Drivers' use of Advanced Driver Assistance technologies

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Abstract
The aim of this project was to investigate drivers' knowledge, attitudes toward and use of Advanced Driver Assist (ADA) pre-crash technologies in Western Australia (WA). Drivers' use of and attitudes toward ADA technologies were investigated through a telephone survey involving 301 Western Australian drivers whose primary vehicle was fitted with at least one ADA technology. Overall, the surveyed drivers appeared to have high rates of use and favourable attitudes toward current ADA technologies. A high proportion of drivers agreed technologies such as Blind Spot Monitoring, Lane Keeping Assist and Autonomous Emergency Braking reduced their chance of crashing and helped them to be a safer driver. However, there were indications drivers had less than favourable attitudes toward some elements of ADA technologies, such as Lane Keeping Assist and Lane Departure Warning which they thought produced unnecessary or distracting alerts.

Keywords
Advanced Driver Assist; Forward Collision Avoidance; Lateral Collision Avoidance Systems; Driver Attitudes; Pre-Crash Technologies

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ABBREVIATIONS

AA	Attention Assist
ACC	Adaptive (or Advanced) Cruise Control
ADA	Advanced Driver Assistance
AEB	Autonomous Emergency Braking
ANCAP	Australian New Car Assessment Program
BSM	Blind Spot Monitoring
FCW	Forward Collision Warning
HLDI	Highway Loss Data Institute
LDW	Lane Departure Warning
LKA	Lane Keeping Assist
MY	Manufacture Year
UCSR	Used Car Safety Ratings

EXECUTIVE SUMMARY

Introduction

Despite the effectiveness of various Advanced Driver Assist (ADA) technologies to reduce crash involvement (Cicchino 2018a; Cicchino 2018b; Cicchino 2018c), there is evidence to suggest drivers do not always rate these technologies favourably and sometimes opt to disable or downgrade their functionality (Reagan et al. 2018). Consequently, the primary safety status of the vehicle and the driver's risk of crash involvement may be compromised. As a result, it is important to understand how drivers of vehicles with these technologies are interacting with the technology and whether their experiences and attitudes are leading them to disable systems or downgrade its functionality.

The aim of this project was to investigate drivers' knowledge, attitudes toward and use of Advanced Driver Assist pre-crash technologies. The specific objectives of the study were to:

1. Establish drivers' knowledge, perceptions of and attitudes toward ADA technologies and their use of these systems;
2. Develop recommendations for the strategic promotion of ADA technologies and the education of owner drivers for the appropriate use of the technologies.

Method

Between December 2018 and January 2019, a telephone survey was conducted involving 301 Western Australian drivers of vehicles with at least one of seven ADA technologies: Radar or Adaptive Cruise Control (ACC), Forward Collision Warning (FCW), Autonomous Emergency Braking (AEB), Lane Departure Warning (LDW), Lane Keeping Assist (LKA), Blind Spot Monitoring (BSM), and/or Attention Assist (AA). The questionnaire included 103 items which collected information on: basic driver demographics (3 items); details of the car most frequently driven (12 items); driver's knowledge, experience with and use of their car's ADA technologies (3 items per technology), and driver's attitudes toward each of their car's ADA systems (59 items; 7-10 items per technology). All questions were multiple choice, with the exception of two questions relating to manufacture year and the length of time driving the car. To assess drivers' attitudes, they were asked to indicate their level of agreement/disagreement with a series of statements on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree". The questionnaire used conditional branching so that drivers who indicated

their car did not have a particular ADA feature or were unsure of the fitment were not asked questions regarding use, experience with, and attitudes toward the specific technology.

All participant recruitment and data collection was conducted by the Edith Cowan University Survey Research Centre. Data was provided to C-MARC in SPSS format with all statistical analyses conducted using IBM SPSS Statistics for Windows, Version 25.

Selected Results

Description of the sample

Of the 301 drivers who completed the telephone survey, the majority were male (n=180; 59.8%), located in metropolitan WA (n=257; 85.4%), and aged 50-59 years (n=135; 44.9%) or 40-49 years (n=89; 29.6%). The median age of the car most frequently driven was 3 years (range: ≤1 year to 15 years), which did not differ by location (i.e., metropolitan vs. regional WA). The most frequent manufacture year was 2017 (n= 71; 23.8%), followed by 2018 (n=68; 22.8%). There were 29 vehicle makes represented in the sample with the most common being Mercedes-Benz (n=42; 14%), which was closely followed by Toyota (n=41; 13.6%).

Prevalence of ADA technologies in the sample

Vehicles most frequently had four ADA features fitted to their car (n=65; 21.6%), followed by three features (n=55; 18.3%). The self-reported fitment of ADA technologies from most to least prevalent was as follows: 73.4% (n=221) for FCW, 65.1% (n=196) for ACC, 60.8% (n=183) for BSM, 57.8% (n=174) for LDW, 46.8% (n=141) for AEB, 22.3% (n=67) for LKA, and 19.9% (n=60) for AA.

Drivers' knowledge

Depending on the technology, between 6% and 15.9% of all drivers did not know if the car they drove most frequently was fitted with the ADA feature in question. Overall, drivers were most unsure of the fitment of AEB (n=48; 15.9%) and AA (n=39; 13%).

Use of ADA technologies

The majority of drivers indicated they always had the ADA system switched on and unchanged from factory settings, ranging from 71.6% for LKA to 97.3% for BSM. Lane Keeping Assist had the highest percentage of drivers who mostly or always drove with the system switched off (13.4%), followed by LDW (10.3%).

Experienced ADA system's alert/operation

The majority of drivers with each ADA technology responded that they had experienced the system's alert or the system in operation. Nearly all drivers of cars with BSM reported experiencing the system's alert (96.7%). The lowest levels of experience were for AEB (73.8%) and AA (71.7%), with around one-quarter of drivers with the technologies responding that they had never experienced the system in operation (24.1% and 26.7%, respectively).

Drivers' Attitudes toward ADA technologies

Drivers appeared to have a positive attitude toward ADA technologies fitted to their car overall; for example, the majority of drivers thought BSM (94.5%), LDW (77.6%), LKA (76.1%) and FCW (72.4%) helped them to be a safer driver and ACC (87.2%) helped them maintain a safe distance from the car in front. A high proportion of drivers agreed BSM can reduce their chances of colliding with another car in an adjacent lane (96.7%), LDW and LKA can reduce their chances of running off the road (86.8% and 86.6%, respectively), and AEB can reduce their chances of having a rear-end crash or colliding with another object (72.4%). There were high levels of trust among drivers in our sample for BSM and ACC, with nearly nine in ten drivers indicating a level of trust in the systems (89.5% and 88.2%, respectively), while eight in ten drivers showed trust in LDW (83.4%) and over three-quarters of drivers trusted the effectiveness of AEB (78%).

However, there were indications that drivers had less favourable attitudes toward some elements of ADA technologies: 20.9% disagreed FCW can reduce their chances of having a rear-end crash, over one-quarter thought LDW alerts and LKA can be distracting (28.2% and 26.9%, respectively), 29.9% agreed that LKA unnecessarily tried to move their car back into the lane, and 28.2% believed LDW produced false or unnecessary alerts. Furthermore, there was a level of distrust of certain crash avoidance technologies among those surveyed: one in five drivers with LKA (20.9%), FCW (19.9%) and AA (18.3%) indicated to some degree that they did not trust the respective system.

Discussion

The majority of drivers surveyed were aware of the different ADA technologies available in their car, thought the technology may help them avoid being involved in a collision and claimed to always have their respective ADA system switched on and unchanged from factory settings. Lane Keep Assist, Lane Deviation Warning and Adaptive Cruise Control had the highest percentage of drivers who reported they mostly or always drive with the system switched off (13.4%, 10.3% and 9.7% respectively).

However, one in five drivers with Lane Keep Assist (20.9%), Forward Collision Warning (19.9%) and Attention Assist (18.3%) indicated to some degree that they did not trust the respective system. Nearly 30% of drivers indicated that the lateral collision avoidance systems have the highest rates of false operations. A quarter of drivers also indicated that Attention Assist produces false or unnecessary alerts about their drowsiness (26.7%) and that Forward Collision Warning was too sensitive and leads to unnecessary alerts of an imminent crash (25.3%). Close to one in five drivers thought Autonomous Emergency Braking (AEB) leads to unnecessary, automatic braking (18.4%).

A number of limitations were noted for the study which may limit the validity, reliability and generalisability of the findings. The limitations relate to the (i) recruitment and sampling of drivers and their vehicles and (ii) how information about the drivers' vehicles was retrieved and categorised. In particular, middle-aged drivers are overrepresented while younger-age and regional drivers are underrepresented in this sample. Furthermore, information collected on ADA fitment and the activation status of the technologies are self-reported with no validation of participant responses.

It is therefore important, that vehicles with Advanced Driver Assist Technologies continue to be promoted to increase market penetrance across the population in general. Further to this we need to raise awareness about these technologies so people are aware of what they are, how they work and what the benefits are and are less inclined to switch them off. A previous C-MARC report addressed the issue of promoting safe vehicle technologies (Palamara 2018). Recommendations from this report will specifically address the issue of education regarding safe vehicle technologies so that people understand their purpose and how they may help protect them in a crash.

Recommendations

1. Develop a consumer guide to advanced safety features which should be:
    - Specific for cars available in Australia
    - Highlight information about extra protection provided by advanced safety features.
    - Include case histories to show how the technologies have prevented crashes and/or injury outcomes.
    - Readily available at car yards and on the internet, particularly websites, social media sites where cars are for sale.
    - Available in formats targeted at specific demographic groups, including infographics and video.
    - Video clips may focus on the specific technologies that are most likely to be switched off, eg. Lane Keep Assist, Lane Deviation Warning and Adaptive Cruise Control.

    The guide could initially be targeted at consumer groups who are most likely to have cars with advanced safety features. From this survey we would suggest those aged 40-59 years and living in the metropolitan area. However, this may be more accurately determined by analysis of WA new vehicles sales data.

2. Education about advanced safety features to be targeted to the workforce via fleet managers and/or as part of occupational health and safety training.

To conduct a second phase of research into drivers' attitudes toward and experience with ADA technologies which incorporates a more in-depth and qualitative methodology. This should give drivers the opportunity to describe specific scenarios where they find the technology does not work well and is particularly important in the regional and remote context

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The authors would like to acknowledge all of the drivers who provided their time to complete the telephone survey and the staff at the Edith Cowan University Survey Research Centre for their assistance with participant recruitment and data collection.

1 INTRODUCTION

1.1 Background

'Safe Vehicles' have technologies and systems installed that reduce the incidence of crash involvement (primary safety) and the risk of injury to vehicle occupants in the event of a crash (secondary safety). The use of vehicles with high levels of primary and secondary safety is thus a key component of the State's *Toward Zero 2008-2020* road safety strategy. In recent years, crash avoidance technologies have become more advanced and readily available to new and second hand vehicle buyers. Advanced Driver Assist (ADA) technologies that mitigate forward and lateral collisions, such as Autonomous Emergency Braking (AEB), Lane Departure Warning (LDW), Lane Keep Assist (LKA) and Blind Spot Monitoring (BSM), have the capacity to reduce the incidence of death and injury on Western Australian roads to support the State's *Toward Zero* strategy. Therefore, it is important to monitor the purchasing trend of vehicles with these technologies and, where necessary, promote their uptake.

However, despite the known effectiveness of various ADA technologies to reduce crash involvement, there is evidence to suggest that drivers do not always rate these technologies favourably and in some cases opt to disable or downgrade their functionality. This may compromise the primary safety status of the vehicle and the driver's risk of crash involvement. It is therefore important to understand how drivers of vehicles with these technologies are interacting with the technology and whether their experiences and attitudes are leading them to disable systems or downgrade their functionality. If drivers' understanding and experiences of these technologies are less than favourable, as has been documented in previous research, this has the potential to limit the use and effectiveness of the technology in reducing death and serious injuries in WA, undermining the State's *Toward Zero* strategy.

1.2 Project Aim and Objectives

The overall aim of this project was to investigate drivers' knowledge, attitudes toward and use of Advanced Driver Assist pre-crash technologies.

The specific objectives of the study were to:

1. Establish drivers' knowledge and perceptions of and attitudes toward Advanced Driver Assistance technologies and their use of these systems;

2. Develop recommendations, where appropriate, for the strategic promotion of Advanced Driver Assistance technologies and the education of owner drivers for the appropriate use of the technologies.

1.3 Project Benefits

The research findings will provide the State with important data regarding the uptake of primary safety technologies and potential barriers to their effective use by drivers of vehicles with these features. This information can then be used for the development of marketing and education materials to promote crash avoidance technologies and their appropriate use.

2 METHODS

2.1 General Study Design

This project was undertaken in three stages: **Stage One** involved a review of the literature pertaining to drivers' perceptions of and attitudes toward Advanced Driver Assist (ADA) technologies and identified barriers toward the use of the technologies; **Stage Two** involved surveying a convenience sample of WA drivers of vehicles with ADA technologies to investigate their knowledge, use of and attitudes toward various ADA technologies; **Stage Three** was to develop recommendations for the (i) marketing and promotion of ADA technologies and (ii) the education of drivers in the appropriate use of ADA technologies.

2.2 Ethics Approval

The research was undertaken with the approval of the Human Research Ethics Committee, Curtin University: approval number HRE2018-0619 (18th September 2018).

2.3 Literature Review

A search of the peer review and 'grey' literature published in Australia and internationally (2000-2019) was undertaken to identify, retrieve and review material related to:

- ADA technologies and their potential benefits (i.e., impact on crashes);
- Acceptance and use of ADA technologies, and
- Drivers' perceptions of and attitudes toward ADA technologies as well as barriers to their use.

Keywords (e.g., advanced driver assist technologies, pre-crash technologies, collision avoidance, fatigue monitoring system, lane maintenance systems) were used to search databases such as Google, Google Scholar, ProQuest, Medline, and ScienceDirect for the retrieval of reports, scientific journal articles, conference papers, and educational-promotional materials. In addition, a 'web-scan' was undertaken of the content and information of international and Australian websites targeting safe vehicle technology.

2.4 Advanced Driver Assist Vehicle Owner Survey

This stage of the study addresses objective one: Establish drivers' knowledge, perceptions and attitudes toward ADA technologies and their use of these systems. This involved surveying a non-probability sample of WA drivers of vehicles with ADA technologies via a telephone questionnaire.

2.4.1 Design and Development of Telephone Interview Questionnaire

A telephone questionnaire was developed for the purposes of conducting a convenience sample cross-sectional survey of Western Australian drivers whose primary car contains at least one of seven ADA technologies[1]. These technologies included the following: Adaptive Cruise Control (ACC); Forward Collision Warning (FCW); Autonomous Emergency Braking (AEB); Lane Departure Warning (LDW); Lane Keeping Assist (LKA); Blind Spot Monitoring (BSM), and Attention Assist (AA). The intention of the survey was to collect information on the vehicle most frequently driven and to describe the drivers' knowledge and use of as well as their attitudes toward these technologies. The content of the survey is summarised below (please refer to APPENDIX 1 for a complete copy of the questionnaire).

All questions were multiple choice, with the exception of two questions relating to manufacture year and the length of time driving the car. The questionnaire used conditional branching (i.e., 'skip logic'); drivers who indicated their car did not have or were unsure if it had a particular ADA feature were not asked questions regarding use, experience with, and attitudes toward that technology. There were 103 items in total, which collected information on the following:

Demographics

- Gender
- Age group (17-25, 26-39, 40-49, 50-59, 60-69, 70+ years)
- Postcode (to determine metropolitan or regional status)

Details of the car most frequently driven – 12 items

- Make, model and variant (e.g., Ford Fiesta Trend)
- Year of manufacture

[1] Because the survey used convenience sampling and required that each participant had at least one of seven ADA technologies in their primary vehicle, participants tended to be people who had the financial resources and interest in purchasing a vehicles with ADA technology: middle-aged, driving more expensive vehicles and with an interest in motoring. Using other sampling methods would have added considerably to the cost of the survey and lengthened data collection time. This limited the generalisability of results across the population but was an accurate reflection of those who have access to these technologies at present.

- Length of time driving the car (in years and/or months)
- How vehicle was acquired (e.g., self-purchased or provided by another person)
- Driver's rating of certain qualities of their car (e.g., reliability, safety features, ease of learning to use the various safety technologies, driving performance, ease of driving, and maintenance costs). Qualities were rated on a 5-point scale: very poor, poor, acceptable, good, and very good.

Driver knowledge, understanding and use of their car's Advanced Driver Assist technologies – 3 items (per technology)

- Knowledge of the presence of select ADA technologies in their car: "*To the best of your knowledge is your car fitted with [insert technology]?"*
- Understanding and use of each of the ADA technologies fitted to their car: "*Which one of the following statements best describes your understanding and use of the [insert technology] fitted to your car?"*
- Had experienced the ADA system's alert (e.g., warning sound, seat vibrations) or the system in operation (e.g., car automatically braked) whilst driving the car.

Driver attitudes toward their car's Advanced Driver Assist *systems – 59 items (7-10 items per technology)*

- To assess drivers' attitudes toward each ADA feature fitted to their car, they were asked to indicate their level of agreement/disagreement with a series of statements on a 5-point Likert scale anchored by 1="*strongly disagree"* and 5="*strongly agree"*.
- Participants were asked for their level of agreement/disagreement with 7 to 10 statements depending on the technology (**NB:** statements were not the same across all technologies and did not cover all of the same themes; for all statements, please refer to APPENDIX 1). The statements related to the following themes:
    - Sensitivity of the system (i.e., too sensitive, false or unnecessary warnings), e.g., "*FCW is too sensitive and leads to unnecessary alerts of an imminent crash"*.
    - Reliability, e.g., "*ACC is unreliable; it does not always maintain the speed or distance settings"*.
    - Distraction, e.g., "*LDW alerts can be distracting"*.

- On/Off preference, e.g., "*I would prefer it if my car's LKA could be permanently switched off*".
- Trust, e.g., "*I do not trust the BSM system fitted to my car*".
- Attention, e.g., "*I think I have become less attentive as a driver because of the fitment of FCW in my car*".
- Behavioural control, e.g., "*I feel less in control of the car when AEB is switched on*".
- Safer driving (improved performance), e.g., "*BSM helps me to be a safer driver*".
- Reduced chances of crashing, e.g., "*AEB can reduce my chances of having a rear-end crash or colliding with another object*".
- Fatigue, e.g., "*ACC can reduce the likelihood of feeling fatigued when driving long distances*".
- Usefulness, e.g., "*LDW alerts give me enough time to move my car safely back into the lane*".

2.4.2 Sample Size

The target sample size for this study was 300 Western Australian drivers, which aimed to include 200 participants sampled from metropolitan WA and 100 drivers sampled from regional WA. However, there was difficulty sampling and recruiting drivers from regional areas. Calls made to metropolitan drivers were approximately 3.7 times more productive (C. Hill, personal communication, January 10, 2019); that is, metropolitan drivers were more likely to drive cars with at least one ADA technology while regional drivers were driving older vehicles with no ADA technology. Therefore, the targets for metropolitan and regional drivers were revised to reflect the difficulties in recruitment.

2.4.3 Selection Criteria

To be eligible for participation in the study, the individual had to meet the following criteria: holds a current motor vehicle license, drives a car fitted with at least one of the seven target ADA technologies (see Section 2.4.1), drives the vehicle at least once per week, speaks English, and is over 18 years of age.

2.4.4 Sampling Strategy

Participants were recruited using a commercial Sample Broker. The Broker has a listing of individuals who are willing to participate in survey-based research for a 'fee' (payable by the

Broker). For this research, the Broker provided the Survey Research Centre (Edith Cowan University) with the contact details of individuals who were classified as 'high income earners'. It was presumed that this group of individuals were more likely to have recently purchased or currently drive a newer vehicle. Therefore, this is a non-probability sample of drivers of vehicles with ADA technologies and might not accurately reflect the views and experiences of low income earners to ADA technologies.

2.4.5 Data Collection

On behalf of C-MARC, the Survey Research Centre at Edith Cowan University in Perth, WA performed all participant recruitment and data collection. The recruitment of drivers occurred between December 2018 and January 2019. The Survey Research Centre telephoned the individual, explained why they were being contacted, provided a summary of the study, and ensured they met the eligibility criteria. If the individual was interested in participating, the interviewer then read out a preamble, followed by the study and consent information. This detailed the scope of the project, the requirements of their participation, as well as information on their rights of participation and the University's obligation in relation to anonymity and data protection. The complete preamble to the telephone interviews can be found in APPENDIX 1. Drivers were not required to provide information that could be used to identify them and their responses (for example, their name, address, motor vehicle driver licence number, vehicle registration plate number, or email contact). Data was only collected from individuals who provided verbal consent. All survey data were provided to C-MARC as IBM SPSS (Version 25) data files.

2.4.6 Data Manipulation

Due to differences in participant recall of the make and variant of the model as well as the variation and misspelling of certain car names during data entry, the complete list of cars was exported from SPSS into Microsoft Excel for editing. The list was reviewed manually and known recording errors (e.g., misspelling, incorrect casing, hyphenation and/or spacing of a name) were corrected so that the reporting was uniform across a specific make and model. For example, "Toyota Kluga" and Toyota Kluger"; "Toyota Land Cruiser", "Toyota Landcruiser" and "Toyotaland Cruiser"; "XC60 Volvo", "Volvo XC60" and "Volvo XC 60" (see APPENDIX 2 for the complete, unedited list of vehicles). These input errors impact data analysis in SPSS. Consequently, only the make and model are reported in section 5.2.2, except for the few variants that occurred most often in the sample.

2.5 Data Analysis

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 25 (IBM Corp., Armonk, NY, USA). A p-value of < 0.05 was considered statistically significant in all tests. A series of univariate analyses (e.g., frequency counts, median score tests, cross-tabulations, and chi-squared tests) were conducted to describe and compare the questionnaire responses across all drivers and, where appropriate, by location (i.e., metropolitan WA vs. regional WA). Mann-Whitney U tests were conducted to understand if attitudes toward each ADA technology differed based on gender and/or location and Kruskal-Wallis tests were conducted to determine if attitudes toward ADA technologies differed by age group.

3 LITERATURE REVIEW

Safe Vehicles not only provide vehicle occupants with a higher level of protection against injury in the event of a crash, but crash avoidance technologies can also mitigate the occurrence of certain crash types in particular locations targeted by the *Toward Zero* strategy. Features that maintain vehicle lane position (e.g., LDW, LKA, BSM) and safe headway distance (e.g., FCW, AEB, ACC) can help reduce the incidence of 'priority crash types' such as single vehicle run-off-road and head-on crashes in regional and remote areas, and rear-end crashes at metropolitan intersections (Palamara 2018).

This review will focus firstly on describing the primary types of Advanced Driver Assist (ADA) technologies available in the current market and discuss their potential to reduce crashes. This will be followed with a discussion of drivers' acceptance and use of ADA technologies. The final sections of the review will focus on the perceptions of and attitudes toward ADA technologies as well as the potential barriers that can impact the use of these technologies by drivers.

3.1 Advanced Driver Assist (ADA) Pre-Crash Technologies

Sections 3.1.1 and 3.1.2 of this review are based on the previous RSC project, *Promoting Safe Vehicles to Vulnerable Drivers,* by Palamara (2018) and have been edited and updated for this report. This section will describe the function of each of the key ADA Technologies included in the study (e.g., FCW, AEB, ACC, LDW, LKA, BSM, and AA) and summarise their (potential) impact on crash risk.

3.1.1 Forward Collision Avoidance Systems

Technologies to mitigate forward collisions (e.g., front to rear end vehicle crashes; crashes with pedestrians) are increasing in their sophistication and availability. The earliest systems provided an alert or warning only to drivers to adjust their speed if their vehicle was judged to be too close to a vehicle in front (Eichelberger et al. 2016). Contemporary, advanced forward collision avoidance systems will not only warn the driver but will also apply the vehicle's brakes and reduce speed – autonomously – should the driver not take action (Mosquet et al. 2015). Forward Collision Warning (FCW), Autonomous Emergency Braking (AEB) and Adaptive Cruise Control (ACC) are three examples of ADA technologies to mitigate forward collisions. Each of these technologies is summarised below (Palamara 2018).

Forward Collision Warning

Using a camera or radar, FCW systems are fitted to detect other vehicles or objects in front of the car that are stationary or moving at a slower speed. They issues a warning to the driver if their closing speed suggests risk of impending collision. As such, FCW systems are designed to prevent or reduce the severity of front-end crashes (Khan et al. 2019). Certain FCW systems are packaged with AEB technology (discussed in Section 0) that automatically applies the brakes should the driver not react in time to the initial warning (Khan et al. 2019).

Studies in the United States (US) have provided evidence supporting the benefits of FCW systems in preventing and reducing the severity of rear-end collisions. As early as 2011, the Highway Loss Data Institute (HLDI) reported significant reductions in insurance claim rates for early implementations of FCW both with and without automatic emergency braking. The HLDI has continued to find consistently lower rates of insurance claims for vehicles with forward collision avoidance systems across car manufacturers, including Mazda, Honda, Mecedes-Benz and Subaru, compared with cars that are not equipped with the systems (Highway Loss Data Institute 2012; Highway Loss Data Institute 2015; Highway Loss Data Institute 2016a; Highway Loss Data Institute 2016b; Highway Loss Data Institute 2016c; Reagan et al. 2018)

A recent investigation by Cicchino (2018c) also found that cars equipped with Front Automatic Braking and Forward Collision Alert from General Motors were involved in 43% fewer rear-end crashes of all severities, 64% fewer rear-end crashes with any injuries, and 68% fewer rear-end crashes with third-party injuries compared with the same vehicles without a forward collision avoidance system. Moreover, rear-end crash involvement rates were 17%, 30%, and 32% lower, respectively, among cars with only FCW compared with cars without any ADA system (Cicchino 2017).

In another study, Yue et al. (2018) estimated the crash avoidance effectiveness of various ADA technologies including the effectiveness of FCW technology under foggy conditions. The analysis found that FCW could reduce up to 35% of near-crash events in foggy conditions with 100% market penetration, while a combination of FCW and AEB could reduce up to 50% of light vehicle rear-end crashes (Yue et al. 2018).

In addition to studying crash reductions associated with FCW, researchers have also investigated the costs and benefits of certain ADA technologies. In the US, Khan et al. (2019)

estimated the societal and private benefits and costs associated with equipping all passenger vehicles with BSM, LDW and FCW. The estimates were based on based on insurance claim data from the Highway Loss Data Institute, relevant crash data from the Fatality Accident Reporting System (FARS) and General Estimate System (GES) datasets for the year 2015, and economic data from a National Highway Traffic Safety Administration report. Approximately 25% of crashes occurring in the US in 2015 were relevant to either BSM (i.e., lane change crashes), LDW (i.e., lane departure crashes) or FCW (one and two-vehicle front-end crashes). Notably, they estimated that 1.6 million police-reported crashes, including 7,200 fatal crashes, would be prevented or of lower severity each year with fleet-wide deployment of these ADA technologies. More specifically, FCW systems could impact the largest number of crashes overall, whereas LDW systems could affect the greatest number of fatal crashes. Khan et al. (2019) estimated that there would be a $20.6 billion annual net-societal benefit with 100% deployment of all three technologies across the passenger vehicle fleet, which translates to an approximate net benefit of $360 per passenger vehicle.

Autonomous Emergency Braking

AEB emerged internationally around 2006 (Mosquet et al. 2015). In Australia, it is estimated that up to 30% of all new passenger vehicles and 20% of Sports Utility Vehicles (SUV) delivered to the Australian market have AEB functionality (National Road Safety Partnership Program 2017). Based on the 30-year estimate by Gargett et al. (2011) for the spread of safety technologies into 90% of the Australia passenger and light commercial vehicle fleet, AEB may not reach that level until closer to 2040. However, this time frame could be reduced as ANCAP indicated that from 2018 a 5-Star safe vehicle rating would only be awarded to those passenger cars fitted with AEB (McCowen 2017).

Contemporary, advanced AEB uses sensing systems (e.g., radar, laser or cameras) to detect objects, pedestrians, or other vehicles that, taking into account vehicle speed, could potentially result in a collision. If a collision is imminent, the system will 'autonomously' brake to reduce the vehicle's speed (Dávideková et al. 2017). There are at least three variants of AEB systems. Low speed systems relate to city area driving to prevent low speed impact collisions (e.g., up to 30-40km/hour) (www.howsafeisyourcar.com.au/Safety-Features/Safety-Features-List/Low-Speed-Auto-Emergency-Braking/; Fildes et al., 2015), whereas high speed systems use long range radar (up to 200 metres) to prevent crashes at much higher speeds (www.howsafeisyourcar.com.au/Safety-Features/Safety-Features-List/Higher-Speed-Auto-

Emergency-Braking/). In addition, some manufacturers offer AEB systems that use a combination of radar and camera technologies to detect pedestrians to avoid collisions with these unprotected road users (www.howsafeisyourcar.com.au/Safety-Features/Safety-Features-List/Pedestrian-Auto-Emergency-Braking/).

Studies of the effectiveness of AEB vary in terms of the features evaluated (e.g., AEB with and without forward collision warning), the methodologies used (e.g., simulation studies, evaluation of real-world crashes), and the outcomes (e.g., rear-end crashes, collisions with pedestrians). Overall, there is consistent evidence of the effectiveness of AEB systems to reduce rear-end and pedestrian crashes and associated injury outcomes.

The review by Fildes et al. (2015) of 11 published studies using a mix of simulation and real-world crash methodologies noted that AEB was associated with reductions in rear-end crashes of 25% to 40% and reductions in pedestrian crashes of 4.3% to 44%. Less than half of the studies reviewed provided evidence of the associated reductions in injuries. Of those that did, the reduction in fatalities varied between 2.2% and 50% for rear-end crash fatalities and 15% for pedestrian crash fatalities.

Further evidence of the effectiveness of AEB on crash outcomes has been obtained through the application of 'induced exposure' methods (to adjust for the lack of true exposure information on the use of AEB) to administrative crash data (Fildes et al. 2015;Rizzi et al. 2014). Rizzi et al (2014) analysed 3,922 injury crashes occurring in Sweden, 2010-2014, and found that low-speed AEB systems were associated with a 35% to 41% reduction in striking rear-end crashes, irrespective of the posted speed limit. The effect was even higher for striking rear-end crashes occurring in 50km/hour zones: 54%-57%. Using the same induced exposure methods, Fildes et al. (2015) undertook a meta-analysis of the unpublished effects of low speed AEB across 3,326 all-injury rear-end crashes reported by six (unnamed) predominantly European countries. They reported a *"…38% [95% CI 18%-53%] overall reduction in real-world, rear-end crashes for vehicles fitted with low speed AEB compared to a comparison sample of equivalent vehicles* [without AEB]" (Fildes et al. 2015).

A more recent study was undertaken by Cicchino (2017) of 197,606 police-reported crashes occurring during the period 2010 to 2014 in the US. The study analysed the crashes of seven different vehicle makes without AEB or fitted with Collision Warning (CW) only, AEB only, or both Collision Warning and AEB (CW+AEB). The results indicated differing levels of impact on crash and injury outcomes by AEB/CW type. After adjusting for exposure based on days of insurance, the study reported rear-end striking crash reductions of 27% (CW), 43% (AEB) and 50% (CW+AEB). Similar reductions were noted for rear-end striking crashes that resulted in injury: 20% (CW), 45% (AEB) and 56% (CW+AEB). These findings suggest that the most effective forward collision avoidance system is a combination of FCW and AEB.

Adaptive Cruise Control

Cruise Control was introduced as early as 1958 (Mosquet et al. 2015) and was originally intended as a 'comfort aid' for drivers to maintain a set speed over long distances (Reyes et al. 2017). Drivers were required to 'set' the speed and to take control over the vehicle (via braking or deactivating the system) if the headway to the vehicle in front was subsequently reduced and threatened to cause a rear-end collision.

Advanced versions of Cruise Control are known as Adaptive Cruise Control (ACC) because the system is designed to adapt the vehicle's speed to maintain a constant, safe headway behind the lead vehicle when in cruise control mode (Dickie et al. 2009). This system relegates the driver to a supervisory role, leaving the adjustment of the vehicle's speed and the maintenance of a safe headway distance under the control of the ACC. Adaptive Cruise Control differs to AEB in that it will not perform emergency braking but may provide moderate braking to maintain a safe headway time (Mehler et al. 2014). Earliest versions of ACC systems were introduced in the late 1990's among luxury vehicles and have been increasingly from the mid-2000's (Reyes et al. 2017).

Like AEB, ACC has the potential to reduce the risk and incidence of rear-end crashes – the most predominant of all crash types (Xiao et al. 2010). Based on the type of crashes ACC has the capacity to prevent, Paine and colleagues (2008) suggested that ACC could be associated with 1.5% reduction in road trauma in Australia. This review could not, however, locate evidence using real-world crash data of the effectiveness of ACC to reduce the incidence of forward collisions and associated injury. At best, field testing has shown that drivers who use ACC maintain longer headway distances to the vehicle ahead and reduce the amount of travel time than drivers maintaining headways of less than 0.5 seconds to the vehicle in front (Kessler et al. 2012). Longer headways are likely to be protective against involvement in a forward collision as the driver will have more time and distance to respond to changes in the speed of the lead vehicle or other potential hazards ahead (Victor et al. 2015).

3.1.2 Lateral Collision Avoidance Systems

Lateral Collision Avoidance systems (also referred to as lane maintenance systems or lane departure prevention systems) function to reduce the occurrence of crashes due to *unintended* lane departures and *unsafe intended* lane departures (Jenkins et al. 2007). Their effectiveness, however, is dependent on drivers keeping these systems active and not deactivating them due to reported false positive warnings (Reagan et al. 2018). Three ADA systems relevant to the prevention of lane departure and side-swipe collisions include Lane Departure Warning (LDW), Lane Keeping Assist (LKA; Jansch, 2017) and Blind Spot Monitoring (BSM; Cicchino, 2018a).

Lane Departure Warning and Lane Keeping Assist

Lane Departure Warning systems alert the driver, through either audio or tactile (e.g., steering wheel vibration) signals that they are unintentionally[2] departing or drifting out of their lane (Mehler et al. 2014). Once alerted, the driver should take corrective action to maintain their lane position. In some vehicles, this technology is packaged with LKA systems (Jansch 2017). The packaged system not only alerts the driver to a lane departure but will, in the absence of a driver response, automatically take corrective action to re-centre the vehicle in the lane (Mehler et al. 2014). The packaged technology has the potential to reduce the incidence of lane departure crashes among drivers who are distracted, inattentive or impaired due to fatigue or sleepiness (Jansch 2017). At present, the successful operation of both systems is reliant on the accurate detection of road lane markings, which may not always be present across rural and remote area roads where fatigue-related crashes commonly occur (Palamara et al. 2016).

Few published studies have evaluated the effectiveness of LDW and/or LKA on real-world crashes, due in part to the limited installation of the technologies as well as the comparatively short implementation period thus far (Sternlund et al. 2017). In respect to LDW, early research by the US Highway Loss Data Institute using insurance crash data failed to provide consistent evidence to suggest these systems were associated with a significant reduction in relevant crash types (Reagan et al. 2018). However, a more recent US investigation by Cicchino (2018b) of relevant police-reported crash types occurring 2009-2015 found that LDW had significantly reduced the crash types it has been designed to prevent, such as single-vehicle, sideswipe, and

[2] Meaning that the driver has not activated their indicator to signify an intended change of lane.

head-on crashes. Crash rates were significantly lower for vehicles equipped with LDW, with an 18% reduction in crashes of all severities, 24% reduction in injury crashes, and an 86% reduction in fatal crashes; however, this did not control for driver demographics. After adjusting for relevant driver demographics, LDW significantly reduced lane departure crashes of all severities by 11% and injury crashes by 21% (Cicchino 2018b).

Furthermore, Sternlund et al. (2017) evaluated the effectiveness of LDW and LKA systems in reducing real-world injury crashes among Volvo passenger cars in Sweden. Data on police-reported crashes that occurred in Sweden between January 2007 and September 2015 which involved injured drivers in Volvo passenger cars manufactured between 2007 and 2015 were extracted from the Swedish Traffic Accident Data Acquisition database. Using an induced exposure method, the analysis found that the presence of LDW/LKA was significantly associated with a reduction in the crash types the systems have been designed to prevent: there was an estimated 53% reduction in head-on and single-vehicle injury crashes on Swedish roads with higher speed limits (70-120 km/h) and visible road markings (i.e., not covered by snow or ice). When including all speed limits and road conditions, the overall effectiveness of LDW/LKA in reducing head-on and single-vehicle crashes was estimated to be 30% (Sternlund et al. 2017).

Other studies have reported that drivers of vehicles fitted with LDW improved their lane-keeping by 34%, while unintentional lane departures were reduced by 50% (Mehler et al. 2014).

Blind Spot Monitoring

Through a series of cameras or sensors fitted to the side mirrors, BSM systems detect and visually alert the driver to an adjacent lane vehicle in their ‘blind spot’, that is, a vehicle that is outside the usual range of visibility provided by a standard side mirror (Cicchino 2018a;Keegan 2018). BSM is also referred to as blind spot warning, blind spot detection, side blind zone alert, lane-change alert, or side-view assist, depending on the manufacturer (Cicchino 2018a). The alert typically presents as a solid activated light on the relevant side mirror and is sometimes accompanied by an audible tone (Cicchino 2018a). Once alerted, the driver is expected to maintain their current lane position and not depart until the alert is deactivated (i.e., the adjacent lane vehicle has passed or the driver travels clear of the vehicle in the adjacent lane). Recently, some vehicle manufacturers, such as Volvo, offer ‘active’ BSM systems where the system actively steers the car back into the original lane if another vehicle is detected in the blind spot zone. On some vehicles, BSM is bundled with LDW and LKA systems (Keegan, 2018), thus making it difficult to evaluate the independent effect of BSM.

There is emerging evidence to show BSM technologies are effective in reducing the incidence of lane departure/lane change crashes in line with consumer reports of their effectiveness. Cicchino's (2018a) investigation of crashes occurring in the US between 2009 and 2015 found that lane-change-related crashes of all severities were 14% lower and injury crashes were 23% lower among vehicles fitted with BSM compared to those without BSM (after adjusting for other crash avoidance features). Cicchino (2018a) estimated that 50,000 crashes and 16,000 injuries could have been prevented if BSM had been fitted to all vehicles and performed at the optimal level in the US in 2015.

A recent study in Sweden evaluated insurance claims data for lane change crashes during the period 1 January 2013 and 31 December 2016 involving Volvo passenger cars (models: V70, XC70, V60 and XC60) with a manufacture year (MY) 2010 to 2015. Isaksson-Hellman et al. (2018) reported that there was no significant reduction in the total number of crashes when evaluating all types of lane change crashes and severity levels for Volvos equipped with BSM (i.e., Blind Spot Information System technology). However, when analysing only crashes that were more severe (i.e., repair cost greater than US$1,250), there was a significant 31% reduction in lane change crashes for cars equipped with BSM compared with cars without BSM. Furthermore, cars with BSM technology had an average of 30% lower claim costs for reported lane change crashes, indicating a reduction in crash severity. The authors concluded that although lane change crashes may not be avoided, BSM systems can help to mitigate or reduce the severity of these types of crashes (Isaksson-Hellman et al. 2018).

3.1.3 Driver Attention Assist Systems

Driver Attention Assist (AA) systems, also known as Driver Attention Warning (Hyundai), Driver Attention Alert (Mazda, Nissan), Fatigue Detection System (Volkswagen) and Driver Monitoring System (Subaru), are designed to monitor the driver for alertness and/or drowsiness. Depending on vehicle manufacturer, these in-vehicle systems vary in regard to their monitoring and surveillance methods, ranging from physiological measures (e.g., ocular and facial features or head position, such as dipping or nodding) to driving performance-related measures (e.g., steering wheel grip, speed, lane position variability, lane departures) (Lupova

2017). Although these driver alert systems can be closely related to LDW systems – due to visual monitoring of lane markings to detect any vehicle deviations – the systems differ in that LDW aims to prevent *any* lane deviation whereas AA systems are primarily concerned with detecting signs of driver fatigue (Laukkonen 2016). Therefore, the systems look for 'erratic movements' characteristic of an impaired driver, while some systems monitor the driver's eyes and face for indications of drowsiness, such as drooping eyelids or slackened facial muscles. If signs of drowsiness or fatigue are detected, then the system takes corrective action, which varies by manufacturer and is often a multi-tiered response. In general, the system will start by sounding an alarm or buzzer and illuminating a light on the dashboard; if the driver fails to react and adjust their driving, then the system may initiate an even louder alarm requiring the driver to interact with the system in order to switch it off. In some cases, there is a further tier should the driver not respond which necessitates the driver pull the vehicle over to the side of the road and either open the driver's door or switch off the engine before the AA system's alarm is cancelled (Laukkonen 2016).

In WA, 15 fatalities in 2018 were fatigue-related, with 70% of serious crashes being caused by symptoms of fatigue (Road Safety Commission 2019). Thus, there is the possibility for driver AA systems to be a significant crash avoidance technology, with there being potential for the systems to reduce the incidence of single-vehicle, loss of control, roll over, or head-on crashes resulting from fatigue (Vehicle Safety Research Group n.d.). However, no research could be located evaluating the effectiveness of AA in reducing real-world crashes and injuries, which could be attributed to the limited installation of the technologies as well as the comparatively short implementation period thus far.

3.2 Acceptance and Use of ADA Technologies

A minimum requirement for effective ADA technologies is that they be turned on; thus, their effectiveness depends in part upon their activation status (Reagan et al. 2018). The acceptance and levels of use of ADA systems vary between and within technologies. Previous studies have collected objective evidence of drivers' use of lane departure warning and forward collision warning systems. In the US, Reagan et al. (2018) recently observed the activation (on-off) status of lane maintenance systems and other ADA technologies fitted in Cadillac, Chevrolet, Ford, Honda, Lexus, Lincoln, Mazda, Toyota and Volvo passenger cars that were being serviced at 14 dealerships across metropolitan Washington, DC. A total of 983 vehicles were included in the analysis of lane maintenance systems. Across all car manufactures, an average of 51% (range: 21-77%) of vehicles had their lane maintenance systems turned on at the point of service. However, there was significant variation in on-off status of lane maintenance systems between manufactures, with Cadillac, Chevrolet, Honda, Lexus/Toyota, Mazda, and Volvo vehicles being 2-4 times more likely to have their system turned on compared with Ford vehicles. Vehicles fitted with LKA (i.e., systems that provide braking or steering at the point of lane drift) were 35% more likely to have the system turned on compared to vehicles fitted with LDW. Furthermore, the activation rate was higher for systems with braking or steering interventions and vibrating warnings, and decreased with total mileage (Reagan et al. 2018).

There were 659 vehicles included in their analysis of observed on-off rates of front crash prevention systems, of which 93% (range: 87-98%) had their systems switched on. Although the proportion of vehicles with the front crash prevention system switched on varied by manufacturers, it did not drop below 87%. Ninety-nine percent of 663 Cadillac, Chevrolet, Honda, Lexus/Toyota, and Mazda vehicles with BSM were observed to have the system turned on. Additionally, an average of 90% of the vehicles fitted with driver monitoring alert systems had the systems turned on, which ranged from 83% for Ford systems, 94% for Lexus/Toyota systems to 98% for Volvo systems (Reagan et al. 2018).

Similarly, Reagan et al. (2016) previously conducted a pilot study assessing the activation status of LDW and FCW systems on Honda vehicles being serviced at dealership service centres in Germantown, Maryland and Alexandria, Virginia. Of the 265 vehicles observed to have the two systems, only one-third of vehicles had the LDW system turned on (n=87; 32.8%), while 99.5% (n=264) of vehicles had FCW turned on (Reagan et al. 2016).

In another study, Flannagan et al. (2016) employed a telematics-based data collection technique to collect on-road data on 1,958 General Motors (GM) vehicles fitted with LDW and FCW that were driven approximately 19 million miles over the course of one year. The results showed that LDW was turned on during approximately 50% of driving time, whereas FCW was turned on 91% of the time. The systems that alerted the driver by vibrating the driver seat were more likely to be turned on compared to systems that alerted the driver via a series of beeps (Flannagan et al. 2016).

Previous studies have also found that a lower percentage of car owners self-report driving with LDW turned on all the time compared to FCW, while a higher percentage of drivers indicated that LDW alerts are more annoying than FCW alerts (Braitman et al. 2010; Cicchino et al. 2015; Eichelberger et al. 2016). Evidence coming from self-reported use of BSM also indicates that drivers overwhelmingly keep the systems turned on (Braitman et al. 2010; Cicchino et al. 2015). For instance, 95% of Dodge and Jeep vehicle owners surveyed in the US self-reported always driving with the BSM system active (Cicchino et al. 2015).

Thus there is consistent evidence in the published literature demonstrating higher activation rates for FCW systems compared to LDW systems across a range of vehicle manufacturers, using various data collection methods as well as strong evidence for high rates of use of BSM.

3.3 Perceptions of and Attitudes toward ADA Technologies

Activation status and user acceptance of ADA systems are influenced by a number of factors, including trust in the technology, perceived usefulness, perceived ease of use and attitudes toward using the system (Ghazizadeh et al. 2012). Literature relating to driver's perceptions of and attitudes toward ADA technologies is discussed below.

In addition to observing activation status of lane maintenance and front crash prevention systems, Reagan et al. (2018) also identified factors associated with increased use and acceptance of these technologies among drivers. More specifically, they developed and used manufacturer-specific questionnaires to measure self-reported frequency of use, acceptance, annoyance, and perceived usefulness of the respective systems. A total of 162 drivers of Honda (n=111) and GM (n=54) vehicles completed the survey. Of the 123 drivers who experienced lane departure warnings, 21% of drivers thought lane departure warnings were distracting and 34% thought their system gave them many unnecessary warnings. Of the 109 drivers who experienced lane departure beeps, 28% thought they were annoying, while only 6% believed the beeps were not useful. More specifically, a greater percentage of drivers whose lane maintenance systems were turned off agreed that the warning beeps were annoying, compared with drivers whose systems were turned on (42% vs. 13%, respectively). Conversely, among the 50 drivers who experienced lane departure vibrations, only 6% thought it was annoying and 19% believed it was not useful. A total of 81% of drivers who were aware they had a lane maintenance system wanted LDW on their next car (Reagan et al. 2018).

Regarding front crash prevention systems, one in ten Honda drivers who were aware their vehicle had FCW agreed that the system's warning beep was annoying (12%) or not useful

(10%), while only a small percentage of GM drivers who experienced the system's beep thought it was annoying (2%) or not useful (2%). Eighty-six percent of drivers indicated that they want FCW on their next car (Reagan et al. 2018).

Another important determinant of the acceptance and use or non-use of an ADA technology is trust (Ghazizadeh et al. 2012). Recently, Kidd et al. (2017) examined driver trust in five ADA technologies, including FCW, ACC, BSM, LDW, and LKA following real-world use of production vehicles containing these systems. They reported that drivers did not exhibit strong trust in any ADA technology overall. Drivers' trust also varied by ADA system type and implementation following use in real-world driving conditions. Blind Spot Monitoring was trusted the most by drivers, whereas LKA was trusted the least. Regarding system implementations, participants trusted Honda's ACC less than Infiniti's ACC, while drivers trusted Infiniti's BSM less than Honda's and Audi's systems. More specifically, over 80% of complaints about Honda's ACC mentioned the functionality and/or performance of the system; for example, participants indicated that Honda's ACC made late and harsh changes to vehicle speed, while such comments were not made regarding other vehicles' ACC systems. Drivers also reported that they received far more warnings from Honda's FCW system compared to the other vehicles' systems and stated that they disliked the fact that Honda's system issued warnings too early. In contrast, the majority of participants who drove the Honda and Audi did not complain about BSM, while a common complaint about Infiniti's BSM was that it gave false alerts when passing guardrails, roadside terrain and static roadside objects such as mailboxes and poles. Regarding LKA, participants complained about inconsistent recognition and tracking of lane markings and that steering inputs from the system were inappropriate or discomforting (Kidd et al. 2017).

Notably, drivers tend to report high satisfaction with BSM systems and report higher trust in them than in other types of collision avoidance and driver assistance systems (Kidd et al. 2017). Moreover, a US consumer survey of 57,000 drivers of vehicles fitted with BSM reported that up to 83% of drivers were in favour of and satisfied with the technology, but this can vary with the brand of the vehicle (Monticello 2017). In addition, up to 35% of drivers claimed that BSM helped them avoid a crash, while only 1% of drivers reported finding the system annoying (Monticello 2017). Driver dissatisfaction was most commonly reported when the BSM system gave 'false warning' of a vehicle in the adjacent lane (Monticello, 2017). Likewise, Reagan et al. (2018) reported that drivers who had turned the system off were more likely to complain that lane maintenance systems like BSM were distracting and annoying than drivers who kept the system active.

With respect to ACC specifically, de Winter et al. (2017) conducted a questionnaire-based study in The Netherlands to establish the determinants of drivers' pleasure in using ACC. A total of 182 drivers who owned a car fitted with ACC were surveyed. Overall, the respondents rated their ACC highly. Drivers were most pleased using ACC on roads with high speeds and low traffic density. Regarding safety-related behaviours, respondents somewhat agreed that ACC helped to reduce speeding, prevented head-tail collisions, and helped prevent unsafe situations, compared to driving without ACC. Furthermore, drivers somewhat disagreed that ACC allowed them to pay less attention in traffic and disagreed that they engaged in more activities while driving if ACC is engaged, compared to if the system was not engaged. Of those who reported ACC as being unpleasant, several drivers responded that the ACC sometimes braked unnecessarily, while some drivers expressed concern about the *"restless"* behaviour of their ACC systems; for example, when driving behind a vehicle that then changed lanes, the system suddenly accelerated and then decelerated when arriving behind a new car in front (de Winter et al. 2017).

Generally speaking, young people are known for their willingness to embrace and trust new technologies but this does not seem to extend to ADA technologies which have a higher level of automation (Weiss et al. 2018). During focus groups in the US, Weiss et al. (2018) observed that teenagers were knowledgeable about ADA technologies but were also sceptical of it. Scepticism was primarily related to their perception that the technologies have the potential to fail, while at the same time, the participants displayed overconfidence in their own 'human' driving ability compared with that of the 'machine'. On the other hand, parents were more willing to embrace the technology because of the perceived potential to improve their child's driving skill and reduce their risk of collision. Both young drivers and parents also considered that novices should learn to drive on non-ADA equipped vehicles so they might initially develop the required vehicle handling skills. Unless they did so, there was concern that young drivers might become complacent and develop a *"…false sense of safety and become distracted…"* (Weiss et al. 2018). Regardless of these concerns, participants thought ADA technologies could benefit novice drivers, elderly drivers, and distracted drivers of all ages (Weiss et al. 2018).

Additionally, young drivers expressed interest in being able to customize ADA systems by changing alert and sensitivity settings to control and modulate the technologies. If the system was too sensitive or too intrusive, they suggested they might turn the system off altogether (Weiss et al. 2018). These focus group study findings, whilst exploratory, provide an important insight of the need to ensure that ADA technologies are promoted to highlight their utility and effectiveness to support young inexperienced drivers to reduce their risk of crash involvement (Palamara 2018).

In summary, it is clear that there are multiple factors influencing drivers' perceptions of and attitudes toward different ADA technologies, which include trust, annoyance, distraction, false and unnecessary warnings, and perceived usefulness and safety benefits of the systems. Moreover, these perceptions and attitudes vary between technologies and manufacturers and, in turn, affect a driver's acceptance and use of a system. Based on the published literature, drivers generally have more favourable attitudes toward and greater levels of trust in BSM and ACC compared to LDW and LKA systems. However, at this stage there is no information pertaining to the use of and attitudes toward ADA technologies among drivers in Western Australia.

4 RESULTS: ADVANCED DRIVER ASSIST VEHICLE OWNER TELEPHONE SURVEY

This section of the report addresses objective one and presents the results for the ADA vehicle owner survey including:

- Describing the characteristics of the participants;
- Describing the vehicles most frequently driven by participants;
- Reporting drivers' knowledge of installation, understanding and use of ADA technologies;
- Describing drivers' attitudes toward each ADA technology, and
- Investigating the association(s) between driver demographics and use of and attitudes toward ADA technologies.

A total of 310 telephone interviews were completed of which 301 were retained for analysis. Data from nine interviews were excluded from analysis due to the participants not having any ADA features fitted on their car despite answering 'yes' to having at least one ADA feature during the initial screening.

4.1 Description of Participating Drivers

Of the 301 drivers, most were located in metropolitan WA (n=257; 85.4%) with only 14.6% (n=44) of the sample located in regional WA. The age and gender distributions of drivers by location (metropolitan vs. regional) and overall are presented in **Error! Reference source not found.**. Approximately 60% (n=180) of participants were males, with the proportion of males not differing significantly by location.

Of the 301 drivers, 44.9% (n=135) were aged 50-59 years and 29.6% (n=89) were aged 40-49 years (**Error! Reference source not found.**). Drivers aged 17-25 years only made up 1% (n=3) of the sample while older drivers aged 70+ years only made up 2.7% (n=8). When the drivers were stratified by location (i.e., metropolitan vs. regional drivers), the age distributions did not significantly differ between the two groups. However, drivers aged 26-39 years made up a larger proportion of the regional driver group compared to the metropolitan driver group (20.5% vs. 10.1%, respectively). In contrast, drivers aged 60-69 years made up a larger proportion of the metropolitan driver group compared to the regional driver group (11.7% vs. 2.3%, respectively).

Table 4.1 Sample demographics by location

	Metropolitan WA		Regional WA		Total	
Factor	n	%	n	%	n	%
Gender						
Female	101	39.3	20	45.5	121	40.2
Male	156	60.7	24	54.5	180	59.8
Age Group						
17-25 years	2	0.8	1	2.3	3	1
26-39 years	26	10.1	9	20.5	35	11.6
40-49 years	78	30.4	11	25	89	29.6
50-59 years	115	44.7	20	45.5	135	44.9
60-69 years	30	11.7	1	2.3	31	10.3
70+	6	2.3	2	4.5	8	2.7
Total	257	85.4	44	14.6	301	100

4.2 Description of the Drivers' Vehicles

4.2.1 Age of the Vehicle Most Frequently Driven

Descriptive statistics for the date of manufacture of the vehicle most frequently driven is presented in Table 4.2. Date of manufacture was self-reported by drivers and used to calculate vehicle age (using January 1, 2019 as the reference date). Of the 301 drivers, 3 (1%) participants did not know the manufacture year (MY) of their car; all 3 participants were from metropolitan WA. The median MY was 2016 across all three groups (i.e., metropolitan WA, regional WA, and overall), with the highest number of cars manufactured in 2017 (n=71; 23.8%) followed by 2018 (n=68; 22.8%; Table 4.2). The oldest vehicle with at least one ADA technology fitted was manufactured in 2004 (an Audi RS6 equipped with ACC and BSM).

The age of the drivers' vehicles is summarised in Figure 4.1. Of the 298 participants who knew the MY, and therefore could have the age of their vehicle calculated, the median age of the nominated vehicle was 3 years (minimum age ≤1 year; maximum age 15 years). The median vehicle age was the same for both metropolitan and regional drivers (median=3 years). Furthermore, the mean vehicle age did not significantly differ between metropolitan and regional drivers (mean=3.1 and 3.0, respectively).

Table 4.2 Manufacture year of vehicle most frequently driven by location

	Metropolitan WA		Regional WA		Total	
Manufacture Year	n	%	n	%	n	%
Up to 2012	12	4.7	1	2.3	13	4.4
2013	9	3.5	3	6.8	12	4
2014	25	9.8	6	13.6	31	10.4
2015	41	16.1	7	15.9	48	16.1
2016	49	19.3	6	13.6	55	18.5
2017	62	24.4	9	20.5	71	23.8
2018	56	22	12	27.3	68	22.8
Total	254	100	44	100	298*	100

*n=3 missing vehicle age

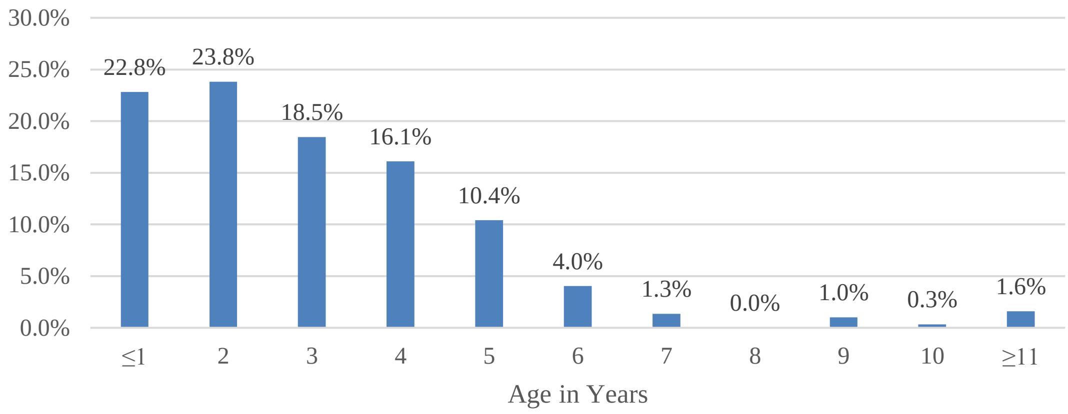


Figure 4.1 Age distribution of vehicles (n=298)

4.2.2 Type of Vehicles Driven

Each participant was asked to name the make, model and variant of the car they drove most often that is fitted with one or more of the ADA technologies. The complete list of cars that were included in the sample is included in APPENDIX 2. Overall, there were 29 vehicle makes represented in the sample, with their frequencies summarised in Table 4.3. The most frequently reported vehicle make was Mercedes-Benz (n=42; 14%), which was closely followed by Toyota (n=41; 13.6%; Table 4.3). Nearly four in ten participants (37%) located in metropolitan WA drove a car manufactured by Mercedes-Benz (n=39; 15.2%), Toyota (n=35; 13.6%) or BMW (n=21; 8.2%). Half the participants located in the regional group drove cars manufactured by either Ford (n=9; 20.5%), Holden (n=7; 15.9%) or Toyota (n=6; 13.6%).

The most frequently reported vehicle (by make and model) with at least one ADA technology in the sample was the Toyota LandCruiser (all variants: n=28; 9.3%), which included 12 (4%) Prado and 7 (2.3%) Sahara variants. This was followed by the Ford Ranger (all variants: n=14; 4.7%), BMW X5 (n=8; 2.7%) and Mazda CX-5 (n=7; 2.3%).

Table 4.3 Car makes included in the sample (n=301)

Manufacturer/Make	Frequency	Percent
Mercedes-Benz	42	14.0%
Toyota	41	13.6%
BMW	22	7.3%
Ford	19	6.3%
Mazda	19	6.3%
Audi	18	6.0%
Holden	17	5.6%
Subaru	17	5.6%
Land Rover / Range Rover	17	5.6%
Lexus	14	4.7%
Volvo	13	4.3%
Volkswagen	10	3.3%
Hyundai	9	3.0%
Jeep	8	2.7%
Kia	6	2.0%
Honda	5	1.7%
Nissan	5	1.7%
Jaguar	3	1.0%
Mitsubishi	3	1.0%
Porsche	3	1.0%
Chevrolet	2	0.7%
Bentley	1	0.3%
Fiat	1	0.3%
Isuzu	1	0.3%
Mini	1	0.3%
Peugeot	1	0.3%
Renault	1	0.3%
Skoda	1	0.3%
Tesla	1	0.3%

4.2.3 Length of Time Driving the Car

The mean length of time that participants had been driving their car was 24.9 months (or 2 years), ranging from a minimum of 1 month through to a maximum of 144 months (or 12 years).

4.2.4 Acquisition of the Vehicle

Nearly three-quarters (n=220; 73.1%) of the drivers stated that they bought the car for themselves to drive (Table 4.4). Sharing ownership and use of the car with another driver was the next most frequent means of acquiring the vehicle (n=52; 17.3%). These two means of acquisition were the most common responses for both metropolitan and regional drivers; however, compared with metropolitan drivers, there were a lower percentage of regional drivers who bought the car for themselves and a higher percentage who indicated they shared ownership and use of the car. No participants responded that the car was 'handed down' to them free of cost (Table 4.4).

Table 4.4 Acquisition of the vehicle

	Metropolitan WA		Regional WA		Total	
Response	n	%	n	%	n	%
I bought the car for myself to drive	194	75.5	26	59.1	220	73.1
I share ownership and use of the car with another driver	40	15.6	12	27.3	52	17.3
Someone else (e.g., family, friend) bought the car for me to drive	6	2.3	1	2.3	7	2.3
Someone else owns the car and I share the use of it with other drivers	3	1.2	2	4.5	5	1.7
It was provided by my employer for me to drive	13	5.1	3	6.8	16	5.3
The car was 'handed down', free of cost, to me to drive	-	-	-	-	-	-
Other	1	0.4	-	-	1	.3
Total	257	100	44	100	301	100

4.2.5 Driver's Ratings of their Vehicle

Each of the drivers were asked to rate the car they drove most often in regard to eight different qualities, ranging from reliability to maintenance costs, which are summarised in Table 4.5. Overall, drivers appeared to rate their car favourably across the different qualities: most drivers rated their car as *"very good"* with respect to ease of driving (86.7%), reliability (86.4%) and overall safety (85.0%). Furthermore, over three-quarters of drivers rated their car as *"very good"* with regard to driving performance (78.4%), features that reduce their chances of having a crash (76.4%) and features that reduce their chances of being injured in the event of a crash (75.4%). The poorest ratings were regarding the maintenance/running costs of the car, with a combined 10 drivers rating the car as *"poor"* or *"very poor"* (n=5; 1.7%, respectively); however, the majority of drivers still rated the maintenance/running costs of the car favourably, with one-third rating the car *"good"* (33.6%) and another third rating the car *"very good"* (35.2%; Table 4.5).

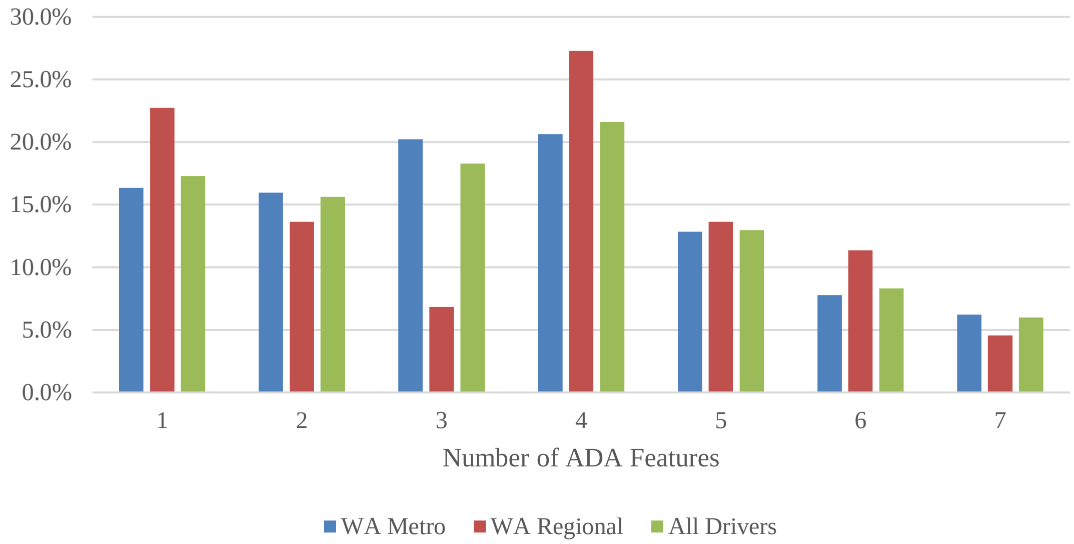
Table 4.5 Summary of drivers' ratings of vehicle qualities (n=301)

	Rating, n (%)					
Quality/Factor	**Very Poor**	**Poor**	**Acceptable**	**Good**	**Very Good**	**Don't Know***
Reliability	2 (0.7%)	1 (0.3%)	2 (0.7%)	33 (11.0%)	260 (86.4%)	3 (1.0%)
Driving performance	0	1 (0.3%)	6 (2.0%)	58 (19.3%)	236 (78.4%)	0
Ease of driving	0	0	4 (1.3%)	36 (12.0%)	261 (86.7%)	0
Overall safety	0	0	3 (1.0%)	41 (13.6%)	256 (85.0%)	1 (0.3%)
Features that reduce chances of having a crash	0	3 (1.0%)	8 (2.7%)	58 (19.3%)	230 (76.4%)	2 (0.7%)
Features that reduce chances of being injured in the event of a crash	0	2 (0.7%)	3 (1.0%)	56 (18.6%)	227 (75.4%)	13 (4.3%)
Ease of learning how to use the car's various safety technologies	1 (0.3%)	4 (1.3%)	30 (10.0%)	128 (42.5%)	137 (45.5%)	1 (0.3%)
Maintenance/ running costs	5 (1.7%)	5 (1.7%)	68 (22.6%)	101 (33.6%)	106 (35.2%)	16 (5.3%)

*Data collection officers did not read out the response option "Don't Know"

4.2.6 Number of ADA Technologies Fitted

Overall, the median number of ADA features fitted to the car was three, which differed by location: cars in the metropolitan group had a median of three ADA technologies compared to a median of four in the regional group. Cars with three ADA features made up 20.2% of the metropolitan sample compared with 6.8% of the regional sample. In contrast, a higher percentage of cars were fitted with four ADA features in the regional sample compared with the metropolitan sample (27.3% vs. 20.6%, respectively; Figure 4.3



). Six percent (n=18) of all vehicles were equipped with all seven technologies while 17.3% (n=52) were only equipped with one ADA technology (Figure 4.2). For the 52 cars with only one ADA technology, the most common feature was ACC (n=18; 34.6%) followed by FCW (n=15; 28.8%) and BSM (n=11; 21.2%).

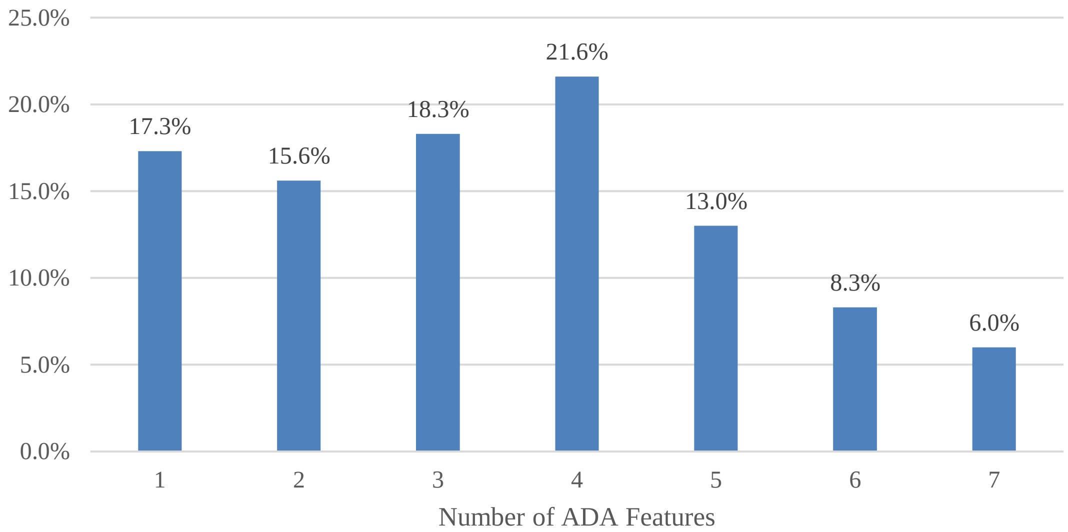


Figure 4.2 Number of Advanced Driver Assist technologies fitted to the car

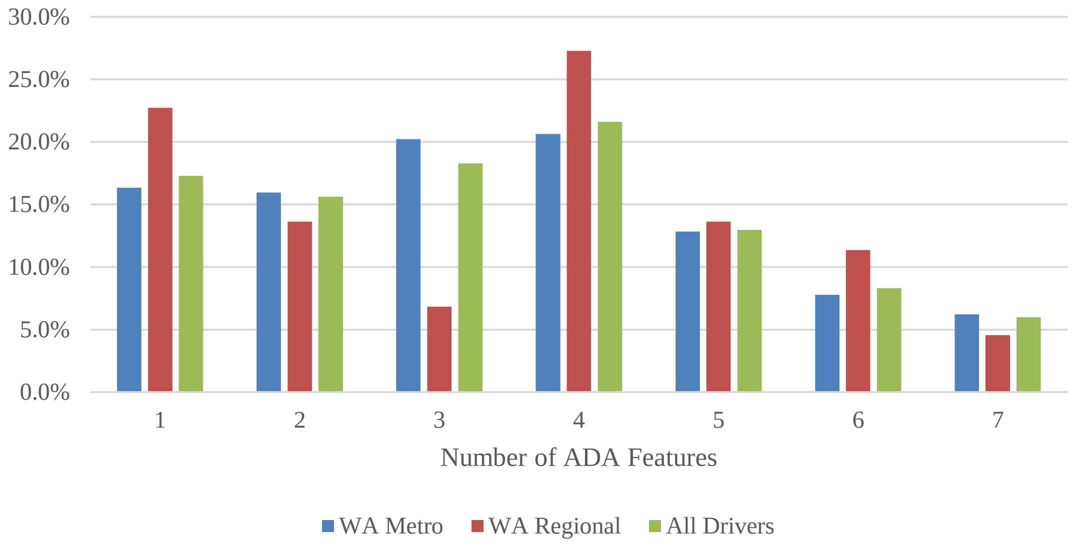


Figure 4.3 Number of Advanced Driver Assist technologies fitted to the car by location

4.3 Driver Knowledge, Understanding and Use of ADA Technologies

4.3.1 Driver Knowledge

Each driver was asked '*To the best of your knowledge is your car fitted with [insert technology]?*' The results for all drivers are presented in Table 4.6 and summarised below.

Table 4.6 Driver knowledge regarding fitment of ADA technologies (n=301)

	Response, n (%)		
Feature	**My car is fitted with this feature**	**My car is not fitted with this feature**	**I am unsure if my car is fitted with this feature**
FCW	221 (73.4%)	62 (20.6%)	18 (6.0%)
AEB	141 (46.8%)	112 (37.2%)	48 (15.9%)
ACC	196 (65.1%)	83 (27.6%)	22 (7.3%)
LDW	174 (57.8%)	108 (35.9%)	19 (6.3%)
LKA	67 (22.3%)	204 (67.8%)	30 (10%)
BSM	183 (60.8%)	96 (31.9%)	22 (7.3%)
AA	60 (19.9%)	202 (67.1%)	39 (13%)

Forward Collision Warning

FCW was the most frequently reported ADA technology fitted to cars, with over seven in ten vehicles equipped with this feature in both the metropolitan and regional groups (73.2% and 75%, respectively; Figure 4.4).

Autonomous Emergency Braking

Slightly less than half of all metropolitan participants were driving cars equipped with AEB (n=125/257; 48.6%), compared with slightly over one-third of regional participants whose cars featured AEB (n=16/44; 36.4%; Figure 4.4).

Adaptive Cruise Control

Nearly two-thirds of all drivers reported having ACC (65.1%), with the percentages being similar between regional and metropolitan drivers (68.2 vs. 64.6%, respectively; see Figure 4.4).

Lane Departure Warning

Close to six in ten of all drivers reported having LDW systems fitted to their car (57.8%). Again, a similar percentage of regional and metropolitan drivers had cars equipped with LDW (61.4% vs. 57.2%, respectively; see Figure 4.4).

Lane Keeping Assist

Lane Keeping Assist was the second least common feature equipped to cars, with less than one-quarter of all vehicles having this system (n=67; 22.3%). A higher percentage of regional drivers reported having LKA compared to metropolitan drivers (31.8% vs. 20.6%, respectively; see Figure 4.4).

Blind Spot Monitoring

Blind Spot Monitoring was reportedly fitted to 60.8% of all cars, with a higher percentage of metropolitan drivers having cars fitted with BSM than regional drivers (64.2% vs. 40.9%, respectively; see Figure 4.4).

Attention Assist

Driver Attention Assist was the least common ADA feature fitted to cars (n=60; 19.9%). A larger percentage of regional drivers reported having AA compared to metropolitan drivers (34.1% vs. 17.5%, respectively; see Figure 4.4).

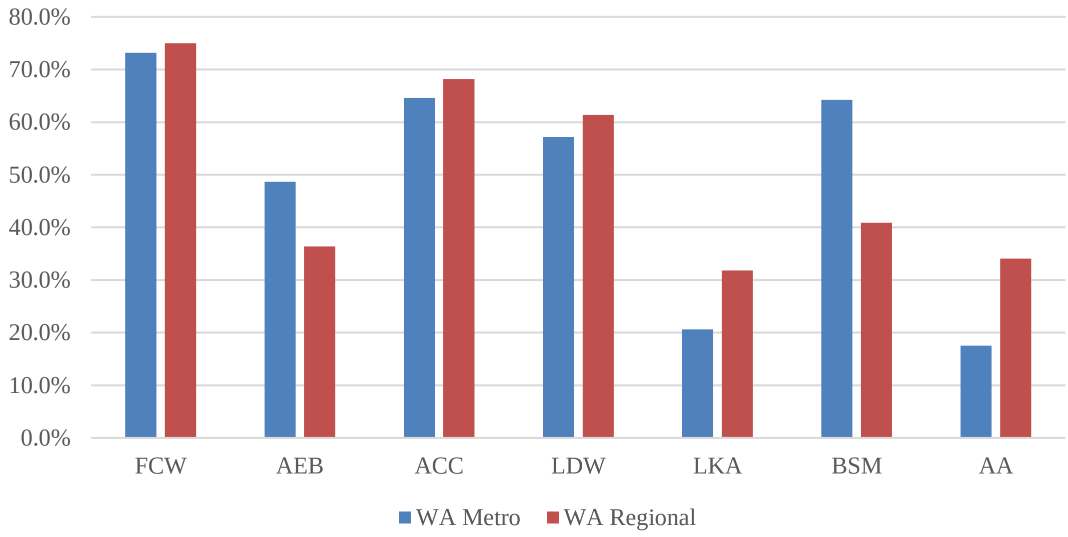


Figure 4.4 Percent of cars fitted with each ADA technology by location

Lack of knowledge regarding fitment of ADA technologies

Depending on the technology, between 6% and 15.9% of all drivers did not know if the car they drove most frequently was fitted with the ADA feature (i.e., responded *'I am unsure if my car is fitted with this feature'*; Table 4.6). Overall, drivers were most unsure of the fitment of AEB (n=48; 15.9%) and AA (n=39; 13%). Forward Collision Warning (n=18; 6%) and LDW (n=19; 6.3%) had the least number of drivers who did not know if the system was fitted. A similar percentage of metropolitan and regional drivers responded that they were unsure of the fitment of each ADA technology (data not shown).

4.3.2 Understanding and Use of each ADA Technology

Drivers who responded with '*My car is fitted with this feature'* were then asked, '*Which one of the following statements best describes your understanding and use of the [insert technology] fitted to your car?*' The responses for each ADA technology are summarised in Tables 4.7 to 4.13.

Most drivers with the ADA technology fitted to their car indicated that they always had the system switched on and unchanged from factory settings: 97.3% for BSM (Table 4.7), 88.7% for AEB (

Table 4.8), 87.3% for FCW (

Table 4.9), 86.7% for AA (

Table 4.10), 77% for LDW (

Table 4.11), and 71.6% for LKA (

Table 4.12).

For the 196 drivers with ACC, 44.9% (n=88) responded that they always drive with the ACC switched on to maintain a safe distance from the car ahead but changed the setting to match the speed limit of the road, while 37.8% (n=74) of drivers were more likely to drive with the ACC switched on when driving outside the metropolitan area or when driving on high speed roads (Table 4.13).

Of the seven ADA technologies, LKA has the highest percentage of drivers who mostly or always drive with the system switched off (13.4%), with an additional 7.5% of drivers responding that they sometimes switch off LKA depending on the road environment (

Table 4.12). Lane Departure Warning had the second highest percentage of drivers who mostly or always drive with the system switched off (10.3%;

Table 4.11).

Across all technologies, only 2.3% or less of drivers did not know if the system in question was switched on or off.

Table 4.7 Understanding and use of BSM (n=183)

	Metropolitan WA		**Regional WA**		**Total**	
Response	n	%	n	%	n	%
I always drive with the BSM switched on, unchanged from the factory setting, to alert me if my cars are in my blind spot	160	97.0	18	100	178	97.3
I always drive with the BSM systems switched on but I change the setting depending on the road environment	1	0.6	0	0.0	1	0.5
I mostly or always drive with the BSM system switched off	4	2.4	0	0.0	4	2.2
Total	165	100	18	100	183	100

Table 4.8 Understanding and use of AEB (n=141)

	Metropolitan WA		**Regional WA**		**Total**	
Response	n	%	n	%	n	%
I do not know if the AEB system in my car is switched on or off	2	1.6	0	0	2	1.4
The AEB system in my car is always switched on, unchanged from factory setting	112	89.6	13	81.3	125	88.7
The AEB system in my car is always switched on but I sometimes change the settings to suit the road environment	5	4.0	3	18.8	8	5.7
I mostly or always drive with AEB systems turned off	5	4.0	0	0	5	3.5
Other	1	0.8	0	0	1	0.7
Total	125	100	16	100	141	100

Table 4.9 Understanding and use of FCW (n=221)

	Metropolitan WA		Regional WA		Total	
Response	n	%	n	%	n	%
I do not know if the FCW system in my car is switched on or off	5	2.7	0	0	5	2.3
The FCW system in my car is always switched on, unchanged from factory setting	166	88.3	27	81.8	193	87.3
The FCW system in my car is always switched on but I sometimes change the settings to suit the road environment	12	6.4	4	12.1	16	7.2
I mostly or always drive with FCW system turned off	4	2.1	2	6.1	6	2.7
Other	1	0.5	0	0	1	0.5
Total	188	100	33	100	221	100

Table 4.10 Understanding and use of AA (n=60)

	Metropolitan WA		Regional WA		Total	
Response	n	%	n	%	n	%
I do not know if the AA system in my car is switched on or off	3	6.7	0	0	5	5.0
I always drive with the AA system switched on, unchanged from the factory setting, to alert me if I become drowsy	40	88.9	12	80	52	86.7
I always drive with the AA system switched on but I change the setting depending on the road environment	0	0.0	1	6.7	1	1.7
Depending on the road environment I sometimes switch off the AA system	1	2.2	0	0.0	1	1.7
I mostly or always drive with the AA systems switched off	1	2.2	2	13.3	3	5.0
Total	45	100	15	100	60	100

Table 4.11 Understanding and use of LDW (n=174)

	Metropolitan WA		Regional WA		Total	
Response	n	%	n	%	n	%
I do not know if the LDW system in my car is switched on or off	4	2.7	0	0	4	2.3
I always drive with the LDW switched on, unchanged from the factory setting, to alert me if my car is wandering out of the lane	118	80.3	16	59.3	134	77.0
I always drive with the LDW systems switched on but I change the setting depending on the road environment	10	6.8	2	7.4	12	6.9
Depending on the road environment I sometimes switch off the LDW system	2	1.4	2	7.4	4	2.3
I mostly or always drive with the LDW systems switched of	11	7.5	7	25.9	18	10.3
Other	2	1.4	0	0.0	2	1.1
Total	147	100	27	100	174	100

Table 4.12 Understanding and use of LKA (n=67)

	Metropolitan WA		**Regional WA**		**Total**	
Response	n	%	n	%	n	%
I do not know if the LKA system in my car is switched on or off	1	1.9	0	0	1	1.5
I always drive with the LKA switched on, unchanged from the factory setting, to alert me if my car is wandering out of the lane	39	73.6	9	64.3	48	71.6
I always drive with the LKA systems switched on but I change the setting depending on the road environment	2	3.8	1	7.1	3	4.5
Depending on the road environment I sometimes switch off the LKA system	4	7.5	1	7.1	5	7.5
I mostly or always drive with the LKA systems switched off	6	11.3	3	21.4	9	13.4
Other	1	1.9	0	0.0	1	1.5
Total	53	100	14	100	67	100

Table 4.13 Understanding and use of ACC (n=196)

Response	Metropolitan WA n	Metropolitan WA %	Regional WA n	Regional WA %	Total n	Total %
I do not know if the ACC system in my car is switched on or off	3	1.8	0	0	3	1.5
I always drive with the ACC switched on to maintain a safe distance from the car ahead but change the setting depending to match the speed limit of the road	74	44.6	14	46.7	88	44.9
I am more likely to drive with the ACC switched on when I am driving outside the metropolitan area or when driving on high speed roads	63	38.0	11	36.7	74	37.8
I am more likely to drive with the ACC switched on when I am driving in the metropolitan area or when driving on lower speed roads	8	4.8	0	0.0	8	4.1
I mostly or always drive with the ACC switched off	15	9.0	4	13.3	19	9.7
Other	3	1.8	1	3.3	4	2.0
Total	166	100	30	100	196	100

4.3.3 Experienced System Alert or Operation

For each ADA technology fitted to the driver’s car, the participant was asked if they had ever experienced the system’s alert (e.g., warning sound or seat vibrations) or the system in operation (e.g., car automatically braking) while driving. The percentage of drivers who have and have not experienced the ADA system’s alert or the system in operation is summarised in Figure 4.5.

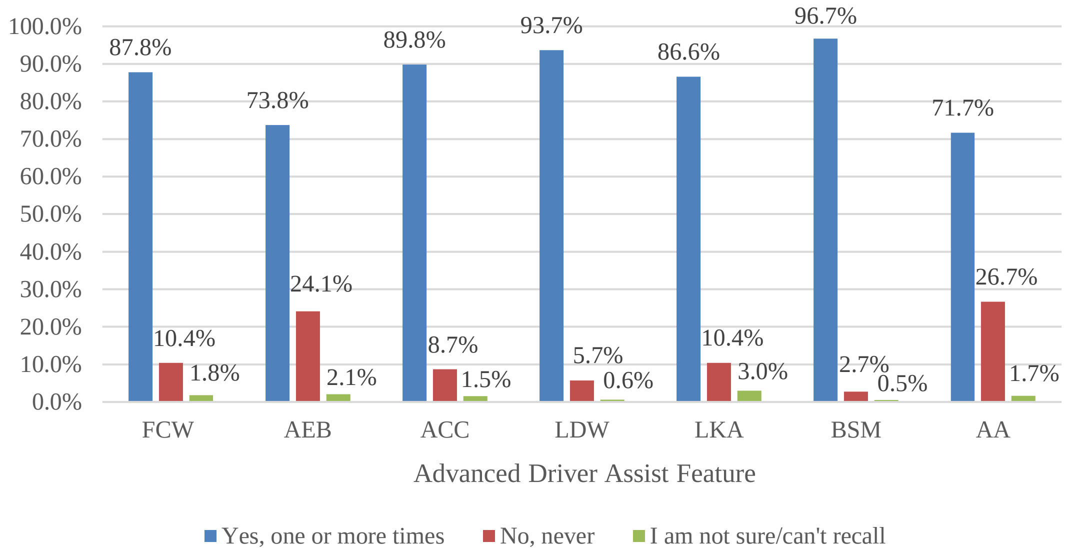


Figure 4.5 Driver has ever experienced the ADA system alert or operation

Forward Collision Warning

Of the 221 drivers who had FCW equipped, 87.8% (n=194) indicated they had experienced the system alert (i.e., alarm or sound) one or more times while driving, with 10.4% (n=23) responding that they had not (Figure 4.5).

Autonomous Emergency Braking

Slightly less than three-quarters of all drivers with AEB fitted to their car had experienced the car automatically brake (n=104/141; 73.8%) while close to one-quarter had not (n=34/141; 24.1%; Figure 4.5).

Adaptive Cruise Control

Of the 196 drivers with ACC, nearly nine in ten (n=176/196; 89.8%) responded they had experienced the system in operation with the speed of the car adjusting automatically to maintain a safe distance from the car in front. Less than one in ten drivers had never experienced ACC in operation (n=17/196; 8.7%; Figure 4.5).

Lane Departure Warning and Lane Keeping Assist

Of the 174 drivers of cars fitted with LDW, 93.7% (n=163) had experienced hearing or feeling an alert that they were wandering out of the lane while driving the car. Furthermore, 86.6% (n=58/67) of drivers with LKA reported experiencing the system in operation; that is, they experienced the car automatically move them back into the lane that they were wandering out of (Figure 4.5).

Blind Spot Monitoring

Compared with other ADA technologies, BSM had the highest percentage of drivers who experienced the system in operation: nearly all of the 183 drivers of cars fitted with BSM had experienced the system alert them to another car in their blind spot while driving (n=177/183; 96.7%; Figure 4.5).

Attention Assist

In contrast, AA had the lowest percentage of drivers who had experienced the system in operation, compared with other ADA technologies. Slightly over seven in ten drivers of cars fitted with AA reported experiencing the system alert them of increased drowsiness levels (n=43/60; 71.7%). Consequently, AA had the highest percentage of drivers respond that they had never experienced the system in operation (n=16/60; 26.7%; Figure 4.5).

4.4 Attitudes toward Each Advanced Driver Assist Technology

Attitudes toward each ADA technology fitted to the car the participant drove most frequently were measured through their agreement/disagreement with a range of statements about the technology. The findings of the analysis of these statements, grouped by technology, are summarised below.

4.4.1 Forward Collision Warning

The results regarding drivers' attitudes toward FCW are shown in Table 4.14. Drivers somewhat disagreed with the statement that FCW is too sensitive and leads to unnecessary alerts of an imminent crash. However, one-quarter of drivers agreed to some extent with this statement, with 19.5% somewhat agreeing and 5.9% strongly agreeing (Figure 4.6).

Table 4.14 Summary of drivers' attitudes toward Forward Collision Warning (n=221)

Statement	Level of Agreement/Disagreement, %				
	Strongly Disagree	Somewhat Disagree	Uncertain/ Don't Know	Somewhat Agree	Strongly Agree
FCW is too sensitive and leads to unnecessary alerts of an imminent crash	34.8%	32.1%	7.7%	19.5%	5.9%
FCW helps me to be a safer driver	5.9%	10.0%	11.8%	43.0%	29.4%
FCW alarms/alerts can be distracting	37.6%	38.0%	6.3%	13.6%	4.5%
I would prefer it if my car's FCW was switched off	52.9%	36.2%	4.1%	4.5%	2.3%
FCW can reduce my chances of having a rear-end crash	10.0%	10.9%	10.4%	29.9%	38.9%
FCW alarms/alerts give me enough time to apply the brakes	1.4%	5.9%	10.0%	42.1%	40.7%
I am not particularly trusting of the effectiveness of FCW	29.9%	42.5%	7.7%	10.9%	9.0%
I think I have become less attentive as a driver because of the fitment of FCW in my car	54.3%	33.5%	3.2%	7.2%	1.8%

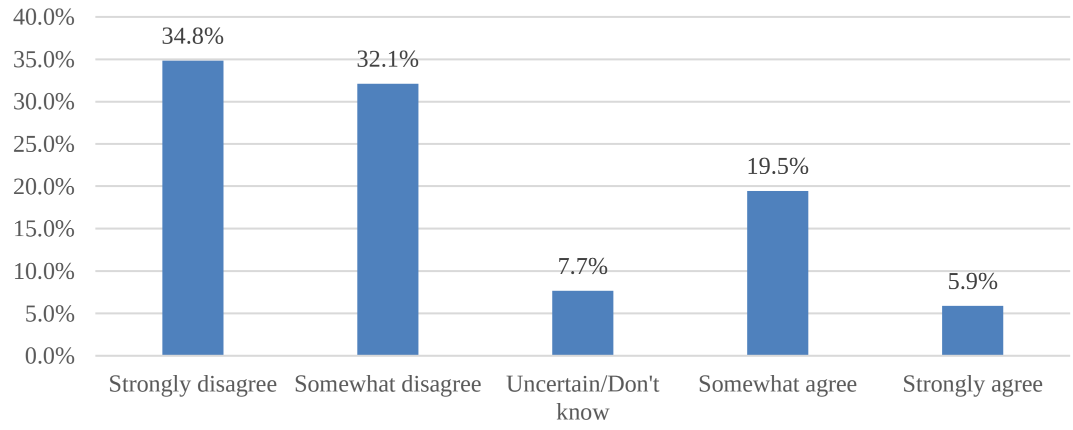


Figure 4.6 FCW is too sensitive and leads to unnecessary alerts of an imminent crash

Drivers strongly agreed that FCW alarms/alerts give them enough time to apply the brakes, while drivers somewhat agreed with the statements that FCW helps them to be a safer driver and that it can reduce their chances of having a rear-end crash. However, one in five drivers disagreed FCW can reduce their chances of having a rear-end crash, with 10.9% (n=24) somewhat disagreeing and 10% (n=22) strongly disagreeing with the statement. At the same time, drivers somewhat disagreed FCW alarms/alerts can be distracting and strongly disagreed with the statement that they would prefer it if their car's FCW system was switched off. There was strong disagreement with the statement, "*I think I have become less attentive as a driver because of the presence of FCW in my car*" (Table 4.14).

Drivers who had FCW fitted to their car were also asked for their level of agreement/disagreement with the statement, "*I am not particularly trusting of the effectiveness of FCW*". Overall, the majority of drivers somewhat disagreed with this statement (Table 4.14). Specifically, 42.5% (n=94/221) of drivers indicated they *"somewhat disagree"* and 29.9% (n=66/221) indicated they *"strongly disagree"* with the statement. However, nearly one in five drivers agreed with the statement, indicating some degree of distrust in the effectiveness of FCW: 10.9% (n=24) answered with *"somewhat agree"* and 9% (n=20) answered with *"strongly agree"* (Figure 4.7).

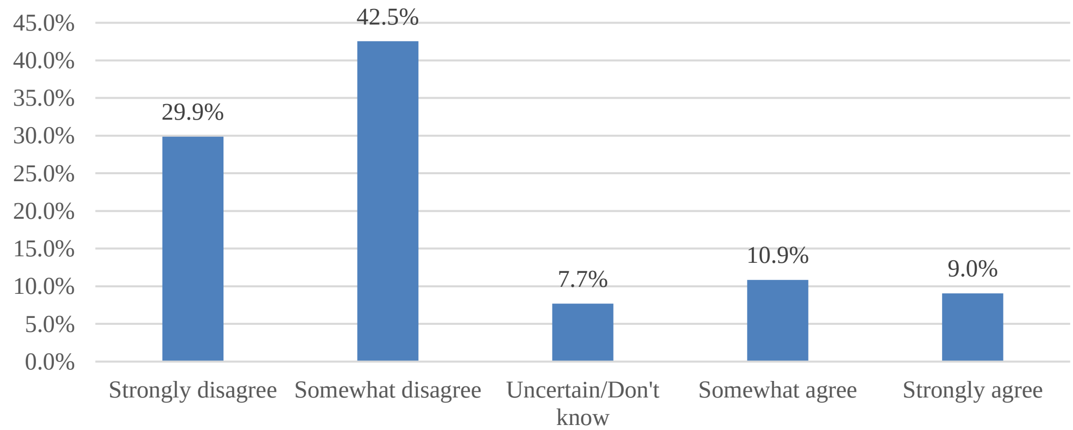


Figure 4.7 I am not particularly trusting of the effectiveness of FCW

4.4.2 Autonomous Emergency Braking

The results regarding drivers' attitudes toward AEB are shown in Table 4.15. In general, drivers somewhat disagreed with the statement that AEB leads to unnecessary, automatic braking. There was strong disagreement from drivers with the statements "*I think I have become less attentive when I drive with AEB switched on and ready to automatically brake*" and "*I would prefer it if my car's AEB was switched off*". Furthermore, drivers strongly disagreed that they feel less in control of the car when AEB is switched on (Table 4.15).

Table 4.15 Summary of drivers' attitudes toward Autonomous Emergency Braking (n=141)

Statement	Level of Agreement/Disagreement, %				
	Strongly Disagree	Somewhat Disagree	Uncertain/ Don't Know	Somewhat Agree	Strongly Agree
AEB leads to unnecessary, automatic braking	39.0%	27.0%	15.6%	9.9%	8.5%
AEB can reduce my chances of having a rear-end crash or colliding with another object	3.5%	6.4%	17.7%	29.8%	42.6%
I have trust in the effectiveness of AEB	2.8%	7.1%	12.1%	38.3%	39.7%
I think I have become less attentive when I drive with AEB switched on and ready to automatically brake	58.2%	30.5%	9.2%	2.1%	0.0%
I would prefer it if my car's AEB was switched off	55.3%	29.1%	10.6%	2.8%	2.1%
I feel less in control of the car when AEB is switched on	51.8%	29.1%	8.5%	9.9%	0.7%
AEB can help me keep a safe distance from the car in front at all times	5.7%	14.2%	12.8%	35.5%	31.9%
I worry that the car behind will run into the back of me if my AEB is suddenly activated	22.0%	35.5%	14.2%	19.9%	8.5%

Drivers strongly agreed that AEB can reduce their chances of having a rear-end crash or colliding with another object, with 42.6% strongly agreeing and a further 29.8% somewhat agreeing with the statement (Figure 4.8).

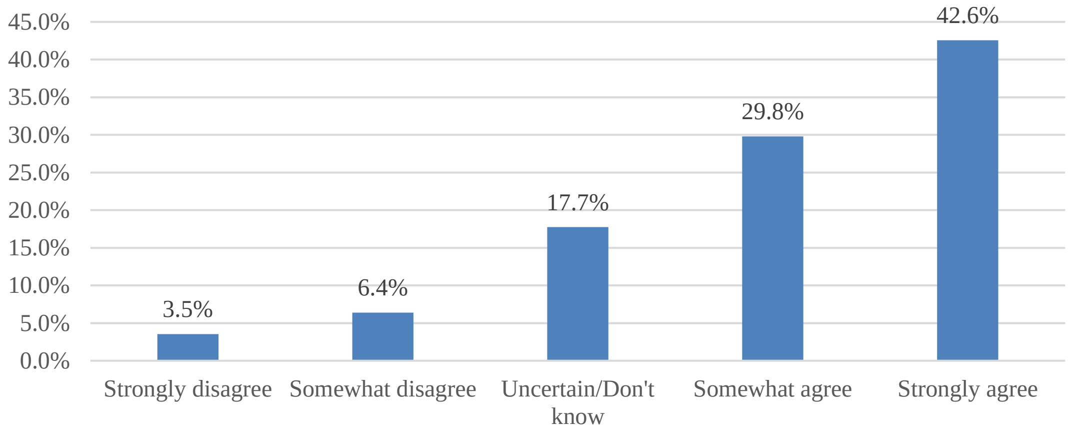


Figure 4.8 AEB can reduce my chances of having a rear-end crash or colliding with another object

Although drivers somewhat disagreed with the statement, "*I worry that the car behind will run into the back of me if my AEB is suddenly activated*" (Table 4.15), over one-quarter indicated some level of agreement: 19.9% of drivers somewhat agreed and 8.5% strongly agreed with the statement (Figure 4.9).

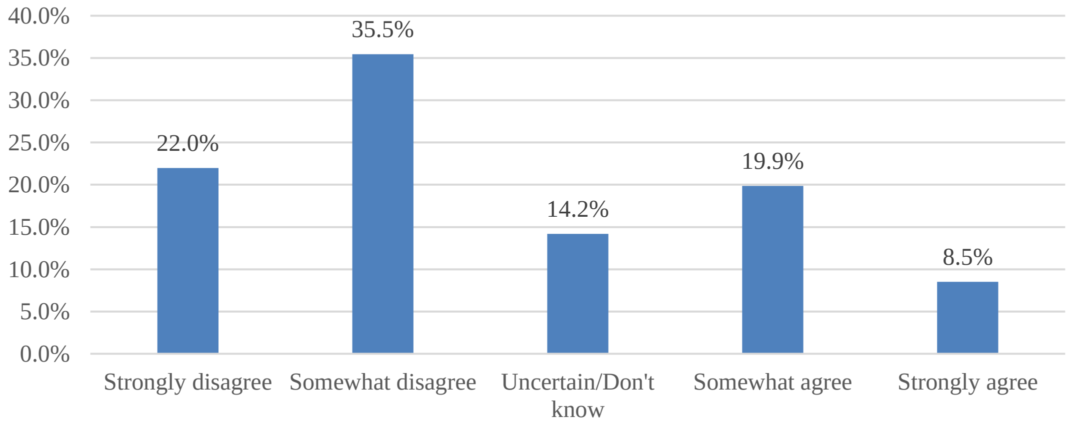


Figure 4.9 I worry that the car behind will run into the back of me if my AEB is suddenly activated

Drivers were asked for their agreement with the statement *"I have trust in the effectiveness of AEB"*. Over three-quarters of drivers with AEB indicated they trust the effectiveness of the system, with nearly an equal percentage of drivers strongly agreeing and somewhat agreeing with the statement (39.7% and 38.3%, respectively). A combined 9.9% of drivers disagreed and had a level of distrust in the effectiveness of AEB (Figure 4.10).

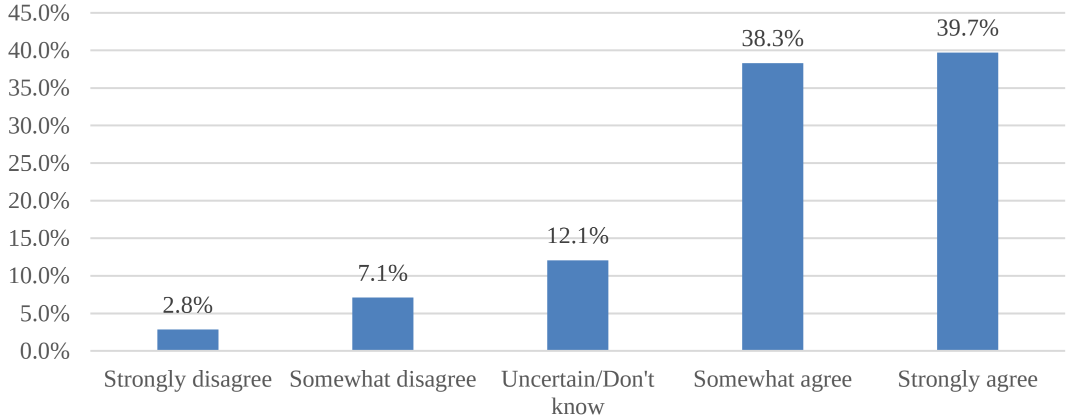


Figure 4.10 I have trust in the effectiveness of AEB

4.4.3 Radar or Adaptive Cruise Control

The results regarding drivers' attitudes toward ACC are shown in Table 4.16. Overall, there was strong agreement from drivers that ACC helps them to keep to the posted speed limit and that it can help them keep a safe distance from the car in front at all times (see Figure 4.11). Drivers strongly disagreed with the statements that ACC is unreliable and does not maintain the speed or distance settings, and that they would prefer it if ACC could be permanently switched off. It appears drivers trust ACC technology, with drivers strongly disagreeing with the statement "*I do not trust the ACC system in my car*". Furthermore, drivers somewhat disagreed with statements that they feel less in control of the car and feel less attentive as a driver when ACC is operational (Table 4.16).

Table 4.16 Summary of drivers' attitudes toward Radar or Adaptive Cruise Control (n=196)

Statement	Level of Agreement/Disagreement, %				
	Strongly Disagree	Somewhat Disagree	Uncertain/ Don’t Know	Somewhat Agree	Strongly Agree
ACC can help me to keep to the posted speed limit	1.5%	2.6%	4.6%	30.1%	61.2%
ACC is unreliable; it does not always maintain the speed or distance settings	56.6%	30.1%	6.1%	4.1%	3.1%
ACC can reduce fuel consumption	6.6%	6.1%	42.3%	29.6%	15.3%
I feel less in control of the car when ACC is in operation	42.9%	34.2%	4.1%	12.8%	6.1%
I would prefer it if my car's ACC could be permanently switched off	56.1%	29.6%	7.7%	3.6%	3.1%
ACC can help me keep a safe distance from the car in front at all times	4.6%	4.6%	3.6%	34.7%	52.6%
I do not trust the ACC system in my car	56.1%	32.1%	5.6%	3.6%	2.6%
ACC can reduce the likelihood of feeling fatigued when driving long distances	14.3%	23.0%	11.7%	28.6%	22.4%
I feel less attentive as a driver when ACC is operational	40.3%	36.2%	5.1%	15.3%	3.1%

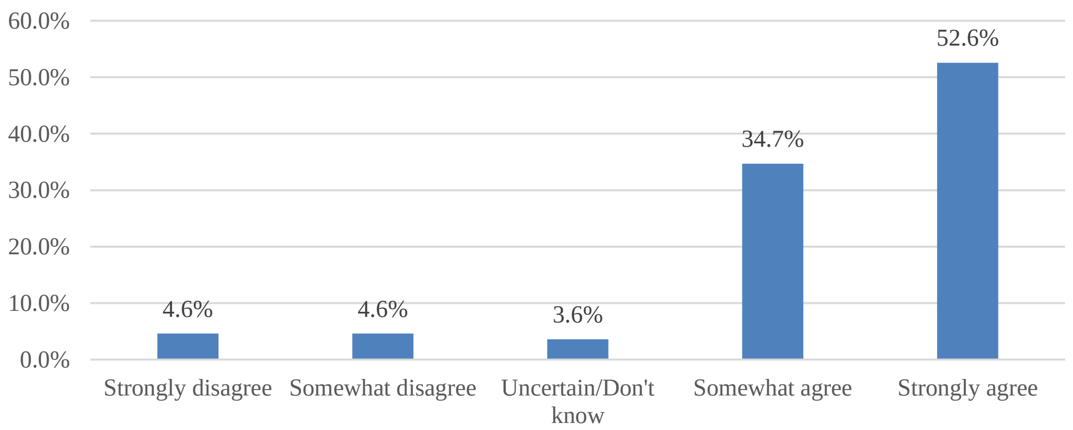


Figure 4.11 ACC can help me keep a safe distance from the car in front at all times

A larger proportion of drivers agreed with the statement that, "*ACC can reduce the likelihood of feeling fatigued when driving long distances*", than disagreed. As shown in Figure 4.12, slightly over one-quarter of drivers with ACC somewhat agreed (28.6%) and 22.4% strongly agreed with the statement, whereas 23% of drivers somewhat disagreed and a further 14.3% strongly disagreed.

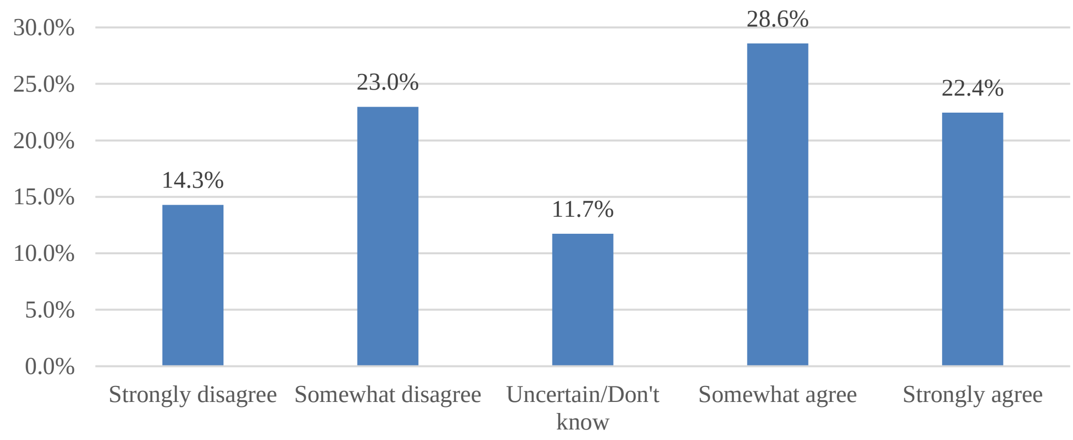


Figure 4.12 ACC can reduce the likelihood of feeling fatigued when driving long distances

Drivers somewhat agreed with the statement that, "*ACC can reduce fuel consumption*" (Table 4.16). However, a large percentage of drivers (42.5%) indicated that they were uncertain or didn't know if ACC reduced their vehicle's fuel consumption (Figure 4.13).

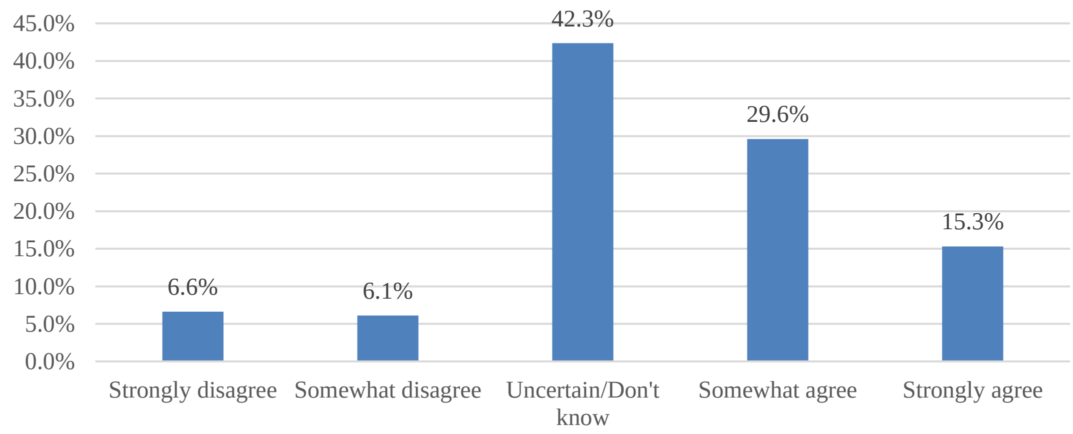


Figure 4.13 ACC can reduce fuel consumption

4.4.4 Lane Departure Warning

Drivers' attitudes toward LDW are summarised in Table 4.17. Drivers agreed with the statement that LDW helps them to be a safer driver, with 48.3% somewhat agreeing and 29.3%

strongly agreeing. Furthermore, there was strong agreement amongst drivers that LDW can reduce their chances of running off the road (43.7% somewhat agreed and 43.1% strongly agreed; Figure 4.14) and that the system alerts give them enough time to move their car safely back into the lane (45.4% somewhat agreed and strongly agreed, respectively; Figure 4.15).

Table 4.17 Summary of drivers' attitudes toward Lane Departure Warning (n=174)

	Level of Agreement/Disagreement, %				
Statement	**Strongly Disagree**	**Somewhat Disagree**	**Uncertain/ Don't Know**	**Somewhat Agree**	**Strongly Agree**
LDW produces false or unnecessary alerts	29.3%	35.1%	7.5%	19.5%	8.6%
LDW helps me to be a safer driver	6.3%	10.9%	5.2%	48.3%	29.3%
I feel less in control of the car when LDW is switched on	51.7%	36.8%	4.0%	4.0%	3.4%
LDW alerts can be distracting	31.0%	38.5%	2.3%	16.7%	11.5%
I would prefer it if my car's LDW could be permanently switched off	48.3%	36.2%	4.6%	2.3%	8.6%
I do not trust the LDW system fitted to my car	46.6%	36.8%	5.2%	6.9%	4.6%
LDW can reduce my chances of running off the road	2.3%	4.6%	6.3%	43.7%	43.1%
LDW will not reduce my chances of having a crash caused by fatigue or sleepiness	35.1%	33.3%	10.9%	12.1%	8.6%
I feel less attentive as a driver when LDW is operational	51.7%	40.8%	3.4%	1.7%	2.3%
LDW alerts give me enough time to move my car safely back into the lane	1.1%	2.3%	5.7%	45.4%	45.4%

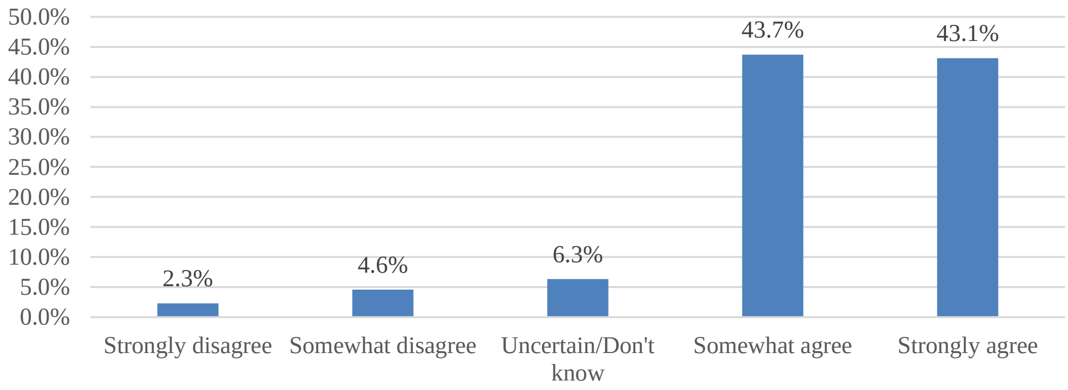


Figure 4.14 LDW can reduce my chances of running off the road LDW

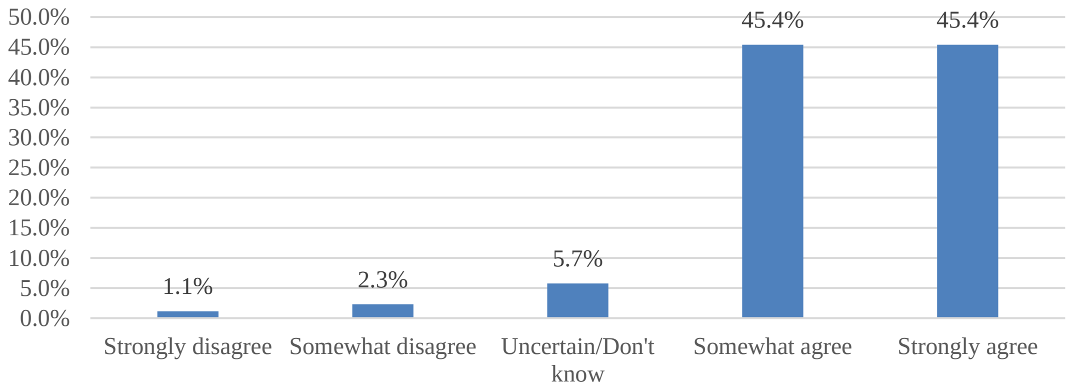


Figure 4.15 LDW alerts give me enough time to move my car safely back into the lane

Drivers strongly disagreed with the statements, "*I feel less attentive as a driver when LDW is operational*", "*I feel less in control of the car when LDW is switched on*", and "*I would prefer it if my car's LDW could be permanently switched off*". Similarly, drivers indicated that they trust LDW systems as shown by their disagreement with the statement, "*I do not trust the LDW system fitted to my car*" (Table 4.17).

In contrast, drivers only somewhat disagreed that LDW will not reduce their chances of having a crash caused by fatigue or sleepiness. Drivers on average somewhat disagreed that LDW produces false or unnecessary alerts and that alerts can be distracting. Notably, over one-quarter of drivers agreed to some extent with the statements that LDW produces false or unnecessary alerts (19.5% somewhat agreed and 8.6% strongly agreed) and that LDW alerts can be distracting (16.7% somewhat agreed and 11.5% strongly agreed; Figure 4.16).

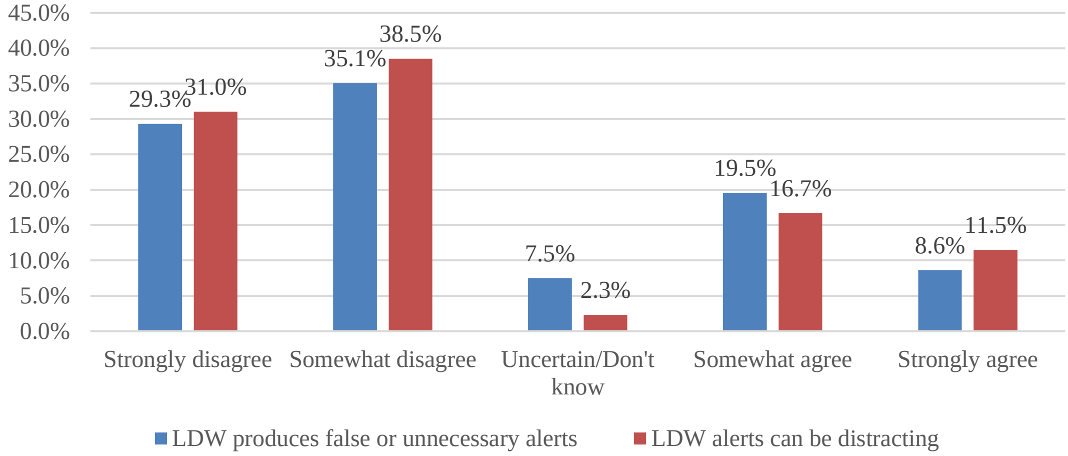


Figure 4.16 Distracting and false LDW alerts

4.4.5 Lane Keeping Assist

Drivers' attitudes toward LKA are summarised in Table 4.18. Drivers strongly agreed that LKA can reduce their chances of running off the road and they thought that LKA helped them to be a safer driver (Table 4.18). Notably, over eight in ten drivers agreed with the statement that LKA can reduce their chances of running off the road, with 49.3% somewhat agreeing and a further 37.3% strongly agreeing. Drivers somewhat disagreed that LKA will not reduce their chances of having a crash caused by fatigue or sleepiness (Table 4.18).

Overall, there was strong disagreement from drivers that LKA negatively impacted their attention while driving, with over half the drivers (53.7%) responding that they *"strongly disagree"* with the statement that having LKA in operation makes them feel less attentive as a driver. Moreover, no drivers of cars fitted with LKA strongly agreed that the technology made them less attentive drivers.

On average, drivers somewhat disagreed that LKA made them feel less in control of the car when the system is switched on (Table 4.18). However, nearly one in five drivers agreed to some extent with the statement, "*I feel less in control of the car when LKA is switched on*", with 9% somewhat agreeing and 10.4% strongly agreeing.

Table 4.18 Summary of drivers' attitudes toward Lane Keeping Assist (n=67)

Statement	Level of Agreement/Disagreement, %				
	Strongly Disagree	**Somewhat Disagree**	**Uncertain/ Don't Know**	**Somewhat Agree**	**Strongly Agree**
LKA unnecessarily tries to move my car back into the lane	29.9%	32.8%	7.5%	19.4%	10.4%
LKA helps me to be a safer driver	6.0%	10.4%	7.5%	52.2%	23.9%
I feel less in control of the car when LKA is switched on	37.3%	37.3%	6.0%	9.0%	10.4%
LKA can be distracting	32.8%	31.3%	9.0%	19.4%	7.5%
I would prefer it if my car's LKA could be permanently switched off	49.3%	29.9%	7.5%	6.0%	7.5%
I do not trust the LKA system fitted to my car	40.3%	31.3%	7.5%	14.9%	6.0%
LKA can reduce my chances of running off the road	3.0%	4.5%	6.0%	49.3%	37.3%
LKA will not reduce my chances of having a crash caused by fatigue or sleepiness	34.3%	29.9%	9.0%	17.9%	9.0%
I feel less attentive as a driver when LKA is operational	53.7%	34.3%	7.5%	4.5%	0.0%

Although drivers generally trusted LKA, as indicated by their disagreement with the statement "*I do not trust the LKA system fitted to my car*", there were 14.9% who somewhat agreed and 6% who strongly agreed with the statement. Similarly, despite drivers somewhat disagreeing that LKA unnecessarily tries to move their car back into the lane, nearly three in ten drivers (29.8%) either somewhat or strongly agreed (19.4% and 10.4%, respectively) that the system performs unnecessary operations (Figure 4.17). In addition, over one-quarter of drivers agreed to some extent that LKA assist can be distracting, with 19.4% somewhat and 7.5% strongly agreeing (Figure 4.17).

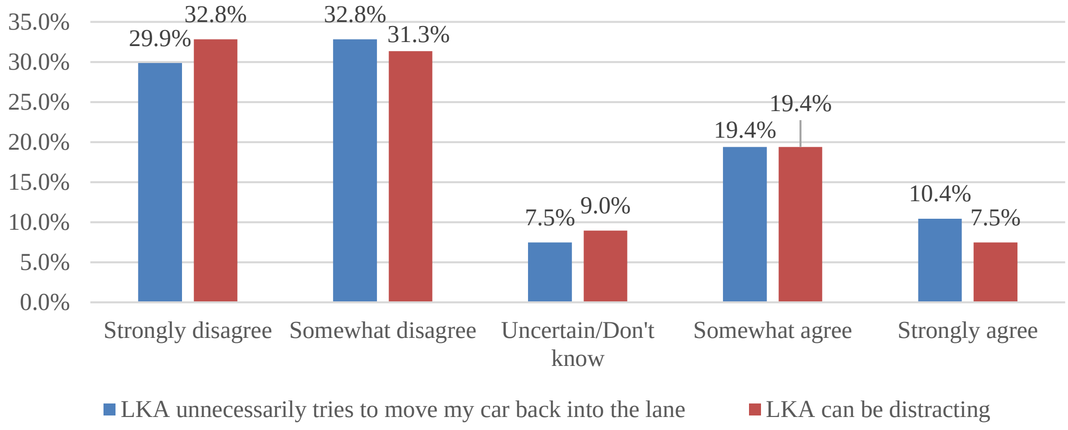


Figure 4.17 Distracting and unnecessary operations by LKA

4.4.6 Blind Spot Monitoring

A summary of the results of drivers' attitudes toward BSM are presented in Table 4.19. Overall, drivers had a favourable disposition toward BSM technology. On average, drivers strongly agreed that BSM helps them to be a safer driver, that it can reduce their chances of colliding with another car in an adjacent lane (Table 4.19), and that the system alerts can help them to change lanes safely (see Figure 4.18).

Drivers strongly disagreed with the following: BSM produces false or unnecessary alerts, the system alerts can be distracting, they do not trust the BSM system fitted to their car, and that they feel less attentive as a driver when BSM is operational (Table 4.19**)**. Drivers also strongly disagreed with the statement, "*I would prefer it if my car's BSM could be permanently switched off*", with well over two-thirds of drivers strongly disagreeing with the statement and only a small percentage agreeing (Figure 4.19).

Table 4.19 Summary of drivers' attitudes toward Blind Spot Monitoring (n=183)

	Level of Agreement/Disagreement, %				
Statement	**Strongly Disagree**	**Somewhat Disagree**	**Uncertain/ Don't Know**	**Somewhat Agree**	**Strongly Agree**
BSM produces false or unnecessary alerts	53.6%	35.0%	2.2%	7.1%	2.2%
BSM helps me to be a safer driver	2.7%	0.5%	2.2%	44.8%	49.7%
BSM alerts can be distracting	53.0%	38.3%	1.6%	4.4%	2.7%
I would prefer it if my car's BSM could be permanently switched off	69.4	27.9	0.5	1.6	0.5
I do not trust the BSM system fitted to my car	57.4%	32.2%	2.7%	3.8%	3.8%
BSM can reduce my chances of colliding with another car in an adjacent lane	0%	1.6%	1.6%	37.7%	59.0%
BSM alerts can help me change lanes safely	1.1%	2.2%	1.1%	32.2%	63.4%
I feel less attentive as a driver when BSM is operational	59.6%	34.4%	1.1%	3.3%	1.6%

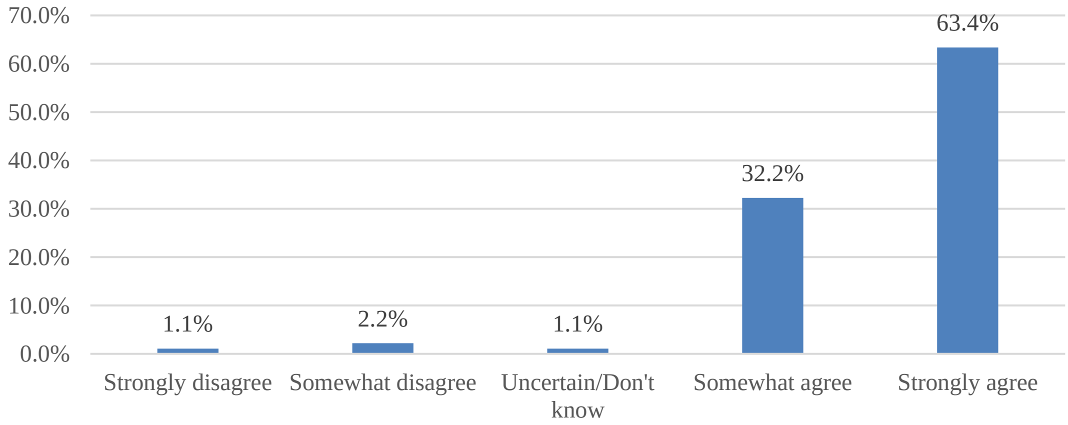


Figure 4.18 BSM alerts can help me change lanes safely

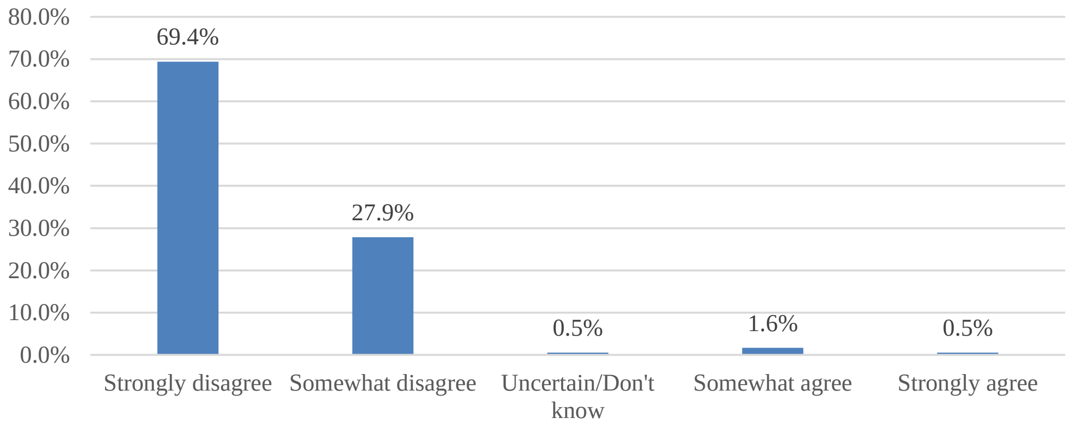


Figure 4.19 I would prefer it if my car's BSM could be permanently switched off

4.4.7 Attention Assist

Drivers' attitudes toward Attention Assist are summarised in Table 4.20. Drivers somewhat agreed that AA helps them to be a safer driver, and they also believed that the system can reduce their chances of having a crash caused by drowsiness or fatigue. Drivers disagreed with the statements that they do not trust the AA system fitted to their car, that they would prefer it if their car's AA system could be permanently switched off, and that AA can be distracting (Table 4.20). Furthermore, the results indicate that drivers are still likely to monitor their own levels of drowsiness or fatigue despite having an AA system fitted to their car. This is based on their strong disagreement with the statement, "*I am less likely to monitor my own drowsiness or fatigue when AA is in operation*" (see Figure 4.20).

Table 4.20 Summary of drivers attitudes toward Attention Assist (n=60)

Statement	Level of Agreement/Disagreement, %				
	Strongly Disagree	Somewhat Disagree	Uncertain/ Don’t Know	Somewhat Agree	Strongly Agree
AA produces false or unnecessary alerts about my drowsiness	30.0%	23.3%	20.0%	20.0%	6.7%
AA helps me to be a safer driver	15.0%	5.0%	16.7%	40.0%	23.3%
AA can be distracting	36.7%	36.7%	16.7%	3.3%	6.7%
I would prefer it if my car's AA system could be permanently switched off	43.3	30.0	16.7	1.7	8.3
I do not trust the AA system fitted to my car	36.7%	28.3%	16.7%	10.0%	8.3%
AA can reduce my chances of having a crash caused by drowsiness or fatigue	10.0%	3.3%	18.3%	35.0%	33.3%
I am less likely to monitor my own drowsiness or fatigue when AA is in operation	46.7%	35.0%	13.3%	5.0%	0%

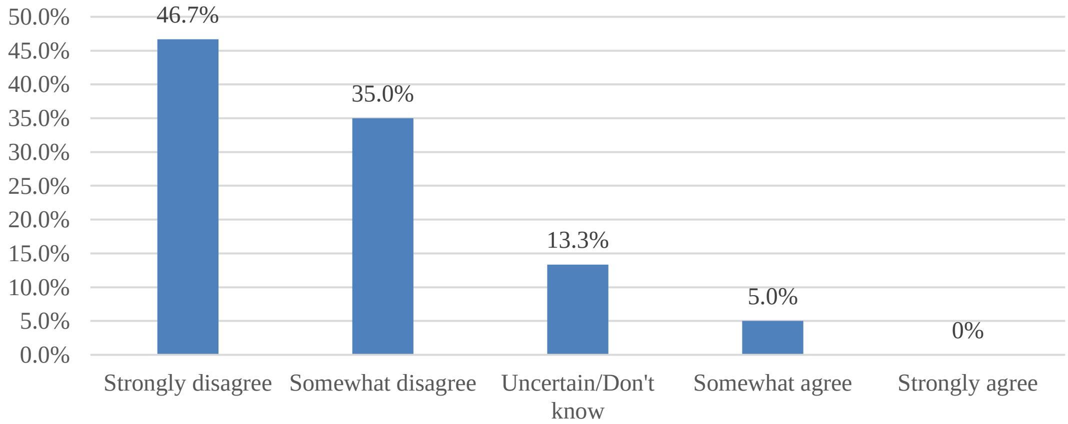


Figure 4.20 I am less likely to monitor my own drowsiness or fatigue when AA is in operation

In contrast, more than one-quarter of drivers indicated that AA produces false or unnecessary alerts, with 20% somewhat agreeing and 6.7% strongly agreeing with the respective statement (Figure 4.21).

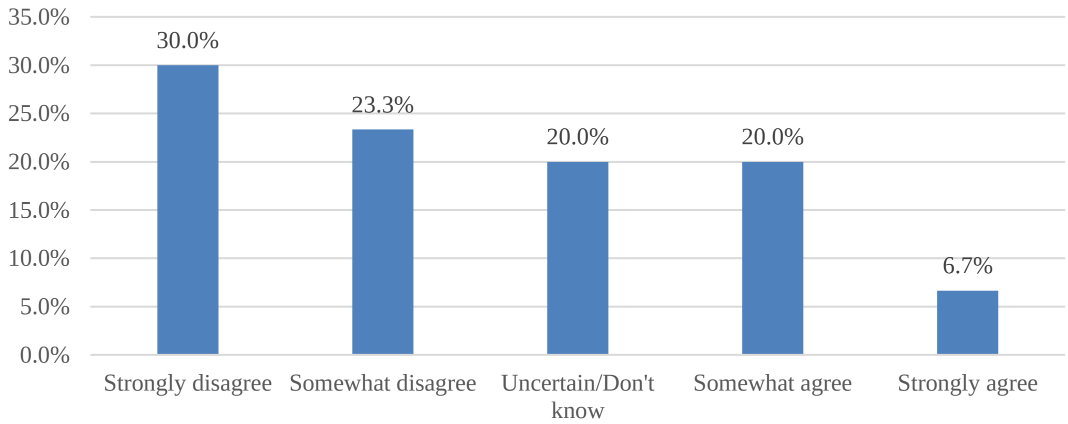


Figure 4.21 AA produces false or unnecessary alerts about my drowsiness

4.5 Differences between Driver Demographics and Attitudes toward ADA Technology

Mann-Whitney U tests were conducted to understand whether attitudes toward each ADA technology differed based on the gender (i.e., male and female) or location (i.e., metropolitan and regional) of the driver. The attitudes toward FCW, AEB, LKA, LDW and BSM did not differ by gender; that is, the levels of agreement/disagreement to the different statements about each ADA technology were similar between male and female drivers. However, there were significant differences between male and female drivers regarding two statements about ACC and one statement about AA. In particular, male drivers had stronger levels of agreement than female drivers with the statement, *ACC can help me keep a safe distance from the car in front at all times* ($p = 0.040$). Female drivers also had stronger levels of agreement with the statement, *I do not trust the ACC system in my car* ($p = 0.025$). Female drivers demonstrated stronger levels of disagreement than male drivers regarding the statement, *AA can be distracting* ($p = 0.003$). Other attitudes toward ACC and AA did not differ based on gender.

The attitudes toward LDW, LKA and AA did not differ based on location status. However, there were a few statistically significant differences between regional and metropolitan drivers concerning their attitudes toward certain aspects of FCW, ACC, AEB, and BSM. More specifically, regional drivers had stronger levels of agreement than metropolitan drivers with respect to the statement, *FCW alarms/alerts give me enough time to apply the brakes* ($p = 0.049$). Similarly, compared to metropolitan drivers, regional drivers had higher levels of agreement with the statement, *ACC can reduce the likelihood of feeling fatigued when driving long distances* ($p = 0.015$). Levels of disagreement were statistically significantly stronger for regional drivers than metropolitan drivers regarding the statements, *I feel less in control of the car when AEB is switched on* ($p = 0.008$), and, *I do not trust the BSM system fitted to my car* ($p = 0.047$). Levels of agreement/disagreement were similar among regional and metropolitan drivers for the other statements about FCW, ACC, AEB and BSM.

The Kruskal-Wallis H test was used to determine if there were statistically significant differences in drivers' attitudes toward each ADA technology between the different age groups. For AA, there were statistically significant differences in the level of agreement/disagreement between age groups with respect to the statements, *AA can reduce my chances of having a crash caused by drowsiness or fatigue* ($X^2(2) = 10.315$, $p = 0.035$), and, *AA helps me to be a safer driver* ($X^2(2) = 9.895$, $p = 0.042$). Drivers' attitude toward certain aspects of LDW also significantly differed based on age group; for instance, levels of agreement/disagreement differed by age group with the statements, *LDW produces false or unnecessary alerts* ($X^2(2) = 12.901$, $p = 0.024$), *LDW alerts can be distracting* ($X^2(2) = 12.705$, $p = 0.026$), and, *I would prefer it if my car's LDW could be permanently switched off* ($X^2(2) = 11.251$, $p = 0.047$). Similarly, the levels of agreement/disagreement significantly differed by age group for the statements, *LKA can reduce my chances of running off the road* ($X^2(2) = 11.805$, $p = 0.019$), and, *I am not particularly trusting of the effectiveness of* FCW ($X^2(2) = 12.163$, $p = 0.033$). Attitudes toward AEB, ACC and BSM did not differ by age group.

5 DISCUSSION

The aim of this research was to investigate Western Australian drivers' knowledge of and attitudes toward select Advanced Driver Assist pre-crash technologies and to report their use of these systems. The survey responses of a sample of 301 drivers from WA have provided information which highlights the factors that potentially enable and dissuade the use of particular Safe Vehicle pre-crash technologies. A discussion of the findings in relation to the specific objectives of the investigation is provided in the following sections.

5.1 Prevalence, Knowledge and Use of ADA Technologies in this Sample

Knowledge

The majority of drivers surveyed demonstrated knowledge of whether or not their car was fitted with the different ADA technologies; however, it should be noted that their responses were not validated by researchers. The prevalence of each technology within the sample varied, with the most common ADA technology being FCW (73.4%) and the least common technologies being AA (19.9%) and LKA (22.3%). Less than one in ten drivers self-reported that they did not know if their vehicle was fitted with the following technologies: FCW (6.0%), LDW (6.3%), BSM and ACC (7.3%, respectively). Conversely, one in ten drivers indicated that they did not know if LKA was fitted, while 13% were unsure of the fitment of AA and 15.9% were unsure of the fitment of AEB. Attention Assist and LKA were also the least common technologies in our sample (only fitted in approximately one in five vehicles), while slightly under half the vehicles were fitted with AEB. The lack of knowledge may well be indicative of the fact the technologies are "new and emerging" and have not penetrated the vehicle fleet as much as the other technologies, such as BSM and FCW.

Use

The majority of drivers surveyed, regardless of gender and/or location, claimed to always have their respective ADA system(s) switched on and unchanged from factory settings, ranging from 97.3% for BSM, 88.7% for AEB, 87.3% for FCW, and 86.7% for AA down to 77% for LDW and a low of 71.6% for LKA. Confirmation of the relatively high acceptance of BSM technology was also noted in the study by Reagan et al. (2018) who reported that only 1% of 983 vehicles fitted with BSM had the technology switched off when the vehicle was presented for service at a dealership. Similarly, 95% of drivers of Dodge and Jeep vehicles equipped with BSM surveyed in the US self-reported always driving with BSM switched on (Cicchino et al. 2015). Reagan et al. (2018) also reported that large proportions of FCW systems with or without AEB (93%) as well as driver AA systems (90%) were enabled (Reagan et al. 2018), which are comparable to our self-reported activation rates.

From our survey responses, it is evident that lateral collision avoidance systems have lower rates of use (i.e., always being switched on) compared with forward collision avoidance systems. Moreover, LKA had the highest percentage of drivers who reported they mostly or always drive with the system switched off (13.4%), with an additional 7.5% of drivers responding they sometimes switch off LKA depending on the road environment; thus one in five drivers of cars with LKA are deactivating the system at some stage. Lane Departure Warning had the second highest percentage of drivers who mostly or always drive with the system switched off (10.3%). The lower rates of use of lateral collision avoidance systems (or higher rates of deactivation) are consistent with previous research. For instance, the relative differences in activation between LDW, front crash prevention (FCW and AEB), and BSM are consistent with self-report data from national samples of owners of vehicles with ADA technologies conducted in the US (Braitman et al. 2010;Cicchino et al. 2015;Eichelberger et al. 2016).

According to self-report surveys conducted with GM and Honda customers, a higher percentage of males had lane maintenance systems turned on. Similar results are reported by Flannagan et al. (2016) and a survey by Cicchino & McCartt found that women report more annoyance with crash avoidance alerts than men (Cicchino & McCartt, 2015). However, not all studies have identified these gender-based differences (Eichelberger & McCartt, 2014). Differing use of these technologies was not found by age, but this may be a result of small numbers in the younger and older age groups. Driver characteristics such as attitudes toward safety technologies and willingness or ability to pay may also affect use of these technologies (Reagan et al. 2018).

Experienced System Alert or Operation

In our sample, the majority of drivers with each ADA technology responded that they had experienced the system's alert or the system in operation. Unsurprisingly, nearly all drivers of cars with BSM reported experiencing the system's alert (96.7%). The lowest levels of experience were for AEB (73.8%) and AA (71.7%), with around one-quarter of drivers with the technologies responding that they had never experienced the system in operation (24.1% and 26.7%, respectively).

5.2 Attitudes toward ADA Technologies

On the whole, drivers surveyed appeared to have a positive attitude toward ADA technologies fitted to their car. For example, the majority of drivers thought the various ADA technologies reduced their chances of being involved in a crash and believed that the systems made them a safer driver. In particular, nearly all drivers with BSM (94.5%) thought it helped them to be a safer driver, while three-quarters of drivers with LDW (77.6%), LKA (76.1%) and FCW (72.4%) thought the systems helped them to be a safer driver. In support of this, many drivers in our sample believed that the LDW and FCW alerts give them enough time to take corrective action (i.e., move safely back into the lane or apply the brakes). Furthermore, nearly nine in ten drivers agreed ACC (87.2%) helped them keep a safe distance from the car in front. Similar favourable attitudes toward the safety benefits of ACC have been reported by de Winter et al. (2017) who surveyed 182 Dutch users of ACC who believed that the system helps them to drive more safely and prevent rear-end collisions.

Reduced chances of crashing

A high proportion of drivers agreed BSM can reduce their chances of colliding with another car in an adjacent lane (96.7%), LDW and LKA can reduce their chances of running off the road (86.8% and 86.6%, respectively), and AEB can reduce their chances of having a rear-end crash or colliding with another object (72.4%). Slightly over two-thirds of drivers with AA believed the system could reduce their chances of having a crash caused by drowsiness or fatigue, while nearly one in five were uncertain of its impact. Drivers in our sample had the least experience with both AEB and AA, which may impact drivers' opinions as to whether or not they think the systems can reduce their risk of crashing. Similarly, two-thirds of drivers with FCW agreed the system could reduce their chances of having a rear-end crash; however, one in five drivers disagreed that FCW reduced their chances of having a rear-end crash, which was the highest proportion of driver disagreement out of the technologies.

Trust

There was a level of distrust of certain crash avoidance technologies among those surveyed. Most notably, one in five drivers with LKA (20.9%), FCW (19.9%) and AA (18.3%) indicated to some degree that they did not trust the respective system. More specifically, nearly one in ten drivers strongly agreed with the statement, *I do not trust the FCW system fitted to my car*. In contrast, there were high levels of trust among drivers in our sample for BSM and ACC: for each system, over half the drivers strongly disagreed and a further one-third somewhat disagreed with the statement, *I do not trust the BSM/ACC system fitted to my car*. Similarly, in the US, drivers tend to report higher trust in BSM systems than in other types of ADA technologies (Kidd et al. 2017). In addition, eight in ten drivers disagreed to some extent (46.6% strongly and 36.8% somewhat disagreeing) with the statement that they do not trust the LDW system fitted to their car, while over three-quarters of drivers with AEB indicated they trust the effectiveness of the system.

Unnecessary alerts/operations

Survey responses indicated that the lateral collision avoidance systems have the highest rates of false operations: three in ten drivers somewhat or strongly agreed (19.4% and 10.4%, respectively) that their LKA system performs unnecessary operations, while a similar percentage of drivers (28.2%) believed LDW produced false or unnecessary alerts. Previous research has also reported that a significantly higher proportion of drivers with these systems turned off agreed that the systems issued unnecessary warnings, compared with drivers who have the systems turned on (43% vs. 25%, respectively)(Reagan et al. 2018).

A quarter of drivers also indicated that AA produces false or unnecessary alerts about their drowsiness (26.7%) and that FCW is too sensitive and leads to unnecessary alerts of an imminent crash (25.3%). Furthermore, close to one in five drivers thought AEB leads to unnecessary, automatic braking (18.4%). The most favourable attitudes were toward BSM and ACC. Over half the drivers with ACC strongly disagreed (56.6%) and a further 30.1% somewhat disagreed that ACC is unreliable and that it does not maintain the speed or distance settings. Nearly nine in ten drivers either strongly (53.6%) or somewhat (35%) disagreed that BSM produces false or unnecessary alerts.

Distracting

With regard to ADA technologies being distracting, there were mixed responses. Overall, the majority of drivers disagreed that the respective ADA technology can be distracting. Drivers had the most favourable attitude toward BSM: over nine in ten drivers disagreed to some extent that BSM alerts can be distracting. Again, there were less favourable responses for lateral collision avoidance systems: over one-quarter of drivers surveyed thought LDW alerts and LKA can be distracting (28.2% and 26.9%, respectively). Based on our survey responses, it appears drivers find BSM to be the least distracting while LDW and LKA are the most distracting out of the ADA technologies. The less favourable responses to LDW and LKA in our study are comparable to previous studies; for example, Eichelberger et al. (2016) reported that 14% of Toyota drivers surveyed found LKA annoying and 9% thought it was distracting, whereas only 1-2% of drivers mentioned that ACC and the Pre-Collision System were distracting or annoying.

Attention and control

Overall, there was strong disagreement from drivers that the ADA technology in question negatively impacted their attention while driving. More specifically, over half the drivers with BSM (59.6%), AEB (58.2%), FCW (54.3%), LDW (51.7%) and LKA (53.7%) fitted to their car indicated strong disagreement with the statement that having the ADA technology in operation makes them feel or become less attentive as a driver. No drivers of cars fitted with AEB or LKA strongly agreed that the technology made them less attentive drivers. The exception to this is ACC, with nearly one in five (18.4%) indicating to some extent that they feel less attentive as a driver when the system is in operation. In a previous study conducted in The Netherlands, some drivers indicated that ACC helps them to perform otherwise unsafe activities such as using a phone. Reassuringly, however, the majority of drivers believed that ACC does not permit them to pay less attention while driving (de Winter et al. 2017). As such, how ACC impacts drivers' attention is an area for further investigation.

Approximately one in five drivers with LKA (19.4%) and ACC (18.9%) felt less in control of the car when the systems were switched on or in operation. Nevertheless, the majority of drivers disagreed that AEB, ACC, LDW or LKA makes them feel less in control of the car when the technology is switched on or in operation.

Impacting driver fatigue

A series of statements were included to understand drivers' attitudes toward ADA technology and its impact on fatigue. A fair proportion of drivers in our sample were sceptical of the impact LKA and LDW systems could have on reducing their chances of having a crash caused by fatigue. Although around two-thirds of drivers indicated that they thought the systems reduced their chances of having a fatigue-related crash, one-quarter of drivers with LKA and one in five drivers with LDW did not think so. In addition, a high proportion of drivers of cars fitted with AA indicated that having the system did not mean they are less likely to monitor their own drowsiness or fatigue. Drivers' attitudes were split regarding whether or not ACC reduced their likelihood of feeling fatigued when driving long distances: 51% agreed and 37.3% disagreed that it does, with the remainder uncertain. Little or no other research could be located that collected drivers perceptions of the technologies' impact on fatigue. Consequently, further research is required to ascertain the impact these technologies have on reducing fatigue-related crashes and if they effect a driver's perceived level of drowsiness or fatigue when driving.

On/Off preferences

The majority of drivers indicated that they would *not* prefer it if their car's respective ADA system could be switched off (permanently or otherwise). Compared to other technologies, BSM had the highest percentage of drivers who did not want the system to be switched off (97.3%), which is consistent with previous research and observed and self-reported use of BSM systems (Braitman et al. 2010;Cicchino et al. 2015;Reagan et al. 2018). Conversely, the technology with the highest proportion of drivers who would prefer it if their car's system could be permanently switched off was for LKA at slightly over one in ten drivers (7.5% strongly and 6% somewhat agreeing). This is unsurprising considering drivers' responses to previous statements relating to trust, unnecessary operations and distraction as well as driver responses in previous surveys conducted in the US (e.g., Eichelberger et al. 2016;Kidd et al. 2017).

5.3 Limitations

There are a number of limitations associated with this study that potentially undermine the reliability and validity of the findings to meet the study objectives and secondly, to permit generalisability of the findings.

Sampling and recruitment of drivers and vehicles

This study employed a non-probability convenience sampling method. This entails the risk of recruiting drivers who are motivated to participate because of their interest in the topic, which in turn has the potential to bias the results. Secondly, it proved difficult to recruit drivers from regional and remote WA compared to the recruitment of drivers in Metropolitan WA. As mentioned in Section 2.4.2., calls made to metropolitan drivers were approximately 3.7 times more productive; metropolitan drivers were more likely to drive cars with at least one ADA technology while regional drivers were driving older vehicles with no ADA technology. Consequently, our sample underrepresents this population of drivers. As discussed in the WA Road Safety Commission report authored by Palamara (2018), regional and remote drivers are a priority population for the uptake of Safe Vehicles and ADA technology due to the nature of their crashes.

In addition, there was likely over-sampling of drivers from higher income, SES areas. The selection criteria required participants drive a vehicle with at least one ADA technology. This meant recruiting drivers with newer (and often relatively more expensive) vehicles equipped with the latest generation of ADA systems. Therefore, drivers from lower income areas and areas of disadvantage are likely underrepresented and their attitudes are not captured in this sample.

Furthermore, of the 301 drivers, the majority were male (n=180; 59.8%), located in the metropolitan area (n=257; 85.4%) and aged 50-59 years (n=135; 44.9%) or 40-49 years (n=89; 29.6%). As such this sample may not be representative of the wider WA driving population. However, the age and gender distribution of participant drivers is more favourable than some previous survey-based/self-report studies (e.g., de Winter et al. (2017): 96% male, 42% older than 60 years, and Eichelberger et al. (2016): 69% male, 50% older than 60 years). Nevertheless, younger-age drivers remain underrepresented both in this study and in previous studies.

The study could have used a quota system, to increase the number of participants from regional and remote areas, female, younger than 40 or older than 60 years old and lower income. However, this would have added considerably to the cost of the survey and lengthened data collection time. The sampling method used does an accurate reflection of those who have access to these technologies in WA.

Cross-sectional study design

This project only included observations of one time point. Changes in use overtime, may impact the generalisability of the results (Reagan et al. 2018). The present survey or a modified version could be periodically repeated to capture year-on year changes in drivers' attitudes toward, satisfaction with and use of different ADA systems as the technologies progress, as suggested by de Winter et al. (2017).

The validity and reliability of data

Self-reported vehicle specifications and fitment of ADA technology were not validated/cross-checked nor was the activation status of ADA technologies. However, Palamara (2018) previously assessed WA drivers' Safe Vehicle-related knowledge with respect to the correct identification of the crash avoidance features fitted to their car. Although the vast majority of the drivers' vehicles in their sample were not fitted with ADA technologies, such as AEB, FCW, LKA, LDW or BSM, around eight in ten drivers correctly understood these features were not fitted to their vehicle. Furthermore, Palamara (2018) believed the high percentage of correct answers may be because the action of these technologies – from the description provided of them in the survey – could be easily determined as being available or otherwise in their car. For example, drivers did not experience audible warnings, a flashing light, or an automated action (Palamara 2018). Similar descriptions were also read out during the telephone interviews in this study. Therefore, it is possible that drivers in this sample also had a high percentage of correct answers regarding the presence of ADA on the car they drove most frequently.

As with other survey-based research investigating drivers' attitudes toward and use of ADA technology (e.g., de Winter et al. 2017)), a limitation of the current study is the validity of the Likert Scale attitude measurement, which can be compromised by social desirability bias. However, the anonymity of the participants was likely to reduce the risk of social desirability bias.

The need to maintain the anonymity of driver responses meant that it was also not possible to implement processes to validate information provided by drivers. This is particularly pertinent to the information drivers provided on the Make, Model and Year of Manufacture as well as the installation of the select ADA technologies. Secondly, no data was collected on the 'test-retest' reliability of the drivers' responses to the survey items (Palamara 2018).

Finally, previous research has noted that drivers' attitudes toward and use of ADA technologies varies between manufacturers (see Reagan et al. 2018), which can be attributed to differences in the performance of systems across the vehicle fleet. For instance, there can be considerable performance differences in such things as the type of alerts (i.e., haptic, visual and/or auditory), alert frequencies, accuracy of alerts, timeliness (i.e., too early or late) and intensity (i.e., gentle *vs.* harsh) of a system's response as well as the design and functionality of the user interface. This should be considered when interpreting the results of the survey.

5.4 Conclusion

The majority of drivers surveyed were aware of the different Advanced Driver Assist (ADA) technologies available in their car, thought the technology may help them avoid being involved in a collision and claimed to always have their respective ADA system switched on and unchanged from factory settings. Lane Keep Assist, Lane Deviation Warning and Adaptive Cruise Control had the highest percentage of drivers who reported they mostly or always drive with the system switched off (13.4%, 10.3% and 9.7% respectively).

However, one in five drivers with Lane Keep Assist (20.9%), Forward Collision Warning (19.9%) and Attention Assist (18.3%) indicated to some degree that they did not trust the respective system. Nearly 30% of drivers indicated that the lateral collision avoidance systems have the highest rates of false operations. A quarter of drivers also indicated that Attention Assist produces false or unnecessary alerts about their drowsiness (26.7%) and that Forward Collision Warning was too sensitive and leads to unnecessary alerts of an imminent crash (25.3%). Close to one in five drivers thought Autonomous Emergency Braking (AEB) leads to unnecessary, automatic braking (18.4%).

Few differences were found between demographic groups, although this may be a result of sampling being predominantly in those aged 40-59 years and living in the metropolitan area. This appears to reflect ownership of vehicles with ADA technologies. It is therefore important, that vehicles with Advanced Driver Assist Technologies continue to be promoted to increase market penetrance across the population in general. Further to this we need to raise awareness about these technologies so people are aware of what they are, how they work and what the benefits are and are less inclined to switch them off. A previous C-MARC report addressed the issue of promoting safe vehicle technologies (Palamara 2018). A 2002 report from the Department for Planning and Infrastructure also addressed this issue and is still relevant in today’s context despite its age (Paine 2002). Recommendations from this report will specifically address the issue of education regarding safe vehicle technologies so that people understand their purpose and how they may help protect them in a crash.

6 RECOMMENDATIONS

3. Develop a consumer guide to advanced safety features which should be:
    - Specific for cars available in Australia
    - Highlight information about extra protection provided by advanced safety features.
    - Include case histories to show how the technologies have prevented crashes and/or injury outcomes.
    - Readily available at car yards and on the internet, particularly websites, social media sites where cars are for sale.
    - Available in formats targeted at specific demographic groups, including infographics and video.
    - Video clips may focus on the specific technologies that are most likely to be switched off, eg. Lane Keep Assist, Lane Deviation Warning and Adaptive Cruise Control.

    The guide could initially be targeted at consumer groups who are most likely to have cars with advanced safety features. From this survey we would suggest those aged 40-59 years and living in the metropolitan area. However, this may be more accurately determined by analysis of WA new vehicles sales data.

4. Education about advanced safety features to be targeted to the workforce via fleet managers and/or as part of occupational health and safety training.

5. To conduct a second phase of research into drivers' attitudes toward and experience with ADA technologies which incorporates a more in-depth and qualitative methodology. This should give drivers the opportunity to describe specific scenarios where they find the technology does not work well and is particularly important in the regional and remote context.

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APPENDIX 1

ADVANCED DRIVER ASSIST TECHNOLOGIES TELEPHONE QUESTIONNAIRE

Advanced Driver Assistance Technology Project Telephone Interview

Hello My name is {...}, and I am calling from the Survey Research Centre at Edith Cowan University on behalf of the Curtin-Monash Accident Research Centre at Curtin University.

Today I am calling to ask people to participate in a survey about people's attitudes toward and use of new vehicle safety technologies. I need to speak with someone who ***holds a motor vehicle drivers' license and drives a car fitted with at least ONE of the following safety features at least once a week***. These features are:

- Radar or Advanced Cruise Control (differs to normal cruise control)
- Forward Collision Warning with or without Autonomous Emergence Braking
- Lane Departure Warning with or without Lane Keeping Assistance
- Blind Spot Monitoring
- Driver Attention Assist to detect drowsy driving

[PROMPT: If respondent is unsure about the fitment of the technology, you can read out a brief description of how each technology works]

Would that be you or someone else in your household who can come to the phone that I can speak with?

If ineligible
Since you do not drive at least once a week or drive a car that has at least ONE of the new safety technologies there is no need on this occasion to do the telephone interview. Many thanks for your time. Goodbye

If eligible
The survey will take up to 20 minutes but could be a lot shorter depending on the type of car you drive most often. No further participation will be required of you beyond this interview. The information you give will be kept completely confidential by the researchers; we do not require you to provide details that would identify you or the particular car you drive most often.

Would you have time to do this interview now? If not we can arrange to call you back in the next couple of days to complete the interview.

If the interview is to take place, please read the Preamble, followed by Study and Consent information.

Preamble:
The Survey Research Centre at Edith Cowan University abides by the Australian Privacy Principles, so before we begin I want to reassure you of the confidentiality of any answers you may give. Your responses will also not be used for any other purposes than this research. Please be advised that parts of this telephone interview may be listened to for training and quality control purposes.

Study Information and Consent:
Before we commence the survey I need to have your consent to participate in this study. I will now read out the key points about this research which you must be made aware of before giving your consent.

The Curtin University Human Research Ethics Committee has approved this survey. Should you wish to be provided with further information about this approval and who you should contact if you wish to discuss your participation or the conduct of this research I can provide you with this information now or later on.

State the following only if requested

Curtin University Human Research Ethics Committee (HREC) approval number HRE2018-0619. HREC Ethics Officer (08) 9266 9223 or Manager, Research Integrity (08) 9266 7093 or email hrec@curtin.edu.au.

CMARC Project Manager Dr Matthew Govorko (08) 9266 9951 email matthew.govorko@curtin.edu.au

Continue with……

The survey will explore car owners'/drivers' knowledge, attitudes and behaviour related to the use of vehicle safety technologies that assist drivers to avoid collisions.

Taking part in the research project is entirely voluntary; you may also withdraw from the survey interview at any stage

The survey information you provide will be kept under secure conditions at Curtin University for 7 years after the research has ended, after which it will be destroyed. You have the right to access, and request correction of your information, where necessary, in accordance with relevant privacy laws.

Do you understand these aspects of being involved in the study? Do you have any questions you would like to ask before consenting to participate in the survey>

Do you consent to participate in the Advanced Driver Assistance Technology Research survey interview?

○ Yes (1)

○ No (2)

Skip To: End of Survey If = No

What is the Make, Model and Variant of the car you drive most often that is fitted with one or more of the previously mentioned vehicle safety technologies?

For example: Holden Commodore SV6; Ford Fiesta Trend; Mazda3 Neo; Lexus RX350 Sport Luxury or DK (don't know)

What is the date of manufacture of the car?

For example, 2016 or DK (don't know)

How long have you been driving the car in question?
_______ Years (1)
_______ Months (2)
________ Don't know/Can't recall

Which one of the following statements best describes how you acquired use of your car? *Please* select one of the following options

- ◯ I bought the car for myself to drive (1)
- ◯ I share ownership and use of the car with another driver (2)
- ◯ Someone else (e.g., family, friend) bought the car for me to drive (3)
- ◯ Someone else owns the car and I share the use of it with other drivers (4)
- ◯ The car was 'handed down', free of cost, to me to drive (5)
- ◯ It was provided by my employer for me to drive (6)
- ◯ Other (*please give details*) (7) [record details]

I am now going to ask you to rate your car on a number of different qualities. The rating options are Very Poor, Poor, Acceptable, Good, and Very Good. Please provide a rating for each of the qualities I am about to read to you.

	Very Poor (1)	Poor (2)	Acceptable (3)	Good (4)	Very Good (5)
The reliability of the car (1)	◯	◯	◯	◯	◯
The features of the car that reduce my chances of having a crash (2)	◯	◯	◯	◯	◯
The features of the car that reduce my chances of being injured if I did have a crash (3)	◯	◯	◯	◯	◯
The driving performance of the car (4)	◯	◯	◯	◯	◯
How easy the car is to drive (5)	◯	◯	◯	◯	◯
The overall safety of the car (6)	◯	◯	◯	◯	◯

The ease of learning how to use the various driving safety technologies in the car (7)	○	○	○	○	○
The maintenance/running costs of the car (8)	○	○	○	○	○

In the following series of questions we will ask you about seven (7) Driver Assistance technologies you may or may not have fitted in the car you had serviced.

Each technology is described by name and its function is to help you identify it.

If you identify that the technology is not fitted to your car or if you are unsure about its fitment you will be asked about the next technology.

To the best of your knowledge is your car fitted with Forward Collision Warning? *This technology will alert you of an imminent crash with another vehicle or object ahead so you can take action (e.g., brake or swerve) to avoid the crash*

○ My car is fitted with this feature (1)

○ My car is not fitted with this feature (2)

○ I am unsure if my car is fitted with this feature (3)

Go to next question only if= My car is fitted with this feature. If (2) or (3) go to next technology, AEB

Which one of the following statements best describes your understanding and use of the Forward Collision Warning (FCW) fitted to your car.

- ☐ I do not know if the FCW system in my car is switched on or off (1)
- ☐ The FCW system in my car is always switched on, unchanged from factory setting (2)
- ☐ The FCW system in my car is always switched on but I sometimes change the settings to suit the road environment (3)
- ☐ The Forward Collision Warning system in my car is switched off at all times when I drive (4)
- ☐ I mostly or always drive with FWC system turned off (5)
- ☐ Other, please explain (6) ____________________

Have you ever experienced the FCW system alert (i.e., an alarm or sound occurred) whilst you have been driving the car?

- ○ I am not sure/can't recall (1)
- ○ No, never (2)
- ○ Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about FCW. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
FCW is too sensitive and leads to unnecessary alerts of an imminent crash (1)	○	○	○	○	○
FCW helps me to be a safer driver (2)	○	○	○	○	○
FCW alarms/alerts can be distracting (3)	○	○	○	○	○
I would prefer it if my car's FCW was switched off (4)	○	○	○	○	○
FCW can reduce my chances of having a rear-end crash (5)	○	○	○	○	○
FCW alarms/alerts give me enough time to apply the brakes (6)	○	○	○	○	○
I am not particularly trusting of the effectiveness of FCW (7)	○	○	○	○	○

I think I have become less attentive as a driver because of the fitment of FCW in my car (8)	○	○	○	○	○

Page Break

To the best of your knowledge is your car fitted with Autonomous Emergency Braking (AEB)? *This technology will detect an imminent crash with another vehicle or object ahead of your car and automatically brake without you having to do so to avoid the crash*

- ◯ My car is fitted with this feature (1)
- ◯ My car is not fitted with this feature (2)
- ◯ I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. If answer (2) or (3) go to next technology, Radar Cruise Control

Which one of the following statements best describes your understanding and use of AEB fitted to your car.

- ▢ I do not know if the AEB system in my car is switched on or off (1)
- ▢ The AEB system in my car is always switched on, unchanged from factory setting (2)
- ▢ The AEB system in my car is always switched on but I sometimes change the settings to suit the road environment (3)
- ▢ I mostly or always drive with the AEB systems turned off (4)
- ▢ Other, please explain (5) ____

Have you ever experienced the AEB_system in operation alert (i.e., the car automatically braked) whilst you have been driving the car?

- ◯ I am not sure/can't recall (1)
- ◯ No, never (2)
- ◯ Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about AEB. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
AEB leads to unnecessary, automatic braking (1)	○	○	○	○	○
AEB can reduce my chances of having a rear-end crash or colliding with another object (2)	○	○	○	○	○
I have trust in the effectiveness of AEB (3)	○	○	○	○	○
I think I have become less attentive when I drive with AEB switched on and ready to automatically brake (4)	○	○	○	○	○
I would prefer it if my car's AEB as switched off (5)	○	○	○	○	○
I feel less in control of the car when AEB is switched on (6)	○	○	○	○	○
AEB can help me keep a	○	○	○	○	○

safe distance from the car in front at all times (7)					
I worry that the car behind will run into the back of me if my AEB is suddenly activated (8)	○	○	○	○	○

Page Break

To the best of your knowledge is your car fitted with Adaptive or Radar Cruise Control (ACC)? *This technology will automatically adjust the speed of your car when in cruise control to maintain a safe distance from the car in front of you.*

- My car is fitted with this feature (1)
- My car is not fitted with this feature (2)
- I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. If answer (2) or (3) then go to next technology, LDW

Which one of the following statements best describes your understanding and use of ACC fitted to your car.

- I do not know if the ACC system in my car is switched on or off (1)
- I *always* drive with the ACC switched on to maintain a safe distance from the car ahead but change the setting depending to match the speed limit of the road (2)
- I am more likely to drive with the ACC switched on when I am driving outside the metropolitan area or when driving on high speed roads (3)
- I am more likely to drive with the ACC switched on when I am driving in the metropolitan area or when driving on lower speed roads (4)
- I mostly or always drive with the ACC switched off (5)
- Other, please explain (6) ____________________

Have you ever experienced the ACC in operation (i.e., the speed of the car adjusted automatically to maintain a safe distance from the car in front) whilst you have been driving the car?

- ◯ I am not sure/can't recall (1)
- ◯ No, never (2)
- ◯ Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about ACC. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
ACC can help me to keep to the posted speed limit (1)	○	○	○	○	○
ACC is unreliable; it does not always maintain the speed or distance settings (2)	○	○	○	○	○
ACC can reduce fuel consumption (3)	○	○	○	○	○
I feel less in control of the car when ACC is in operation (4)	○	○	○	○	○
I would prefer it if my car's ACC could be permanently switched off (5)	○	○	○	○	○
ACC can help me keep a safe distance from the car in front at all times (6)	○	○	○	○	○
I do not trust the ACC system in my car (7)	○	○	○	○	○

ACC can reduce the likelihood of feeling fatigued when driving long distances (8)	○	○	○	○	○
I feel less attentive as a driver when ACC is operational (9)	○	○	○	○	○

Page Break

To the best of your knowledge is your car fitted with Lane Departure Warning (LDW)? *This technology will warn you if your car starts to wander out of the lane and you have not indicated that you intend to change lanes or road position. It will not automatically adjust your car's lane position.*

- ◯ My car is fitted with this feature (1)
- ◯ My car is not fitted with this feature (2)
- ◯ I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. If answer (2) or (3) then go to next technology, LKA

Which one of the following statements best describes your understanding and use of LDW fitted to your car.

- ☐ I do not know if the LDW system in my car is switched on or off (1)
- ☐ I *always* drive with the LDW switched on, unchanged from the factory setting, to alert me if my car is wandering out of the lane (2)
- ☐ I always drive with the LDW systems switched on but I change the setting depending on the road environment (3)
- ☐ Depending on the road environment I sometimes switch off the LDW system (4)
- ☐ I mostly or always drive with the LDW systems switched off (5)
- ☐ Other, please explain (6) ____________________

Have you ever experienced the LDW system in operation (i.e., you heard or felt an alert that you were wandering out of the lane) whilst you have been driving the car?

- I am not sure/can't recall (1)
- No, never (2)
- Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about LDW. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
LDW produces false or unnecessary alerts (1)	○	○	○	○	○
LDW helps me to be a safer driver (2)	○	○	○	○	○
I feel less in control of the car when LDW is switched on (3)	○	○	○	○	○
LDW alerts can be distracting (4)	○	○	○	○	○
I would prefer it if my car's LDW could be permanently switched off (5)	○	○	○	○	○
I do not trust the LDW system fitted to my car (6)	○	○	○	○	○
LDW can reduce my chances of running of the road (7)	○	○	○	○	○
LDW will not reduce my chances of	○	○	○	○	○

having a crash caused by fatigue or sleepiness (8)					
I feel less attentive as a driver when LDW is operational (9)	○	○	○	○	○
LDW alerts give me enough time to move my car safely back into the lane (10)	○	○	○	○	○

Page Break

To the best of your knowledge is your car fitted with <u>Lane Keeping Assist</u> (LKA)? *This technology will detect when your car starts to wander out of the lane, without you having put your indicator on, and will <u>automatically</u> move the car back into the lane without your input*

- ◯ My car is fitted with this feature (1)
- ◯ My car is not fitted with this feature (2)
- ◯ I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. If answer (2) or (3) then go to next technology, BSM

Which one of the following statements best describes your understanding and use of LKA fitted to your car.

- ☐ I do not know if the LKA system in my car is switched on or off (1)
- ☐ I *always* drive with the LKA switched on, unchanged from the factory setting, to alert me if my car is wandering out of the lane (2)
- ☐ I always drive with the LKA systems switched on but I change the setting depending on the road environment (3)
- ☐ Depending on the road environment I sometimes switch off the LKA system (4)
- ☐ I mostly or always drive with the LKA system switched off (5)
- ☐ Other, please explain (6) ____

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Have you ever experienced the LKA system in operation (i.e., your car automatically moved you back into the lane you were wandering out of) whilst you have been driving the car?

- ○ I am not sure/can't recall (1)
- ○ No, never (2)
- ○ Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about LKA. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
LKA unnecessarily tries to move my car back into the lane (1)	○	○	○	○	○
LKA helps me to be a safer driver (2)	○	○	○	○	○
I feel less in control of the car when LKA is switched on (3)	○	○	○	○	○
LKA can be distracting (4)	○	○	○	○	○
I would prefer it if my car's LKA could be permanently switched off (5)	○	○	○	○	○
I do not trust the LKA system fitted to my car (6)	○	○	○	○	○
LKA can reduce my chances of running of the road (7)	○	○	○	○	○
LKA will not reduce my chances of having a	○	○	○	○	○

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crash caused by fatigue or sleepiness (8)					
I feel less attentive as a driver when LKA is operational (9)	○	○	○	○	○

Page Break

To the best of your knowledge is your car fitted with <u>Blind Spot Monitoring</u> (BSM)? *This technology will detect when another vehicle is in the adjacent lane, in your blind spot, and alert you of that vehicle's presence.*

- ◯ My car is fitted with this feature (1)
- ◯ My car is not fitted with this feature (2)
- ◯ I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. If answer (2) or (3) then go to next technology, AA

Which one of the following statements best describes your understanding and use of BSM fitted to your car.

- ☐ I do not know if the BSM system in my car is switched on or off (1)
- ☐ I *always* drive with the BSM switched on, unchanged from the factory setting, to alert me if my cars are in my blind spot (2)
- ☐ I always drive with the BSM systems switched on but I change the setting depending on the road environment (3)
- ☐ Depending on the road environment I sometimes switch off the BSM system (4)
- ☐ I mostly or always drive with the BSM system switched off (5)
- ☐ Other, please explain (6) ____________________

Have you ever experienced the BSM system in operation (i.e., you were alerted to another car in your blind spot) whilst you have been driving the car?

- I am not sure/can't recall (1)
- No, never (2)
- Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about BSM. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
BSM produces false or unnecessary alerts (1)	○	○	○	○	○
BSM helps me to be a safer driver (2)	○	○	○	○	○
BSM alerts can be distracting (3)	○	○	○	○	○
I would prefer it if my car's BSM could be permanently switched off (4)	○	○	○	○	○
I do not trust the BSM system fitted to my car (5)	○	○	○	○	○
BSM can reduce my chances of colliding with another car in an adjacent lane (6)	○	○	○	○	○
BSM alerts can help me change lanes safely (7)	○	○	○	○	○
I feel less attentive as a driver when	○	○	○	○	○

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BSM is operational (8)

To the best of your knowledge is your car fitted with <u>Attention Assist</u> (AA)? *This technology will detect when you show signs of drowsiness and warn that you should stop driving the car or change drivers*

- ◯ My car is fitted with this feature (1)
- ◯ My car is not fitted with this feature (2)
- ◯ I am unsure if my car is fitted with this feature (3)

Go to next question if= My car is fitted with this feature. Answer (2) or (3) go to question on AGE

Q41 Which one of the following statements best describes your understanding and use of AA fitted to your car.

- ☐ I do not know if the AA system in my car is switched on or off (1)
- ☐ I *always* drive with the AA system switched on, unchanged from the factory setting, to alert me if I become drowsy (2)
- ☐ I always drive with the AA system switched on but I change the setting depending on the road environment (3)
- ☐ Depending on the road environment I sometimes switch off the AA system (4)
- ☐ I mostly or always drive with the AA system switched off (5)
- ☐ Other, please explain (6) ____________________

Have you ever experienced the AA system in operation (i.e., you were alerted to increased drowsiness) whilst you have been driving the car?

- ◯ I am not sure/can't recall (1)
- ◯ No, never (2)
- ◯ Yes, one or more times (3)

I am now going to ask you to indicate your level of Agreement/Disagreement with a series of statements about AA. You can choose from Strongly Disagree, Disagree, Uncertain/Don't Know, Somewhat Agree and Strongly Agree. Please indicated your level of Agreement/Disagreement with each statement I am about to read to you.

	Strongly disagree (8)	Somewhat disagree (9)	Uncertain/Don't know (10)	Somewhat agree (11)	Strongly agree (12)
AA produces false or unnecessary alerts about my drowsiness (1)	○	○	○	○	○
AA helps me to be a safer driver (2)	○	○	○	○	○
AA can be distracting (3)	○	○	○	○	○
I would prefer it if my car's AA system could be permanently switched off (4)	○	○	○	○	○
I do not trust the AA system fitted to my car (5)	○	○	○	○	○
AA can reduce my chances of having a crash caused by drowsiness or fatigue (6)	○	○	○	○	○
I am less likely to monitor my own drowsiness or fatigue when AA is in	○	○	○	○	○

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operation (7)

Could you please provide some brief, non-identifying, information about yourself

Which of the following age brackets are you in? *Please select one of the following*

- ◯ 17-25 years (1)
- ◯ 26-39 years (2)
- ◯ 40-49 years (3)
- ◯ 50-59 years (4)
- ◯ 60-69 years (5)
- ◯ 70+ years (6)

What is your gender? *Please select one of the following options*

- ◯ Female (1)
- ◯ Male (2)
- ◯ Other (4)

Please provide your four digit post code.

That is the end of the interview. On behalf of the Curtin-Monash Accident Research Centre, thank you for participating in the Advanced Driver Assistance Technology survey.
As previously mentioned, if you require, I can provide you with contact details of the University's Human Research Ethics office or of the project's research manager.

Finally, if you would like further information about the Driver Assistance Technologies fitted to your vehicle and their settings we recommend that you contact your Dealer Service Centre.

Goodbye.

APPENDIX 2

LIST OF VEHICLE MOST FREQUENTLY DRIVEN BY STUDY PARTICIPANTS

NB: This list has not been edited; vehicle names appear as was inputted by data collection officers at the ECU Survey Research Centre.

Make, Model, Variant	Frequency	Percent
AUDI 23	1	0.3
AUDI A3	1	0.3
AUDI A6	2	0.7
AUDI Q5	6	2.0
AUDI Q7	5	1.7
AUDI RS6	1	0.3
AUDI S3	1	0.3
AUDI SQ 5	1	0.3
BENTLY CONTINENTAL GT	1	0.3
BMW 225I	1	0.3
BMW 3 SERIES	1	0.3
BMW 320	1	0.3
BMW 320 D	1	0.3
BMW 320D	1	0.3
BMW 340	1	0.3
BMW C SERIES	1	0.3
BMW F30 340I	1	0.3
BMW S30I	1	0.3
BMW X1 19D	1	0.3
BMW X3	1	0.3
BMW X5	7	2.3
BMW X6	1	0.3
BMW, 4 30 I CONVERTIBLE	1	0.3
BMX 3 SERIES LUXARY	1	0.3
BMX X5	1	0.3
C250 MERCEDES	1	0.3
CHEVOLET SLIVERADO	1	0.3
CHEVROLET SILVERADO	1	0.3
FIAT ABARTH 124	1	0.3
FORD ESCAPE	1	0.3
FORD EVEREST	1	0.3
FORD EVEREST TREND	1	0.3
FORD MUSTANG BULLITT	1	0.3
FORD MUSTANG GT	1	0.3
FORD RANGER	3	1.0
FORD RANGER FX	1	0.3
FORD RANGER WILDTRACK	2	0.7
FORD RANGER WILDTRAK	2	0.7

FORD RANGER XL	1	0.3
FORD RANGER XLT	3	1.0
FORD WILD TRACT RANGER.	1	0.3
FORD WILDTRAK MK2	1	0.3
HOLDEN ASTRA SPORT WAGON	1	0.3
HOLDEN CAPRISE DK	1	0.3
HOLDEN CAPRISE V	1	0.3
HOLDEN CAPTIVA	2	0.7
HOLDEN COLORADO	1	0.3
HOLDEN COLORADO DUAL CAB 4X4	1	0.3
HOLDEN COMMODORE CALAIS VF	1	0.3
HOLDEN COMMODORE VF	1	0.3
HOLDEN COMMODORE VS	1	0.3
HOLDEN HSC R8	1	0.3
HOLDEN REDLINE SERIES 2	1	0.3
HOLDEN TRAILBLAZER	1	0.3
HOLDEN, COMMODORE UTE	1	0.3
HONDA ACCORD EURO	1	0.3
HONDA CIVIC	1	0.3
HONDA CRV	2	0.7
HONDA HRV	1	0.3
HSV GTS	1	0.3
HSV GTSR	1	0.3
HYANDAI I30	1	0.3
HYUNDA. HIGHLANDER.	1	0.3
HYUNDAI	1	0.3
HYUNDAI I30 DI	1	0.3
HYUNDAI I30 SR	1	0.3
HYUNDAI SANTA FE	1	0.3
HYUNDAI SANTA FE HYLANDER	1	0.3
HYUNDAI SANTA-FE	1	0.3
HYUNDAI SATAFE	1	0.3
ISUZU DMAX	1	0.3
JAGUAR R SPORT	1	0.3
JAQUAR F/PACE SUV	1	0.3
JAQUARE FF PACE	1	0.3
JEEP CHEROKEE DIESEL	1	0.3
JEEP CHEROKEE TRAILHAWK	1	0.3
JEEP CHEROOKE OVERLAND	1	0.3
JEEP GRAND CHEROKEE	1	0.3
JEEP GRAND CHEROOKE	1	0.3
JEEP GRAND CHERORKE SRT	1	0.3
JEEP HEMI WAGON	1	0.3
JEEP OVERLANDER	1	0.3
KHIA SORRENTO 2016 PLATINUM MODEL	1	0.3
KIA CARNIVAL	2	0.7
KIA CARNIVALE DK	1	0.3

KIA RIO SLI	1	0.3
KIA SPORTAGE	1	0.3
LAND CRUSIER TOYOTA 200 SERIES	1	0.3
LAND ROVER	1	0.3
LAND ROVER DISCOVERY SPORT HSE	1	0.3
LANDCRUISER TOYOTA	1	0.3
LANDROVER DISCOVER SERES 4	1	0.3
LANDROVER DISCOVERY	1	0.3
LANDROVER DISCOVERY 4	1	0.3
LANDROVER DISCOVERY SE	1	0.3
LANDROVER DISCOVERY SPORT	1	0.3
LANDROVER RANGE ROVER SPORT	1	0.3
LANDROVER RANGEROVER	1	0.3
LEXUS C2000 HYBRID	1	0.3
LEXUS CT 200 H	1	0.3
LEXUS ES350	1	0.3
LEXUS GS450H	1	0.3
LEXUS IF250	1	0.3
LEXUS IS250	1	0.3
LEXUS IS350	1	0.3
LEXUS NX 200T	1	0.3
LEXUS NX 300	1	0.3
LEXUS NX-300	1	0.3
LEXUS NX300H	1	0.3
LEXUS R350	1	0.3
LEXUS RX 350	1	0.3
MALOO HSV HOLDEN.	1	0.3
MAZADA SIX	1	0.3
MAZDA 3 TOURING EDITION	1	0.3
MAZDA 6	1	0.3
MAZDA 6 KSPEED	1	0.3
MAZDA 6 SPORT	1	0.3
MAZDA ATENZA	1	0.3
MAZDA CX-5	1	0.3
MAZDA CX3	1	0.3
MAZDA CX5	5	1.7
MAZDA CX7 TURBO SPORT	1	0.3
MAZDA CX9	1	0.3
MAZDA FOUR WHEEL DRIVE CX5	1	0.3
MAZDA MX5	1	0.3
MAZDA TWO	1	0.3
MAZDA, CX 5. 2016	1	0.3
MERCEDED C63	1	0.3
MERCEDES 250	2	0.7
MERCEDES 350.	1	0.3
MERCEDES A200	1	0.3
MERCEDES A45 HATCH BACK AMG	1	0.3

MERCEDES AA45	1	0.3
MERCEDES AMG C63 COUPE	1	0.3
MERCEDES AMG C63S	1	0.3
MERCEDES AMG45 GLE	1	0.3
MERCEDES BENZ 350GLE	1	0.3
MERCEDES BENZ CLE45AMG	1	0.3
MERCEDES BENZ E200	1	0.3
MERCEDES BENZ GLC 250	1	0.3
MERCEDES BENZ GLS	1	0.3
MERCEDES BENZ ML350	1	0.3
MERCEDES C CLASS	1	0.3
MERCEDES C200	3	1.0
MERCEDES C300	1	0.3
MERCEDES C45 AMG	1	0.3
MERCEDES CLS 250	1	0.3
MERCEDES E 300	1	0.3
MERCEDES E300	2	0.7
MERCEDES GLC T50 DIESEL	1	0.3
MERCEDES GLC250	1	0.3
MERCEDES GLE	1	0.3
MERCEDES GLS	1	0.3
MERCEDES ML 500	1	0.3
MERCEDES ML 63	1	0.3
MERCEDES ML 63 AMG	1	0.3
MERCEDES ML400	1	0.3
MERCEDES S350	1	0.3
MERCEDES SL3 AMG	1	0.3
MERCEDES TLC	1	0.3
MERCEDES-BENZ 350	1	0.3
MERCEDEZ BENZ CLA 45 AMG	1	0.3
MERCEDEZ BENZ V CLASS	1	0.3
MERCEDEZ C250	1	0.3
MINI COOPER COUNTRYMAN	1	0.3
MITSUBISHI ECLIPSE	1	0.3
MITSUBISHI ECLIPSE CROSS	1	0.3
MITSUBISHI OUTLANDER.	1	0.3
NISSAN PATROL	2	0.7
NISSAN PATROL TIL	1	0.3
NISSAN UASHUAI DK	1	0.3
NISSAN, QUASHAI, 2015	1	0.3
PERGEOT 508	1	0.3
PORCHE CAYENNE	1	0.3
PORCHE MACAN S	1	0.3
PORSCHE CAYENNE TURBO PLATINUM	1	0.3
RANGE ROVER EVOKE	2	0.7
RANGE ROVER SPORT	1	0.3
RANGE ROVER TDV8 AUTO BIOGRPAHY	1	0.3

RANGE ROVER VOGUE HSE	1	0.3
RANGE ROVER VOGUE TDV8	1	0.3
RANGEROVER SPORT V8 DIESEL	1	0.3
RANGEROVER VOGUE	1	0.3
RENAULT KOLEOS	1	0.3
RX350 LEXUS	1	0.3
SABURU FORSTER	1	0.3
SABURU OUTBACK	1	0.3
SKODA OCTAVIA SCOUT	1	0.3
SUBARU FORRESTER	2	0.7
SUBARU FORRESTER TS	1	0.3
SUBARU IMPREZA 2.0 L	1	0.3
SUBARU IMPREZA MY18	1	0.3
SUBARU LIBERTY	1	0.3
SUBARU LRG	1	0.3
SUBARU OUBACK	1	0.3
SUBARU OUTBACK	1	0.3
SUBARU OUTBACK DK	1	0.3
SUBARU OUTBACK PREMIUM MODEL	1	0.3
SUBARU XV	3	1.0
SUBARUOUTBACK PREMIUM	1	0.3
TESLA MODEL S	1	0.3
TOYOTA 200 SERIES	1	0.3
TOYOTA ATARA SL	1	0.3
TOYOTA CHR	1	0.3
TOYOTA COROLLA	1	0.3
TOYOTA HYLUX	1	0.3
TOYOTA KLUGA	1	0.3
TOYOTA KLUGER	1	0.3
TOYOTA KLUGER GRANDE	4	1.3
TOYOTA LAND CRUISER	1	0.3
TOYOTA LAND CRUISER SAHRA	1	0.3
TOYOTA LAND CRUISER VX	2	0.7
TOYOTA LANDCRUISER 150 SERIES	1	0.3
TOYOTA LANDCRUISER 200 SERIES SAHARA	1	0.3
TOYOTA LANDCRUISER PRADO DK	2	0.7
TOYOTA LANDCRUISER PRADO GXL	2	0.7
TOYOTA LANDCRUISER SAHARA	4	1.3
TOYOTA LANDCRUISER VX	1	0.3
TOYOTA ORION	1	0.3
TOYOTA PRADO	5	1.7
TOYOTA PRADO KADADO	1	0.3
TOYOTA PRADO VXL	1	0.3
TOYOTA PRIUS	1	0.3
TOYOTA RAV 4	1	0.3
TOYOTA, CAMRY, SL	1	0.3
TOYOTA. PRADO.	1	0.3

TOYOTALAND CRUISER SAHARA	1	0.3
VOLKSWAGEN AMROK UTE HI LINE	1	0.3
VOLKSWAGEN ARTEON	1	0.3
VOLKSWAGEN GOLF ALLTRACK 7.5	1	0.3
VOLKSWAGEN GOLF GTI	1	0.3
VOLKSWAGEN GOLF WAGON SURAC	1	0.3
VOLKSWAGEN TIGUAN TS1	1	0.3
VOLKWAGEN TOURAG	1	0.3
VOLVO S60	1	0.3
VOLVO X3 60 R	1	0.3
VOLVO XC 60	1	0.3
VOLVO XC60	4	1.3
VOLVO XC70	1	0.3
VOLVO XC90	4	1.3
VW TIGUAN TSI	2	0.7
VW TUEREC SPORT	1	0.3
XC60 VOLVO	1	0.3
Total	**301**	**100.0**