners and driver users of AEB who provided a response to this question (*n* = 184).

Table B.13 Reported issues with forward collision warning

	%
No issues/works fine	83%
Unexpected warning/unnecessary warning	9%
Does not always work	1%
Experience issues (unspecified)	1%
Other/unclear	1%
N/A (never used)	5%

Note. The base is total driver owners and driver users of FCW who provided a response to this question (*n* = 171).

Table B.14 Reported issues with adaptive cruise control

	%
No issues/works fine	80%
Effect is unpredictable/takes getting used to	5%
Dislike the effect	4%
Other	1%
N/A (never used)	8%

Note. The base is total driver owners and driver users of ACC who provided a response to this question (*n* = 217).

Table B.15 Reported issues with lane departure warning

	%
No issues/works fine	78%
Sensors too sensitive and annoying	4%
Cannot differentiate intentional lane departures	3%
Poor detection on non-motorway roads	3%
Experience issues (unspecified)	3%
Other	1%
N/A (never used)	9%

Note. The base is total driver owners and driver users of LDW who provided a response to this question (*n* = 182).

Table B.16 Reported issues with lane keep assist

	%
No issues/works fine	77%
Dislike the effect	5%
Inaccurate detection in specific road environments	4%
Automatic response is forceful/takes getting used to	4%
Other	2%
N/A (never used)	8%

Note. The base is total driver owners and driver users of with LKA who provided a response to this question (n = 137).

Table B.17 Reported issues with blind spot monitoring

	%
No issues/works fine	86%
Annoying	3%
Poor detection in specific road environments/weather conditions	2%
Unnecessary warning	1%
Other	2%
N/A (never used)	6%

Note. The base is total driver owners and driver users of BSM who provided a response to this question (n = 174).

Table B.18 Reported issues with electronic stability control

	%
No issues/works fine	87%
Safety concerns with overcorrection effect	3%
Sensitivity issues	2%
Experience issues (unspecified)	1%
Other	1%
N/A (never used)	7%

Note. The base is total driver owners and driver users of ESC who provided a response to this question (n = 244).

B.9 Relationship between attitudes, knowledge and use

A binomial logistic regression was conducted exploring the extent that attitudes to automated vehicles and knowledge of the technology correctly predicted use of each technology. For each technology, driver owners who used each technology either sometimes or frequently were categorised as ‘users’ of the technology. The knowledge variable was created from the question testing respondents’ knowledge of each technology. The attitude variable was a composite variable that combined respondent scores to five strongly correlated attitudinal statements regarding attitudes to autonomous vehicles.

Overall, the models explained only a very small variance in use of each technology. The models for BSM (Table B.24) ($x^2(2) = 0.456$, $p < 0.796$) and ESC (Table B.25) ($x^2(2) = 1.299$, $p < 0.522$) were not statistically significant. The remaining models explained between 5% and 16% of use in each technology. Attitude tended to have a more pronounced effect on use than knowledge, in each of the models. However, it should be noted, as discussed earlier in the report, that there are some limitations to the knowledge question, given the highly descriptive terms used for each technology, making it relatively easy for respondents to 'guess' the correct answer.

Table B.19 presents the results for AEB. This model was statistically significant ($x^2(2) = 10.574$, $p < 0.005$), explained 8% (Nagelkerke R^2) of the variance in AEB use, and correctly classified 68% of cases. Increasing positive attitude towards autonomous vehicles was associated with increasing likelihood of using AEB, but knowledge (correctly answering the question testing knowledge of AEB) was not significant.

Similarly, the FCW model (Table B.20) was statistically significant ($x^2(2) = 9.032$, $p < 0.011$), explained 8% (Nagelkerke R^2) of the variance in FCW use, and correctly classified 63% of cases. Interestingly, while positive attitude towards autonomous vehicles was not statistically significant, knowledge of FCW (correctly answering the question testing knowledge of FCW) was associated with increasing likelihood of using FCW.

The ACC model (Table B.21) was statistically significant ($x^2(2) = 7.541$, $p < 0.023$), explained 5% (Nagelkerke R^2) of the variance in ACC use, and correctly classified 59% of cases. However, neither attitude nor knowledge of ACC was significantly associated with an increasing likelihood of using ACC.

The LDW model (Table B.22) was statistically significant ($x^2(2) = 7.021$, $p < 0.03$), explained 6% (Nagelkerke R^2) of the variance in LDW use, and correctly classified 59% of cases. While more positive attitude towards automated vehicles was associated with a greater likelihood of using LDW, knowledge about LDW was not a significant predictor of use.

Finally, the LKA model (Table B.23) was statistically significant ($x^2(2) = 16.857$, $p < 0.00$), explained 16% (Nagelkerke R^2) of the variance in LKA use, and correctly classified 70% of cases. While more positive attitude towards automated vehicles was associated with a greater likelihood of using LKA, knowledge about LKA was not a significant predictor of use.

Table B.19 Automatic emergency braking binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	1.84	0.76	5.88		
Attitude towards automated vehicles	−0.19	0.07	7.59	0.01	0.83
Knowledge about AEB	−0.31	0.33	0.92	0.34	0.73

Table B.20 Forward collision warning binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	0.92	0.86	1.14		
Attitude towards automated vehicles	−0.10	0.07	1.88	0.17	0.91
Knowledge about FCW	0.87	0.34	6.49	0.01	2.39

Table B.21 Adaptive cruise control binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	1.165	0.719	2.626		
Attitude towards automated vehicles	−0.113	0.061	3.447	0.06	0.89
Knowledge about ACC	0.62	0.337	3.4	0.07	1.86

Table B.22 Lane departure warning binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	2.388	0.89	7.2		
Attitude towards automated vehicles	−0.188	0.075	6.354	0.01	0.83
Knowledge about LDW	−0.092	0.335	0.075	0.78	0.91

Table B.23 Lane keep assist binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	1.71	1.00	2.93		
Attitude towards automated vehicles	−0.15	0.09	2.92	0.09	0.86
Knowledge about LKA	1.56	0.41	14.46	0.00	4.74

Table B.24 Blind spot monitoring binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	0.92	0.97	0.90		
Attitude towards automated vehicles	−0.05	0.08	0.45	0.50	0.95
Knowledge about BSM	−0.02	0.47	0.00	0.97	0.98

Table B.25 Electronic stability control binomial regression model

Variable	B	S.E.	Wald	*p*	Odds ratio
Constant	−0.06	0.06	1.07		
Attitude towards automated vehicles	0.16	0.28	0.31	0.58	1.17
Knowledge about ESC	0.73	0.70	1.11	0.29	2.08

Appendix C: Consumer awareness, knowledge and use of ADAS – questionnaire

[Survey preamble] Technologies are constantly being developed to improve vehicle performance and safety. This survey aims to explore New Zealanders' knowledge, attitudes, and behaviours regarding these technologies. The findings will be used to develop tools and resources to help inform New Zealanders about the correct and safe use of these new technologies.

SCREENING

In what year were you born? [DROP DOWN LIST NUMBER RANGE 1930 TO 2006] [IF UNDER 18 (>2002) THANK AND TERMINATE/IF AGE 81+ (<1940) THANK AND TERMINATE]

1. How big is the community in which you live? Would you say it is:

01–A main urban area (with a population over 30,000)

02–A secondary urban area (with a population of 10,000 but less than 30,000)

03–A minor urban area (with a population of 1,000 but less than 10,000)

04–A rural centre (with a population of 300 but less than 1,000)

05–A rural area (with a population of less than 300)

06–Don't know/not sure

2. How do you identify yourself?

01–Female

02–Male

03–Other gender identity

99–Prefer not to answer

3. Which ethnic groups do you belong to? *Please select any that apply*

99–Prefer not to answer EXC

01–New Zealand European

02–Māori

03–Other European

04–Samoan

05–Tongan

06–Cook Islands Māori

07–Niuean

08–Chinese

09–Indian

10–Other (Please specify) ___________________________

4. Do you currently have a valid driver licence? ADD QUOTA CHECK

01–Yes, I have a valid driver licence

02–No, I do not have a valid driver licence

VEHICLE TYPE AND USE

[IF LICENSED DRIVER Q4 = 1]

5. Do you currently own or personally lease a vehicle, or have regular access to one (eg, a work vehicle)? Please select based on the vehicle you drive most frequently.

01–Yes, own or personally lease

02–Yes, regular access

03–No skip to Q12

[IF LICENSED DRIVER OWNING, PERSONALLY LEASING, OR WITH ACCESS TO VEHICLE IF Q5 = 1 OR 2] Q6 TO Q8 SHOULD BE ON SAME SCREEN

Please consider the vehicle that you drive most frequently – this includes commuting to and from work. What is the make (eg, Toyota), model (eg, Corolla) and year of this vehicle?

Make

____

99–Not sure (TICK BOX)

Model

____

99–Not sure (TICK BOX)

Year (OE NUM RANGE 1900 TO 2021)

____

99-Not sure (TICK BOX)

ASK IF Q5 = 1 OR 2

6. Do you drive this vehicle: [SELECT ONE]

01–Mostly or exclusively for personal use

02–Mostly or exclusively for business purposes

03–For both personal and business use

ASK IF Q5 = 1 OR 2

7. How many kilometres PER DAY do you drive on a **typical weekday**, that is, Monday to Friday? Please include travelling to and returning from your destination and any trips in between completed in any vehicle you own, lease or have access to. [SELECT ONE]

01–Up to 10 km per day

02–11 to 24 km per day

03–25 to 49 km per day

04–50 to 99 km per day

05–100 or more km per day

06–Do not drive on a typical weekday

07–Cannot say

ASK IF Q5 = 1 OR 2

8. How many kilometres PER DAY do you drive on a **typical weekend day**, Saturday and Sunday, including return trips? Please include travelling to and returning from your destination and any trips in between completed in any vehicle you own, lease or have access to. [SELECT ONE]

01–Up to 10 km per day

02–11 to 24 km per day

03–25 to 49 km per day

04–50 to 99 km per day

05–100 or more km per day

06–Do not drive on a typical weekend

07–Cannot say

SEGMENTATION QUESTION

[ASK ALL. SHOW STATEMENT NUMBER]

9. Below are two statements on attitudes towards vehicle ownership. Please indicate the extent to which you agree with the first or the second:

A car says a lot about a person — my car must reflect my personal style and image

A car is just an appliance — something to get me from point A to point B

Strongly agree with 1

Somewhat agree with 1

Somewhat agree with 2

Strongly agree with 2

No opinion

LEVEL OF AWARENESS OF ADAS

[ASK ALL]

10. When you hear the term ‘automated vehicles’ what kinds of technology come to mind? [Open ended text box NO RESPONSE PERMISSIBLE]

[ASK ALL]

11. How familiar would you say you are with automated vehicles? [SELECT ONE]

Very familiar

Somewhat familiar

Not very familiar

Not at all familiar

Not sure

PUBLIC PERCEPTIONS OF ADAS

[SHOW TO ALL]

Automated vehicles use sensors, onboard computers and software to make decisions. This technology allows the vehicle to take over control of some specific driving functions, under certain conditions – for example, steering, braking, acceleration, and checking and monitoring the driving environment. A fully automated vehicle (not yet available on the market) will be capable of doing all of the driving itself, without the need of a human driver.

[ASK ALL]

12. What do you think are the *advantages*, if any, of automated vehicles? [SELECT ANY THAT APPLY]

Help to manage NZ road/driving conditions

Safer/reduces driver error/fewer bad or impaired drivers

Easier for elderly/persons with (a) disability(ies)

Less stressful/don't have to worry as much about driving

Convenience/can do other things while driving

Better traffic flow/reduces congestion

Better for the environment/reduced emissions

Better fuel economy/cheaper to run

Lower insurance premiums

Anyone can drive/don't need a driver licence

Reduced travel times

Better for the economy (eg, improved productivity)

Other [Please specify]______________________________

No advantages [EXC]

Not sure [EXC]

13. What do you think are the *disadvantages*, if any, of automated vehicles? [SELECT ANY THAT APPLY]

Not safe/suitable for NZ road/driving conditions

Equipment/system failure

Vehicle fails to react to unexpected situations

Drivers will become lazy/pay less attention

Drivers will become less skilful

Concerns about operation in winter/New Zealand weather

Security/hackers/terrorists/fraud

Legal liability/knowing who is at fault

Loss of driver control

Interacting with pedestrians/cyclists

Interacting with other human drivers

Data privacy (eg location tracking)

Driving becomes less fun/enjoyable

Impact on jobs/drivers losing jobs

Other [Please specify]________________________________

No disadvantages [EXC]

Not sure [EXC]

PUBLIC ACCEPTANCE OF ADAS

[ASK ALL] SR CARD SORT FORMAT. RANDOMISE STATEMENTS

Please indicate your level of agreement with the following statements about automated vehicles.

SCALE: [Strongly agree/Somewhat agree/Somewhat disagree/Strongly disagree/Not sure]

14. When vehicles become more automated, system security and data privacy will become more of a concern

15. The idea of fully automated delivery vehicles concerns me

16. Automated vehicles perform better than human drivers in routine driving conditions

17. Automated vehicles will help keep the roads safer for everyone

18. I would be comfortable riding in a fully automated vehicle

[ASK ALL]

19. Do you think [IF HAVE LICENCE Q4 = 1 – 'driving'] [IF UNLICENSED Q4 = 2 – 'riding in'] a vehicle with automated technologies would be more relaxing, or more stressful, than being in a conventional vehicle?

[SHOW 10 PT SCALE OR SLIDER – 1 = RELAXING, 10 = STRESSFUL]

99 = Not sure TICK BOX OUTSIDE OF SCALE/SLIDER

[ASK ALL]

23. Please select which of these vehicle technologies you **have heard of** (including those you have interacted with, experienced as a passenger, seen on a commercial or heard about elsewhere). [SELECT ANY THAT APPLY]

01–Blind spot monitoring/alert system

02–Lane departure warning

03–Forward collision warning

04–Lane keeping assist

05–Automatic emergency braking

06–Adaptive cruise control

07–Electronic stability control (ESC)

08–Cruise control

09–Back-up warning system

10–Automatic parking

11–Back-up camera

98–None of the above [EXC]

99–Not sure [EXC]

[SHOW ALL]

INTRO: Now we would like to ask you a few questions about different advanced driver assistance systems (ADAS). These are newer technologies included on some new vehicle models. You may or may not have had experience with these technologies, as a driver or a passenger.

The <first><next> technology is ________________________ (INSERT NAME).

[SHOW TC DESCRIPTION].

NAME	TC DESCRIPTION
Automatic emergency braking (AEB)	This technology uses sensors to track cars in front of it. It automatically brakes to reduce the impact or severity of a collision, or stops the car to avoid it completely
Forward collision warning (FCW)	This technology alerts you about a possible collision with the vehicle ahead, so you can brake or turn in time.
Adaptive cruise control (ACC)	This technology keeps a set speed and constant distance between your vehicle and the car in front. It may offer some braking to achieve this.
Lane departure warning (LDW)	This technology alerts you if your vehicle drives outside of the lane, as long as the lane lines are visible on both sides of the road.
Lane keep assist (LKA)	This technology steers your vehicle back into your lane if it begins to drift.
Blind spot monitoring (BSM)	This technology alerts you to vehicles in your blind spot.
Electronic stability control (ESC)	This technology detects if your vehicle is nearing the limits of traction during cornering and braking and adjusts braking to improve stability.

[REPEATED FOR ALL TECHNOLOGIES ABOVE. RANDOMISE ORDER]

24. Which statement best describes you in relation to ____________ (bold name) technology [SELECT ONE]

01–I currently own or personally lease a vehicle equipped with this technology

02–I drive or have driven a vehicle equipped with this technology (eg work vehicle, rental, car share) or have previously owned a vehicle equipped with this, but do not own or personally lease one currently

03–I have been a passenger in a vehicle with this technology, but have not driven one personally

04–I have neither driven nor been a passenger in a vehicle with this technology

99–Not sure [EXC]

Q4 (LICENCE OR NON-LICENSED) + Q24 (USE OF 7 ADAS FEATURES) IS USED TO DETERMINE THE USER/NON-USER PROFILE OF EACH RESPONDENT AND SUBSEQUENT QUESTION PATH:

IF 01 AT Q4 + 01 AT Q24 = DRIVER OWNER OF THIS TECHNOLOGY – Q25 TO Q30 ASKED FOR EACH TECHNOLOGY IN Q24 IN CURRENT VEHICLE (OWNED/LEASED) OF RESPONDENT. Q31, Q32 AND Q33–39 ALSO ASKED FOR ANY OF THE REMAINING SEVEN TECHNOLOGIES [01–07] RESPONDENT WAS FAMILIAR WITH IN Q23.

IF 01 AT Q4 + 02 AT Q24 = DRIVER USER OF THIS TECHNOLOGY – Q25 TO Q30 AND Q27 ASKED FOR EACH TECHNOLOGY IN Q24 RESPONDENT HAS EXPERIENCE WITH. Q31, Q32 AND Q33–39 ALSO ASKED FOR ANY OF THE REMAINING SEVEN TECHNOLOGIES [01–07] RESPONDENT WAS FAMILIAR WITH IN Q23 (BUT DOESN'T HAVE CURRENT OR PREVIOUS EXPERIENCE WITH).

IF 01 OR 02 AT Q4 + 03 AT Q24 = NON-DRIVER USER OF THIS TECHNOLOGY – SKIP TO Q31, Q32 AND Q29–35 FOR ANY OF THE SEVEN TECHNOLOGIES [01–07] RESPONDENT WAS FAMILIAR WITH IN Q20.

IF 01 OR 02 AT Q4 + 04 or 99 AT Q24 = NON-USER OF THIS TECHNOLOGY – SKIP TO Q31, Q32 AND Q33–39 FOR ANY OF THE SEVEN TECHNOLOGIES [01–07] RESPONDENT WAS FAMILIAR WITH IN Q23.

HOW OFTEN USING/WHETHER ADAS TECHNOLOGY TURNED OFF/WHY

[Q25–31 REPEATED FOR EACH TECHNOLOGY IN Q24 THAT **DRIVER OWNERS** HAVE EXPERIENCE WITH AND Q25–29 AND Q31 REPEATED FOR EACH TECHNOLOGY IN Q24 THAT **DRIVER USERS** HAVE HAD EXPERIENCE WITH]

25. How often do <INSERT IF Q24 = 2: or did> you use the ___________ feature in your vehicle?

01–Frequently

02–Sometimes

03–Rarely

04–Never

05–I don't use it – temporarily turned it off

08–I have disabled it permanently

06–Not applicable

07–Not sure

10–Turned off – [Not to be shown to anyone, but used for those who selected code 5 in soft launch (and were edited to be code 4)]

26. While using this feature, are you still responsible for monitoring the vehicle's driving functions?

01–All of the time

02–Most of the time

03–Some of the time

04–Only when needed

05–Don't know/Not sure

27. Have you experienced <INSERT IF Q24 = 2: or did you experience> any issues using this feature (for example, the feature not working in the way you expected it to)?

[Open text question NO RESPONSE ALLOWED]

[IF DRIVER OWNER OR DRIVER USER, USING EACH TECHNOLOGY IN Q25 'SOMETIMES/RARELY/NEVER/TURNED OFF/DISABLED' (Q25 = 2, 3 or 4 or 5 or 8)]

28. IF Q25 = 2, 3 or 4 ASK: Which, if any, of the following is a reason why you don't use the ____________ feature [IF SOMETIMES/RARELY add 'more often']?

IF Q25 = 5 OR 8 ASK: Which, if any, of the following is a reason why you have turned off or disabled the ____________feature?

My driving is good/not needed

I don't know how to use it

It is annoying

It is distracting

It doesn't work

Don't drive on the open road a lot

Other (specify)_________________________

Not applicable [EXC]

Not sure [EXC]

[IF DRIVER OWNER OR DRIVER USER, USING EACH TECHNOLOGY IN Q25 'FREQUENTLY/ SOMETIMES/RARELY'(Q25 = 1, 2 or 3)] MR, 14 = EXC

29. When you are using this feature ___________________, would you be **more likely** to do any of the following, **compared to when you are not using the feature**?

Talking on a handheld phone

Talking on a hands-free phone

Reading or sending text messages

Changing the audio entertainment system

Changing the GPS

Eating or drinking

Smoking

Talking with passengers

Attending to children or pets

Looking for, reaching for or tidying up an object

Looking at something outside the vehicle

Thinking about things unrelated to the driving task

Other (please specify):__________________

None of the above [EXC]

[IF **DRIVER OWNER** WHOSE CURRENT VEHICLE (OWNED/LEASED) HAS THE TECHNOLOGY IN Q24]

30. How important a factor was _______________ in your decision to purchase or lease this vehicle?

Very important

Somewhat important

Not very important

Not at all important

TECHNOLOGY AWARE OF AT Q23 OR (IF NOT AWARE AT Q23) IS SELECTED AT Q24 = 1 to 3

31. How important a factor do you think having _______________ will be for you in making a decision about which vehicle to purchase or lease in the future?

01–Very important

02–Somewhat important

03–Not very important

04–Not at all important

KNOWLEDGE OF WHAT ADAS FUNCTIONS DO

TECHNOLOGY AWARE OF AT Q23 OR (IF NOT AWARE AT Q23) IS SELECTED AT Q24 = 1 to 3

32. How **familiar** would you say you are with what ____________ feature does?

01–Very familiar

02–Somewhat familiar

03–Not very familiar

04–Not at all familiar

[ASK FOR **AUTOMATIC EMERGENCY BRAKING**]

33. Based on your experience with **automatic emergency braking (AEB)**, what is this feature designed to do? [SELECT ONE]

01–Avoid collisions from the front, rear, and/or sides of the vehicle

02–Alert the driver of an imminent collision in the rear of the vehicle

03–Automatically applies the brakes if a collision is imminent in front of the vehicle [CORRECT]

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **FORWARD COLLISION WARNING**]

34. Based on your experience with **forward collision warning (FCW)**, what is this feature designed to do? [SELECT ONE]

01–Detect a collision, and automatically apply the brakes if a collision is imminent

02–Detect and warn the driver of an imminent collision [CORRECT]

03–Detect when a collision is imminent, from the front, sides, and/or rear of the vehicle

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **ADAPTIVE CRUISE CONTROL**]

35. Based on your experience with **adaptive cruise control (ACC)**, which statement is correct about this feature? [SELECT ONE]

01–It may accelerate if the vehicle ahead moves out of the detection zone [CORRECT]

02–It works well in thick fog or heavy precipitation because it relies on radar

03–It is able to successfully brake the vehicle in any situation, as long as the system has detected a vehicle ahead

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **LANE DEPARTURE WARNING**]

36. Based on your experience with **lane departure warning (LDW)**, what is this feature designed to do? [SELECT ONE]

01–Provide an alert if another vehicle is entering your lane

02–Provide an alert if your vehicle is departing its lane [CORRECT]

03–Gently steer your vehicle back into the lane if it begins to depart from the lane

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **LANE KEEPING ASSIST**]

37. Based on your experience with **lane keeping assist (LKA)**, what is this feature designed to do? [SELECT ONE]

01–Prevent collisions caused by your vehicle unintentionally drifting out of its lane [CORRECT]

02–Prevent collisions caused by other vehicles that drift out of their lane

03–Avoid collisions from the front, rear, and/or sides of the vehicle

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **BLIND SPOT MONITORING**]

38. Based on your experience with **blind spot monitoring (BSM)**, what is this feature designed to do? [SELECT ONE]

01–Detect when my vehicle is located in another vehicle's blind spot

02–Detect when another vehicle is located in my vehicle's blind spot [CORRECT]

03–Detect when my vehicle is located in another vehicle's blind spot and will sound my vehicle's horn if the other vehicle begins to move into my lane

04–I am unsure of the correct response

99–Prefer not to answer

[ASK FOR **ELECTRONIC STABILITY CONTROL**]

39. Based on your experience with **electronic stability control (ESC)**, what is this feature designed to do? [SELECT ONE]

01–Provide~~s~~ an alert when my vehicle may lose traction with the road

02–Provide~~s~~ an alert when another vehicle located in range may lose control

03–Detect when my vehicle may lose control, such as when going around corners too fast, and stabilises my vehicle [CORRECT]

04–I am unsure of the correct response

99–Prefer not to answer

TRAINING/EDUCATION

[IF **DRIVER OWNER, DRIVER USER** OR **NON-DRIVER USER** OF <u>ANY</u> TECHNOLOGY IN Q24]

40. Which of the following sources, if any, have you used to learn about the advanced driver-assistance features you have experience with – for example, about what they do or how they work? [SELECT ANY THAT APPLY] [RANDOMISE ORDER – LEAVE 97–99 LAST]

01–Online video (YouTube, car company video, etc.)

14–Online search

02–Contacted garage/mechanic

03–Contacted/visited a dealership

04–Manufacturer's website

05–Government website

06–Deleted

07–Books, brochures or pamphlets

08–Social media (Facebook, Twitter etc.)

09–Read the owner's manual

10–Asked friends or family

11–Learned by trial and error

12–Education/information received from seller

13–Previous or current employer

97–None – have not learned about it EXC – ASK Q41

98–Other (Please specify)___________________________

99–Not sure EXC – ASK Q41

[ASK IF NOT ASKED Q40 OR NONE (97)/NOT SURE (99) IN Q40]

41. If you wanted to get more information about an advanced driver-assistance feature, for example, about what they do or how they work, which, if any, of the sources listed below would be **your preferred source**? [SELECT ANY THAT APPLY] [RANDOMISE ORDER – LEAVE OTHER/NONE/NOT SURE LAST]

01–Online video (YouTube, car company video, etc.)

14–Online search

02–Contact garage/mechanic

03–Contact/visit a dealership

04–Manufacturer’s website

05–Government website

06–Books, brochures or pamphlets

07–Social media (Facebook, Twitter etc.)

08–Read the owner’s manual

09–Ask friends or family

10–Learn by trial and error

97–None – do not want to learn about it EXC

98–Other (specify)_________________________

99–Not sure EXC

DEMOGRAPHICS

[ASK ALL]

The following are a few questions about you and your household, for statistical purposes only. Please be assured all of your answers will remain completely confidential.

42. In what region of New Zealand do you live?

01–Northland

02–Auckland

03–Waikato

04–Bay of Plenty

05–Gisborne

06–Hawkes Bay

07–Taranaki

08–Wanganui

09–Manawatū

10–Wairarapa

11–Wellington

12–Nelson Bays

13–Marlborough
14–West Coast
15–Canterbury
16–Timaru-Oamaru
17–Otago
18–Southland

43. Which of the following categories best describes your current employment status? [SELECT ONE]
01–Working full-time (35 or more hours per week)
02–Working part-time (less than 35 hours per week)
03–Self-employed
04–Unemployed, but looking for work
05–A student attending school full-time
06–Retired
07–Not in the workforce (a full-time homemaker OR unemployed and not looking for work)
08–Other (DO NOT SPECIFY)
99–Prefer not to answer

44. Which of the following categories best describes your **total household income**? That is, the total annual income of all persons in your household combined before tax. [SELECT ONE]
01–Under $20,000
02–$20,000 to just under $40,000
03–$40,000 to just under $60,000
04–$60,000 to just under $80,000
05–$80,000 to just under $100,000
06–$100,000 to just under $150,000
07–$150,000 and above
99–Prefer not to answer

ASK IF **01 AT Q4 + 01 OR 02 AT Q24** (FOR ANY TECH)
45. Would you be willing to participate in a phone interview and/or ride-along interview about this topic? We will offer you a $100 gift voucher to compensate for your time in the phone interview and a further $150 gift voucher for the ride-along interview component.
01–Yes – would definitely be interested in taking part if it was at a convenient time/place
02–Maybe – would like to know more about what's involved before deciding
03–No – would not be interested

ASK IF Q45 = 1 OR 2
46. In order for us to get in touch with you please provide your contact details below. Your name will only be used for us to contact you and will not be linked to any of the answers you provide.
Name (your first name will do): (1) ________________________________
Email address: (2)_________________________ ADD STANDARD VALIDATION CHECKS
Contact number: (3) (_ _ _) _____________________ MUST HAVE 7 TO 11 DIGITS

Appendix D: ADAS vehicle owner interviews and ride-along interview topic guide

Interview topic guide

Note: main questions in bold, possible probing questions in bullet points

INTRODUCTION

- Welcome
- Background to the research topic and purpose of the interview
- Explanation of how the information collected in the interview will be used; the confidential nature of the interviews; remind participant they can withdraw at any time; seek consent to record interview, and have provided their consent.

BACKGROUND

1. **Can you tell me a bit about your daily travel and activities, on a typical weekday and weekend?**
    - For example, if you work, how do you typically travel to and from work? What type of road environments do you regularly experience? For example, do you primarily drive on the open road or in busy traffic?
2. **From your pre-interview responses, I understand you own a [year, make, model] vehicle. Is that correct? And it has the following technologies: [list all relevant technologies of the 7 tested]. Is that correct?**
    - Are you aware of your vehicle having any other advanced driver-assistance features?
    - How long ago and where did you purchase this vehicle? What prompted you to purchase a new vehicle?
    - Prior to owning your current vehicle, can you tell me about any experience you had with these technologies? For example, as a passenger, in a hire car or work vehicle?

PRE-PURCHASE

Influence of ADAS on vehicle purchasing decision

3. **Thinking back to when you were in the process of purchasing your current vehicle, can you tell me about any vehicle features that you were specifically looking for?**
    - You mentioned your current vehicle has [x] and [x] technology.
        - How important was it that your current vehicle had these technologies? Why?
    - Can you tell me about where or who you sought information about vehicles with ADAS features, if at all? For example, friends or family, the internet?
        - And can you tell me about how, if at all, this information about ADAS features influenced your decision to purchase a vehicle with these technologies?

PURCHASE

Information/training provided at POS

4. **Thinking back to when you were purchasing your current vehicle, can you tell me about any information and/or training that the dealership [or private seller] provided you in relation to [x] and [x] technologies?**
    - Can you tell me about what this involved? For example, were the features demonstrated to you during a test drive?
    - Relative to other vehicle features, how much information or training did you receive on these technologies?

Level of awareness and understanding of ADAS

- At this point, can you tell me how well informed you felt about what each of these technologies did?
- At this point, can you tell me about how confident you felt using [x] and [x] technologies correctly?
- [If not a factor in purchasing decision] At this point, what were your impressions of these technologies? How likely was it that you thought you would use them?

POST-PURCHASE

Frequency of use/non-use/reasons for turning off

5. **Can you tell me about how often you use each of the ADAS features in your vehicle?**

    [Explore for each feature that is turned off/rarely used]

    - **Can you tell me about why you have turned off/disabled this feature?**
    - **Can you tell me about the types of driving situations when you are more likely to use [x] technology?** By driving situations, I mean things such as different driving conditions, including poor weather or heavy traffic, road types such as a quiet residential street or the open road, trip lengths, vehicle speeds.
    - Can you tell me about why you are less likely to use this technology in other driving situations?
    - How did you learn to use this [ADAS feature] in your vehicle?
    - How confident do you feel now, using this feature?

Exploring trust in technology

6. **Do you feel the [ADAS feature] generally works in the way you expect it to?** *(Repeat for each feature)*

    [Only asked for ADAS features that provide alerts/warnings, not asked for ESC, AEB:]

    - Do you feel the timing of alerts or warnings are provided with sufficient time for you to take action? Can you provide any examples?
    - Do you feel the alerts are generally appropriate to the situation? For example, does the vehicle provide alerts during events you perceive as trivial? Or, not provide alerts during events you perceive as serious? Can you provide any examples?

7. **Can you tell me about any experiences you have had with the technology not working in the way you had anticipated?**

- For example, not providing an alert when the system had previously provided an alert to you in a similar situation? How did you respond? How has this impacted the way you use this technology now?

[Repeat for each technology participant has in their vehicle.]

8. **Can you tell me about how often you use two or more technologies at the same time? Which technologies do you typically use together?**
   - Can you describe how this changes the way you drive, if at all?

Experiences with incorrect use

9. **Can you tell me about how you see your role as a driver while using this feature?**
   - For example, are you still responsible for monitoring the vehicles' driving functions?
10. **While using any of these features, does the level of attention you give to driving change?**
    - For example, perhaps not using the steering wheel?
    - Can you tell me about any activities you are more likely to do now when you are using this technology?
    - Do you feel comfortable with the level of monitoring the system does of your driving while using these features? For example, does the system alert you at regular intervals to check your readiness to take over the task?

CLOSE

- Do you have any final comments about the use of these technologies?
- Thank participant for their time and close.

Ride-along component

The first part of the ride-along component will explore the interface with ADAS technologies. Participants will be asked questions regarding how visible, easy and intuitive they find using each of the ADAS features in their vehicle. Participants will then be asked to drive on a short route, encompassing two of the following three scenarios:

- Scenario 1 – High traffic arterial road (BSM, FCW, ACC, AEB, LKA, LDW)
- Scenario 2 – High vehicle and pedestrian traffic shopping strip (BSM, FCW, AEB)
- Scenario 3 – Winding or narrow suburban roads (ESC, LKA, LDW)

Ride-along guide

Semi-structured interview

The interview component will be conducted in the participant's vehicle, with the researcher sitting in the front passenger seat and the participant sitting in the driver's seat. The vehicle will be stationary for the duration of the initial interview component (described in the previous section) and parked in a safe location away from hazards. The interview component will follow the same format, as outlined above.

Ride-along component

The ride-along component will involve two parts:

- Interface with the technology

- Short trip accommodating two scenarios

Interface with the technology

Participants will be asked:

[Note: main questions in bold, possible probing questions in bullet points]

1. **Can you describe the features of the vehicle and what they do, as if I know nothing about them?**
2. **Can you tell me about how intuitive it is using the ADAS features on your vehicle?**
   - How easy was it to first locate each feature? How easy is it to turn on/off? Did you need to refer to your vehicle's manual to locate the feature?
3. **Can you tell me about anything that is unclear about operating each ADAS feature on your vehicle?**

Short trip

Participants will be asked to drive a short circular route around their neighbourhood, accommodating two of the three scenarios. Once complete, they will be advised to pull over and park at a safe location. The interviewer will sit in the front passenger seat for the duration of the interview and ride-along.

During the trip, participants will be asked to 'think aloud' their reactions to ADAS features that come on during the interview. They will be asked to vocalise whatever they are thinking, doing or feeling in relation to the ADAS features. For instance, if a warning or alert comes on, they will say whether they are frustrated, confused or unsure about how to respond to the alert and their response to it – such as a ignoring it.

Depending on the scenario taken, participants will then be asked the following during key points (mapped in advance) of the interview:

4. **Did the advanced safety features help you at all on the trip we have just taken?**
5. **Can you tell me about why you did not use [x] ADAS feature on the trip?**
   - [Explore reasons for non-use]
6. **Can you tell me about how familiar you are with using this feature?**
7. **Can you tell me about what you expect might happen if you turned on the feature?**
8. **Can you tell me about what would make you feel confident about using that feature in the future?**
9. **Imagine your next car – in what way would the features work better? What else would it have?**

CLOSE

- Do you have any final comments about the use of these technologies?

Thank participant for their time and close.