Public Perceptions of Shared Autonomous Vehicles and the Supplementation of Public Transport Infrastructure in Christchurch City

Table of Contents

Executive Summary

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The Christchurch City Council are considering the introduction of shared autonomous vehicles (SAVs) as a form of public transport in Christchurch. To do this successfully, they are looking at trialling their SAV on a CBD route. This research project focused on gauging public perceptions of AVs and determining if there were any perceived gaps in the public transport infrastructure that could be used to trial them. The research questions were:

- What is the public perception towards the integration of autonomous vehicles (AV) within Christchurch; and
- What routes would complement current and future infrastructure?

To gather data, systematic sampling was used when conducting in-person surveys. These were conducted at the Metro Bus Interchange on weekdays. Analysis showed that most people felt safer in a conventional vehicle than in an AV, and on average males feel safer than females in an AV (3.31/5 vs 2.85/5). Two CBD-based trial routes were designed based on survey analysis to meet the current and future transport needs of the public.

Introduction

Autonomous vehicles (AVs) are defined as automobiles that can partially or fully drive themselves without a human driver (Anderson et al., 2014). Though New Zealanders may be a while off owning fully automated private cars; the conversation around the use of shared autonomous vehicles (SAVs) is gathering momentum, with Christchurch leading the way. The Christchurch City Council (CCC) are looking at introducing SAVs as a form of public transport in Christchurch; one of the early stages of this project is the creation of a CBD-based route to trial an SAV on. The CCC want the route to enhance public engagement with the scheme and promote individualsô familiarity with the idea of AVs, while filling any perceived gaps in CBD public transport. Based on this brief, the following research questions were produced:

1. What is the public perception towards the integration of AVs within Christchurch?
2. What routes would complement current and future infrastructure?

The following research objectives were chosen to accompany the questions:

1. When considering the introduction of AVs, what demographic links are observed? Are there specific demographics that are more accepting?
2. What gaps are there in current transport infrastructure?
3. Considering form of transport, frequency, and purpose, how do individuals currently use transport systems?
4. What AV routes could compliment the current transport systems?

This report will detail the research that answers these questions, beginning by reviewing previous literature regarding perceptions of AVs, and subsequently explaining the methods used to gather the data. Following this, results will be presented and analysed; concluding with a discussion of research limitations and suggestions for future research avenues to pursue.

Literature Review

Many countries are considering the introduction of AVs as a more sustainable mass transport option. A wide array of research regarding AVs already exists; however, very few of these studies utilised their data for practical, real-world purposes (such as route generation) ï most present summary statistics and only provide basic analysis. Consequently, our work fits into a unique niche within existing literature.

Despite this, previous research into the perceptions of AVs still maintains relevance; it indicates the publicôs willingness to embrace a new system. The changing disposition of the Christchurch public around AV use will g0 1 170.1215.65 Tm0 g0 G[w)5(i)-4(l)-4(l)-4( )-16(g0 1 170.1215.

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ranging from one to five, were also used to gauge acceptance of the AV technology. Scale-based questions prompts the respondent to think about the question more than a closed answer; providing more detail than a yes/no answer, while avoiding the difficulty of having to analyse large quantities of open-ended responses (Clifford et al., 2010).

Data Gathering and Rationale

Survey respondents were targeted both in person and online to enable a good response rate, as well as encouraging a representative and unbiased sample of the population. In-person responses were collected over several sessions in the Christchurch CBD; the two targeted locations were the Cathedral Square and the Central Bus Interchange. The initial outings resulted in eighteen respondents over a four-hour period, which was a significant underachievement; the decision was made to share the survey online, which was not originally planned. The low response rate also led to the consideration of new locations for the in-person data collection. Thus, with permission from the Christchurch City Council (CCC) the primary survey location was changed to the Central City Bus Interchange.

During the first two data collection sessions at the interchange, approximately sixty responses were gathered over a three-hour period; proving to be a far more efficient location than Cathedral Square. Due to the response rate and time efficiency, it was decided to use the bus interchange for the remainder of the research period. It was noted by the researchers that this location may result in a respondent bias, as all those interviewed were current public transport users. However, it was decided that, overall, this was beneficial, as the respondents were likely more knowledgeable and willing to provide more qualitative detail when it came to the transport use questions. This enhanced the researcherôs ability to accurately generate routes that would best serve the public and compliment the current public transport infrastructure.

To obtain data from online respondents, the survey link was shared on multiple Facebook community groups (e.g. Halswell and Bishopdale community pages). These groups comprised of approximately 80,000 people, allowing for an extensive reach. When sharing the survey online, it was noted by the group that the respondents will likely be from a narrow demographic,


North Hagley Park
Botanic
Victoria Square

Discussion

Demographics Breakdown

A wide range of data was collected from our survey, all the data that is relevant to answering

Figure 2 shows a breakdown of the ages of people that completed the survey; it was observed that the 18-25 age demographic is overrepresented in our results when compared to other fields and census information for Christchurch (Figure 2). This potentially skewed some of the figures and could be attributed to a range of factors, primarily due to the ages of people completing the survey online and the researchers subconsciously surveying younger people, even though a random sample was taken.

Figure 3 shows us the genders of the respondents that completed the survey;

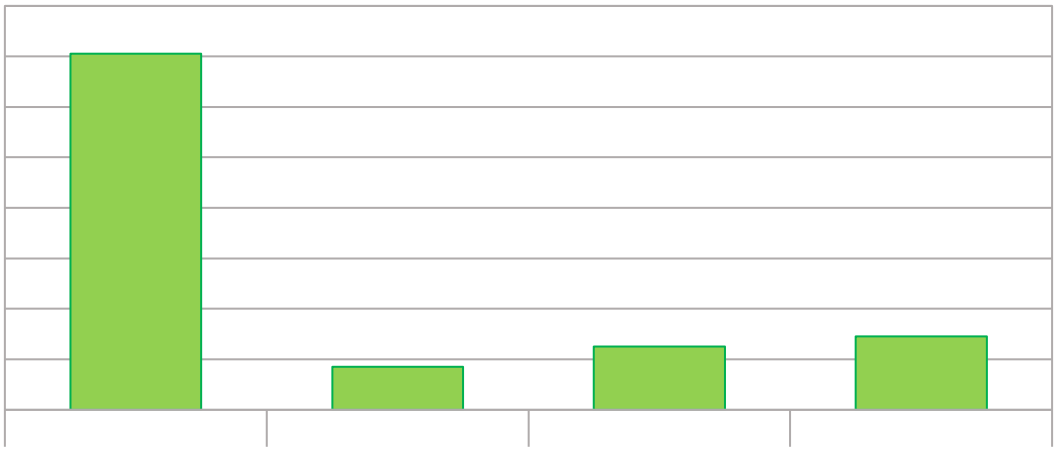


Figure 4: Graph showing a breakdown of the licence type respondents held

Figure 4 shows the type of licence, if any, the respondents had. As seen in the graph above, 141 respondents had full licences, 17 held their restricted, 25 had their learners and 29 held no licence whatsoever. This field could potentially be skewed by our data collection methods, as it is likely that the people surveyed at the bus interchange used public transport because they have no licence, therefore increasing the quantity in this field.

Age/Gender Comparisons

When examining the perceptions of autonomous vehicles, one of the parameters used to gauge respondentsô opinions was Question 7, which read ó On a scale of 1-5 how safe would you feel being a passenger in a driverless vehicle, compared to how safe you feel when you're a passenger in a conventional vehicle?ô

This caused some interesting results when comparisons were made between gender, age and how respondents perceived themselves regarding technology adoption. When examining the difference between genders, the mean score for how safe the 100 females felt in autonomous vehicles was far lower when compared with the 126 males; 2.85 and 3.31 respectively. This supports previous research on this topic conducted by Bansal, Kockelman & Singh, 2016; which found that females are more concerned about AV safety than males.

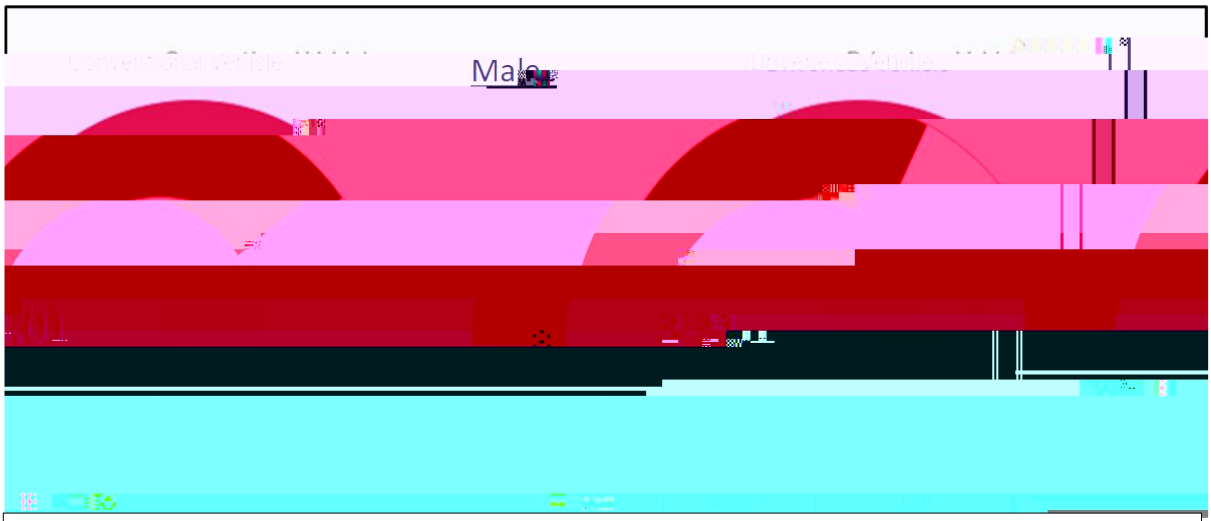


Figure 5: Graphs depicting the mean score of how safe males felt in conventional and autonomous (driverless) vehicles.

Figure 6: Graphs depicting the mean score of how safe females felt in conventional and autonomous (driverless) vehicles

Similarly, there was a clear link between age and how safe people felt aboard autonomous vehicles, as seen in Figures 7, 8 and 9. People over 50 scored themselves more than 0.5 points lower, on average, compared with people 50 and younger; this was expected, as in general, older people are slower to adopt new technologies. This is supported by studies such as Vaportzis, Giatsi, Clausen, & Gow, (2017), and Schoettle & Sivak, (2014), who found that younger respondents are more willing to and feel safer riding in self-driving vehicles.

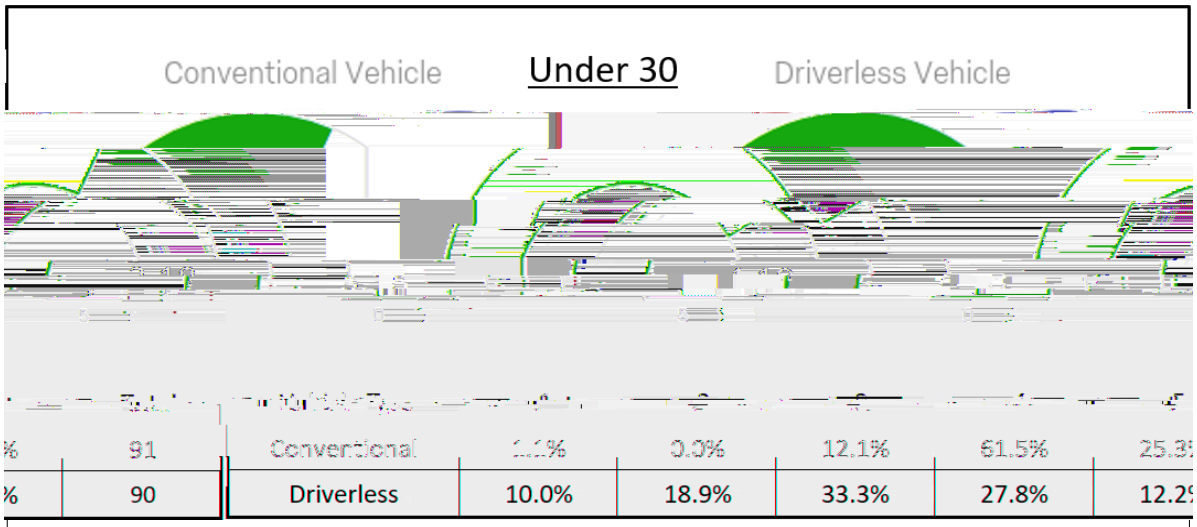


Figure 7: Graphs depicting the mean score of how safe respondents aged 30 and under felt in conventional and autonomous (driverless) vehicles

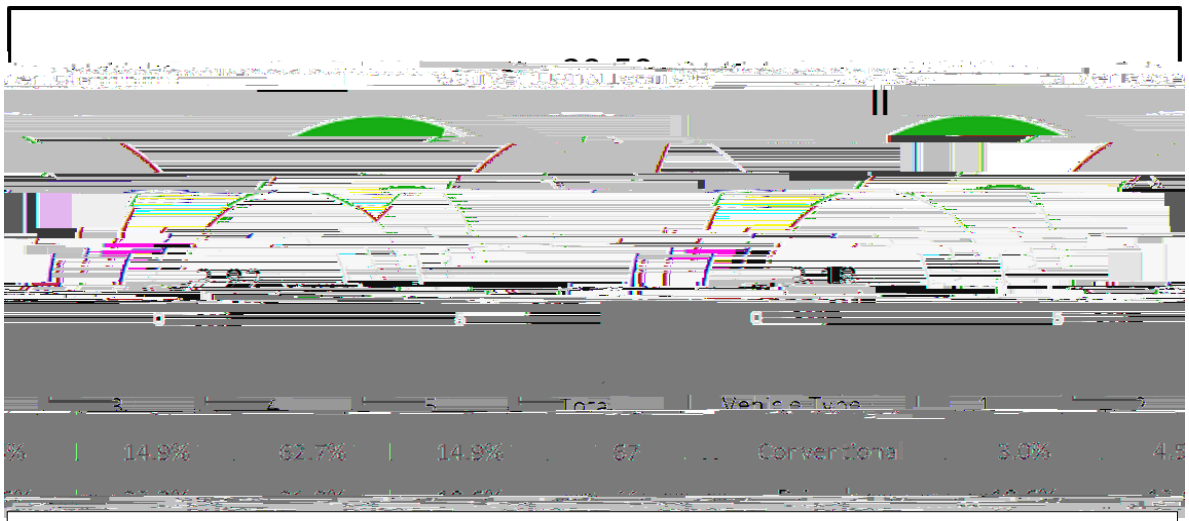


Figure 8: Graphs depicting the mean score of how safe respondents aged 30-50 felt in conventional and autonomous (driverless) vehicles

Safety and

Mode of Transport: Use and Frequency

of 78 daily bus users also walk daily as a mode of transport. This finding aligns well with our research, as it shows the need for first and last mile transport solutions. The first and last mile was referred to throughout the project by both the researchers and community partners; filling this gap is one of the primary objectives when introducing shared autonomous vehicles. It must be noted, however, that some respondents who selected ówalkô as a daily mode of transport may have had very different perceptions towards how much walking must be undertaken to define 1 72.04ne 1 0003>820ons towa1shows1sh(s)65(1r)16(a)7(e)-5(r)-1665(1t)-5(.-4(ĴTJ)17(i)-4(s)6( )-16,-

The results of the question ñWhat are the factors that are most important to you when considering the use of public transport?ò, displayed on Figure 14; show that the leading three answers were frequency, reliability and cost. This information was a key factor when designing the routes, which resulted in the prioritisation of service frequency and reliability through short geographical distances, while allowing for as many desired stop-off locations as practical; this keeps running costs down.

The survey question that provided this data was inspired by the work of UK-based Doug Paulley et al (2006), who completed a report on the demand of public transport, and the key factors contributing to the service quality. When comparing the findings to Paulleyôs, we found that the respondents ranked service frequency and reliability relatively high; on the other hand, the primary finding in Paulley et al (2006) was that interchange between transport modes was prioritised by UK public transport users. This was our third least important factor selected; this is likely due to differences in public transport infrastructure between Christchurch and the UK.

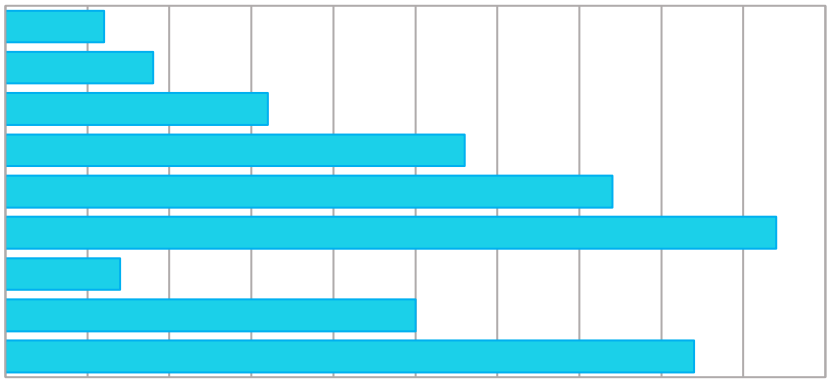
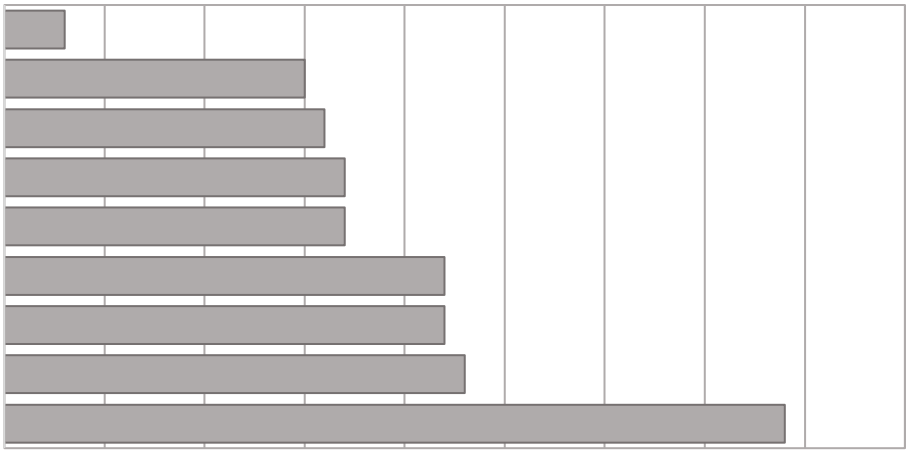


Figure 14: Graph showing the factors most important to respondents when considering the use of public transport in Christchurch

Age and Destinations

Question 17 read ôBeginning at the bus interchange in the CBD, what locations or areas most appeal to you when considering the development of new public transport routes?ô. This multi-choice question provided a choice of location themes to use when developing the routes. When this data was split into respective age groups it yields interesting results. In Figures 16, 17 and 18, one can see that individuals aged 30-50 rated hospitals lower than those under 30 and over 50 years old, and the 30-50 responses were relatively even across the categories. Another interesting finding is that younger people wanted to travel to residential areas, whereas older



Limitations

Method Limitations

193 of the 211 total in-person surveys conducted were with members of the public at the Lichfield Street bus interchange between 4-6pm on weekdays. While the results are useful, we encountered numerous limitations, and observed increased bias for the research results and subsequent analysis within this report.

Primarily, conducting in-person surveys at the bus interchange resulted in a bias towards individuals that already use public transport. Consequently, the sample demographics are not truely representative of the Christchurch population when compared to the 2013 census data. It can be observed that the 18-25 age demographic is overrepresented; this skewed some of the results.

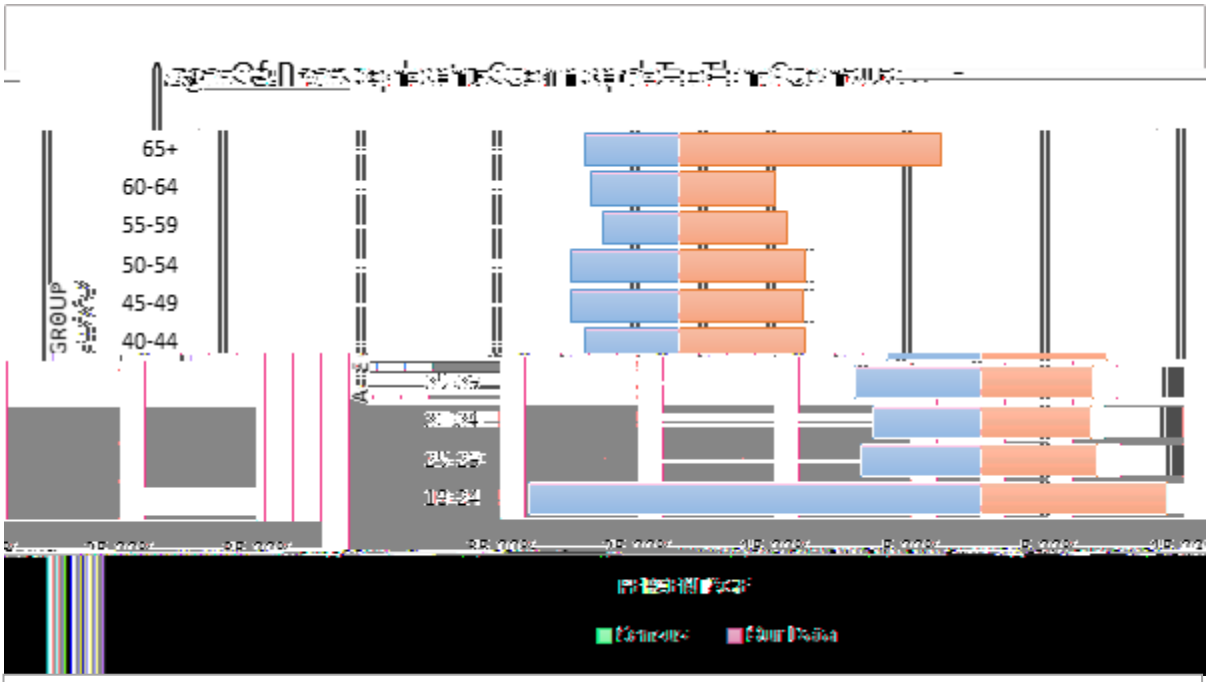


Figure 19: Graph showing a breakdown of the ages of respondents relative to the 2013 NZ census for Christchurch.

Figure 19 shows the bias that lies in the demographics of the age 18-24 respondents compared to the 2013 census; on the other hand, the 65+ age demographic is shown to be heavily underrepresented throughout our surveying. We attempted to minimise this bias by surveying people across multiple days and utilising a systematic sampling method where every *nth* person is selected, so that everyone has an equal chance of being selected (Oxford University Press, 2014). An attempt to survey every third individual was made. In future studies, we would recommend researchers attempt to target those that use other modes of transport in various hotspots around the city.

Surveying between 4-6pm on weekdays meant people surveyed were primarily those that commute to and from the CBD for work. This allowed us to improve the time efficiency of our surveying due to increased foot traffic; however, it may have biased the results towards the perceptions of workers, which are possibly different to other users. Any significant gaps in

current public transport infrastructure, however, are likely to have been recognised due to the large sample size of 277 and thematic saturation of their responses. In future studies, it would be recommended that researchers conduct their surveying during different times to minimise this bias.

By surveying in the CBD, the opinions of people who do not travel there due to accessibility may be missing from our results. This group are arguably the most important, as it could be those gaps in the infrastructure that are preventing travelling into town. Nava et al., (2017) also makes the point that while AVs could benefit many people, if their disability prevents them from accessing the stops or routes in the CBD, then nothing has been done to improve the groupsô mobility. This could be a future research project; apart from our online survey, we were unable to consider the opinions of groups outside our surveying location.

The use of online surveying methods contributed to our limitations through increased selection bias, as certain demographics are more likely to complete online surveys (Nulty, 2008). It can be observed that 18-25s were greatly overrepresented in our online survey results and no individuals in their 50s completed the survey online. This can be attributed to the demographics and algorithms of the platforms we shared the survey to, however, we were able to recognise these patterns by using a separate online survey version, so results could be compared.

Researcher and Route Limitations

This research only considers the development of proposed routes for AV trialling within the CBD, to increase public engagement and to utilise desirable destinations in an effective and efficient manner. In the locations that are recommended on the potential AV routes, there are areas where current infrastructure may not be able to accommodate the use of these vehicles. An example is the shared bike and walkways within Hagley Park; they have already been subject to controversy, and our proposal to introduce AVs into this environment will likely increase this (Macbeth et al., 2018). This leads to portions of the proposed routes being unsuitable for use, new or enhanced infrastructure to be implemented, or legislation introduced that accommodates AVs. For the results and legitimacy of the routes generated, we assumed that new legislation or enhanced infrastructure will be implemented alongside AV introduction.

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Conclusions

When considering AV implementation, one may be expecting it in the distant future. However, this may not be the case; researchers and companies are already developing prototypes and production vehicles across the globe (Litman, 2017). An AV network is widely considered to be the transport of tomorrow, as we focus on a sustainable future. This advanced timeline supports the need for more research on the social, economic and environmental effects of

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