



Future of Transport Technology 2017

Leading Indicators of Change

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Executive summary

The arrival of electric vehicles (electric cars, hybrid cars, and electric bikes) as well as the prospect of fully autonomous (self-driving) cars has significant implications for the current transport system in New Zealand. With growing media attention the general public is becoming increasingly aware of the potential benefits, as well as risks of these new transport modes. This report contributes to the literature by helping to gauge the attitudes of a sample of New Zealanders towards these new transport technologies.

This study has analysed the four different transport technologies in relation to Prochaska and DiClemente's Stages of Change framework (Prochaska and DiClemente, 1984). Studies of change have found that people tend to move through a series of stages when modifying their behaviour. For the adoption of technology, it is expected that people will become aware of a technology, gain knowledge about it and then form a perception of it. This is then followed by a decision to use or reject it (Prochaska and DiClemente, 1984).

The findings from this report are compared to those in a similar earlier report undertaken by the Ministry of Transport in 2016 (Wither, 2017). The findings from the 2016 report and this report are relatively consistent. For example, cost is cited as the main concern surrounding electric vehicle adoption and safety as the most important factor in self-driving car adoption. One noticeable difference between the findings of the 2016 report and this report is that the later has a decrease in knowledge and awareness of self-driving cars. Further research is needed to understand the potential reasons for this decrease.

In addition, this report compares the enablers and barriers to the adoption of these four new transport technologies in the United States, the United Kingdom, the Netherlands, Norway, China and Singapore. These countries have been selected because they are early adopters of these technologies. This comparison helps support this report's findings and provides insight into how the New Zealand context differs from overseas.

Key findings

Electric cars:

- 99% of the sample had heard of electric cars (no significant difference between 2016 and 2017).
- Knowledge of electric cars remained static between 2016 and 2017 at 3.59 on a 7-point Likert scale from 1 meaning "I know nothing about this" to 7 indicating "I know a great deal about this."
- Males reported greater knowledge as well as greater perceived attractiveness of electric cars compared to the females of the study.
- There was a moderate positive correlation between knowledge and attractiveness of electric cars.

- Electric cars were the only transport technology that showed a significant increase in usage between the 2016 and 2017 sample.

Hybrid cars:

- Awareness of hybrid cars was at 93.3% and remained consistent with the 2016 findings. Males indicated a greater awareness of hybrid cars compared to females.
- Self-reported knowledge of hybrid cars was 3.42 on a 7-point *knowledge scale* and did not differ significantly from the 2016 sample. Males tended to report greater knowledge of hybrid cars than females.
- On average, Auckland residents indicated greater knowledge of hybrid cars compared to the other regions.
- There was a moderate positive correlation between knowledge and attractiveness of hybrid cars.
- Usage of hybrid cars remained similar to the 2016 sample with 90.1% of respondents citing having not used a hybrid car in the past month.

Electric bikes:

- Awareness of electric bikes significantly increased between 2016 and 2017, with males tending to report greater awareness of electric bikes than females.
- An increase in age was linked with greater knowledge and awareness of electric bikes.
- Respondents with higher incomes reported a greater awareness of electric bikes.
- Secondary urban areas (places with populations of 10,000 – 29,999 people) reported greater awareness of electric bikes than those from main urban areas or rural areas however they had the lowest usage levels.
- There was a strong positive correlation between knowledge and attractiveness of electric bikes.
- The majority of respondents (95.4%) had not used an electric bike in the past month.

Self-driving cars:

- The average self-reported knowledge and awareness of self-driving cars decreased between 2016 and 2017.
- Older participants indicated a greater awareness of self-driving cars compared to the younger respondents. However, younger participants tended to view self-driving cars as safer and more attractive than the older respondents.
- There was a moderate positive correlation between knowledge of self-driving and perceived attractiveness.
- Aucklanders reported greater knowledge of self-driving cars and perceived them as safer than the other regions.

All four transport technologies:

- Male respondents tended to report greater knowledge and perceived attractiveness of all transport technologies compared to the female respondents. This discrepancy between genders was also reflected in the 2016 cohort.
- All four transport technologies showed moderate to strong correlations between knowledge and attractiveness.

Barriers and Enablers:

- The main barrier and enabler to adoption of electric vehicles (hybrid cars, electric cars and electric bikes) centred on cost.
- Safety was cited as both the biggest barrier and enabler to self-driving car adoption.
- Other countries reported similar barriers and enablers to the adoption of electric vehicles and self-driving cars to that in this report.

Monitoring the development of public attitudes towards electric vehicles and self-driving cars will continue to be an important task over the coming years. If the public is not convinced about the benefits of these technologies, then it is likely to be challenging to integrate them into the wider transport system.

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Definitions

Autonomous cars (AVs) also known as 'self-driving' or 'driverless' cars are vehicles that are capable of sensing their environments and navigating without human input. There are five levels of classification for autonomous cars ranging from some human control to no interference. This report will focus on the Society of Automotive Engineers' Level 5 Automation that describes cars that are completely autonomous i.e. cars with no human involvement or intervention (Dryve, 2014). "Self-driving cars" is the main terminology used in this report as it is most widely recognised to the general public (based on preliminary research), and is what was used for the survey questions in this study e.g. "Have you heard about self driving cars?".

Electric vehicles (EVs) include electric cars, hybrid cars and electric bikes in this research.

Significant defines those findings that are statistically significant at the 95% confidence level ($p = < 0.05$) as this follows typical social science convention.

1 Reading the report

This report looks at respondents' attitudes towards a number of new and emerging transport technologies in New Zealand:

1. Electric vehicles:
 - Electric cars
 - Hybrid cars
 - Electric bikes
2. Self-driving cars

Electric vehicles currently exist, and are in use in New Zealand whereas, aside from occasional pilot and test scenarios, self-driving vehicles are not currently on the main streets of New Zealand.

In order to better understand where each of the transport technologies (listed above) sit in the minds of the public, the vehicles will be analysed in terms of perceived attributes and potential consequences of adoption. The report is ordered according to the Stages of Change framework (Barry, 1987; Prochaska and DiClemente, 1984). This adoption framework observes new technologies in terms of 1) awareness, 2) knowledge, 3) attractiveness and 4) usage. Applying this framework is useful for demonstrating where New Zealand is currently positioned in terms of acceptance of new transport technologies in relation to other countries. The framework also allows for comparisons between the findings in the 2016 report (Wither, 2017) and this report.

This report also identifies the barriers and enablers to adoption of the four transport technologies. These barriers and enablers are then compared to findings from international research to identify any similarities and differences between New Zealand and other countries. Comparing the findings from this study to international work also helps to identify whether there are any issues that are more or less pertinent in New Zealand compared to other countries and invites further research to establish why there may be differences.

1.1 Statistical significance and guidance

After conducting a range of statistical tests, the findings in this report were selected on the basis of two guiding factors: whether the findings were statistically significant with 95% confidence ($p = < 0.05$), or whether the findings were interesting because they were not statistically significant.

1.2 Reading the Likert scales

The following table shows how to interpret the Likert scales for each of the three categories (knowledge, attractiveness and safety):

	1	2	3	4	5	6	7
<i>Knowledge scale</i>	I know nothing about this						I know a great deal about this
<i>Attractiveness scale</i>	Not at all attractive						Extremely attractive
<i>Safety scale</i>	Extremely unsafe						Extremely safe

1.3 Research methods

The Leading Indicators Future of Transport Technologies survey was sent to 3,740 people who were part of a panel of people who had previously completed the New Zealand Household Travel Survey and indicated that they would be happy to take part in further research. 935 people completed the survey online. This is the same methodology and question set as the survey conducted by the Ministry of Transport in 2016 (Wither, 2017). Most of the questions featured 7-point Likert scales that allowed respondents to rank their attitudes towards various aspects of electric vehicles and self-driving cars. After collection, the data was analysed using the statistical analysis program SPSS and the findings are presented in the following report.

1.4 Secondary research

Attitudes towards future transport technologies are further explored in this report through secondary research on transport developments in other countries. The findings in this section are drawn from academic articles, websites, news items and reports from government and business entities. The focus of this secondary research is on the top five countries that are either most likely to adopt, or have the greatest rate of adoption of electric and self-driving vehicles compared to other countries.

2 The sample and their groups

The sample comprised 935 New Zealanders between the ages of 15-65+. Respondents were from all regions in New Zealand and most were of New Zealand European decent.

2.1 Demographic distribution of the sample

The following section shows the demographic distribution of the sample by age, gender, region and area of residence as well as ethnicity.

Age distribution

The respondents' ages ranged from 15 years old to 87 years old. The largest age bracket is with the 45-54 year olds (23.3%) and the mean age of the sample is 50.4 years old. There is an underrepresentation of 18-24 year olds in this study, and an overrepresentation of all other age groups. The limited number of 18-24 year old respondents potentially skewed some results, for example, the identified correlations between age and perceived attractiveness and safety of autonomous vehicles may be greater than that reported.

Table 2.1: Age of respondents

Age range	Sample count	Sample percent	2013 Census percent
15-17	10	1.1	N/A
18-24	35	3.7	10
25-34	102	10.9	13
35-44	186	19.9	13
45-54	218	23.3	14
55-64	194	20.7	11
65+	190	20.3	14
Total	935	100	75

Gender of respondents

Of the respondents, 53.7% (502) are female and 46.3% (432) are male which reflects the general population within +/- 3% of the 2013 census data, where females are 51.3% and males are 48.7% (Statistics New Zealand, 2013).

Region of residence

The following tables show the regions (Table 2.2), Auckland and other regions (Table 2.3) and the rural/urban divide (Table 2.4). The percentage of each region in this study mostly reflects that of the New Zealand population, however Auckland is underrepresented with only 16.6% of respondents from this region when Aucklanders make up approximately a third of the country.¹

Table 2.2: Region of respondents

Region	Count	Percent	2017 Census percent (approximation) ¹
Auckland	155	16.6	34.6
Bay of Plenty	81	8.7	6.3
Canterbury	125	13.4	12.8
Gisborne	32	3.4	1.0
Hawke's Bay	35	3.7	3.4
Manawatu-Wanganui	55	5.9	5.0
Nels-Marlb-Tas	58	6.2	3.1
Northland	29	3.1	3.7
Otago	62	6.6	4.7
Southland	29	3.1	2.1
Taranaki	36	3.9	2.5
Waikato	106	11.3	9.6
Wellington	112	12	10.7
West Coast	19	2	0.7
Total	934	100	100.2

Table 2.3: Auckland and other regions

Region	Count	Percent	2017 Census percent (approximation) ²
Auckland	155	16.6	34.6
Other regions	779	83.4	65.6

¹ HTS sampling is for regional reporting, rather than population distribution, so Auckland underrepresentation is a feature of the sampling. It is compensated for by the weighting in the main HTS survey, but the panel surveys are a subset of a subset, so weights not calculated.

² Statistics New Zealand (2018).

Table 2.4: Rural/urban divide

	Count	Percent
Main urban area	661	70.7
Rural	215	23
Secondary rural area	59	6.3

Ethnicity of the sample

The self-reported ethnicity of the sample is shown in Table 2.5. The percentage of European New Zealanders in the sample closely aligns with the 2013 census data (74.6%, Statistics New Zealand, 2013). There is a slight underrepresentation of Maori respondents who make up 15.6% of the population, as well as Pacific peoples who make up 7.8%. Asian residents make up 12.2% of the New Zealand population and are also underrepresented in this data set. Those who cited 'Other' were of predominantly European as well as Asian, Filipino, African, Australian, Fijian, Argentine, and Canadian decent. The total is slightly above 100 percent (103%) as some respondents belonged to more than one ethnic group.

Table 2.5: Ethnicity of respondents

Ethnicity	Count	Percent
New Zealand European	730	75.6
Maori	93	9.6
Samoan	7	0.7
Cook Island Maori	5	0.5
Tongan	2	0.2
Niuean	2	0.2
Chinese	20	2.1
Indian	20	2.1
Other	91	9.4
Don't know	5	0.5
Total	966	103

3 Electric vehicles

The following chapter will look at three types of electric vehicles: electric cars, hybrid cars and electric bikes in relation to the Stages of Change framework (Prochaska, 1984). Specific barriers and enablers to the adoption of electric vehicles will also be discussed.

3.1 Electric cars

The overwhelming majority of respondents had heard of electric cars (99%, as shown on Table 3.1). Respondents' awareness of electric cars was more than that of the other transport technologies in this study, however, there was no statistically significant percentage change from the 2016 survey (98.2%) to the 2017 sample. There was also no significant difference in awareness of electric cars between genders, age or regions.

Table 3.1: Comparison of awareness of transport technologies between 2016 and 2017

Question	2016 Percent	2017 Percent	Percent Change
Have you heard about electric cars?	98.2	99	+ 0.8 (n.s.)*
Have you heard about hybrid cars?	92.8	93.3	+ 0.5 (n.s.)
Have you heard about electric bikes?	91.8	95.2	+ 3.3
Have you heard about self-driving cars?	94.5	91.1	- 3.3

*(n.s.) = non significant

Knowledge and attractiveness

The mean self-reported knowledge of electric cars was 3.59 on a 7-point *knowledge scale*, and remained almost identical to the 2016 survey (3.58) despite a different cohort. There were no statistically significant differences in knowledge of electric vehicles between regions and areas (e.g. urban or rural). However there was a gender difference with males reporting greater knowledge of electric cars (4.04) compared to females (3.21) ($p = < 0.000$) as seen in Table 3.2 and Figure 3.2.

Table 3.2: Gender differences in knowledge of future transport technologies

Question	Male	Female	Difference
How knowledgeable do you feel about electric cars?	4.04	3.21	0.83
How knowledgeable do you feel about hybrid cars?	4.03	2.89	1.14
How knowledgeable do you feel about electric bikes?	3.95	3.31	0.64
How knowledgeable do you feel about self-driving cars?	3.06	2.32	0.74

Likewise with knowledge of electric cars, the males also exhibited higher scores with regards to perceived attractiveness of electric cars (4.53) compared to females (4.16) as observed in Table 3.3 ($p = < 0.004$) and Figure 3.3.

Table 3.3: Gender differences in attractiveness of future transport technologies

Question	Male	Female	Difference
How attractive to you are electric cars?	4.53	4.16	0.37
How attractive to you are hybrid cars?	4.13	3.77	0.36
How attractive to you are electric bikes?	4.08	3.8	0.28
How attractive to you are self-driving cars?	3.06	2.69	0.37

Correlations

There was a moderate correlation between knowledge and attractiveness of electric cars ($p = < 0.000$, $r = 0.434$). This indicates that increased knowledge of electric cars is linked with greater perceived attractiveness (as demonstrated in Figure 3.1).

There were no significant differences in knowledge and usage of electric cars, or any of the other transport technologies in this study, between age groups.

Usage

Only 8 respondents cited using an electric car everyday/almost everyday representing less than one percent of the sample (0.9%). Twenty-two respondents (2.4%) had used electric cars once or twice in the last month while the vast majority (95.8%) had not used an electric car in the last month (refer to Table 3.4).

Sample comparison (2016/2017)

There were no significant differences in knowledge or attractiveness of electric cars between the 2016 and 2017 samples. In terms of usage, electric cars showed the only statistically significant change between 2016 and 2017 of the transport technologies in this report ($p = < 0.038$), however the change was small.

Figure 3.1: Knowledge and attractiveness of electric cars

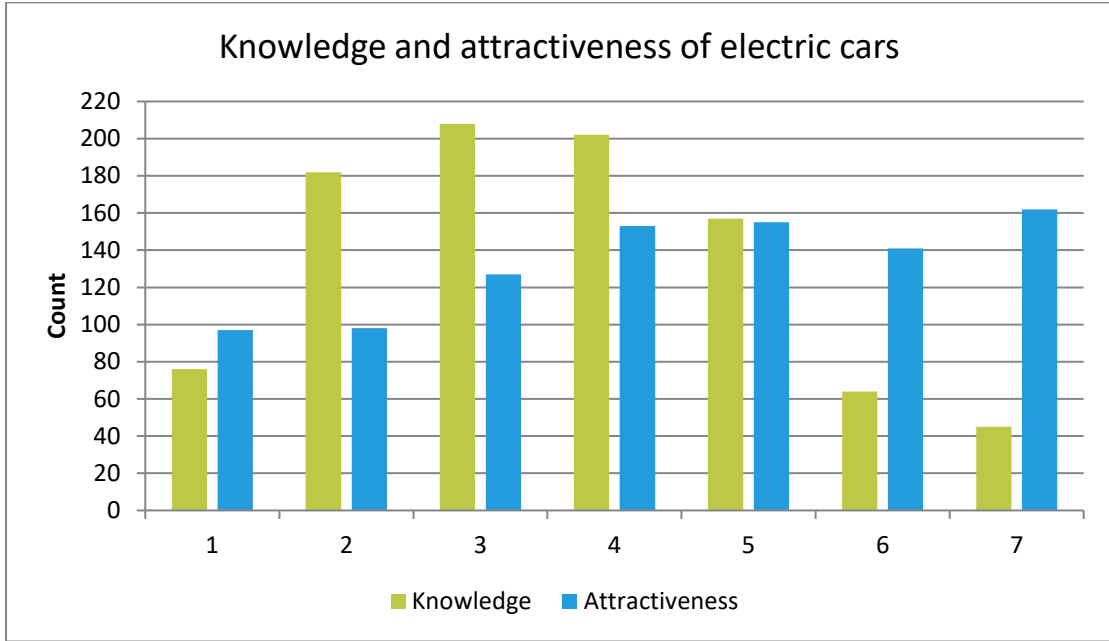


Figure 3.2: Relationship between gender and knowledge of electric cars

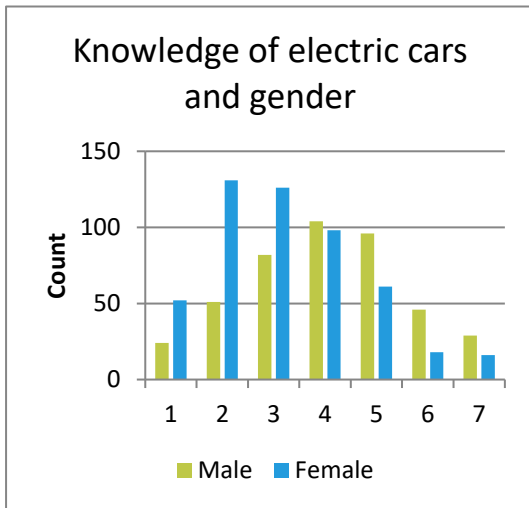
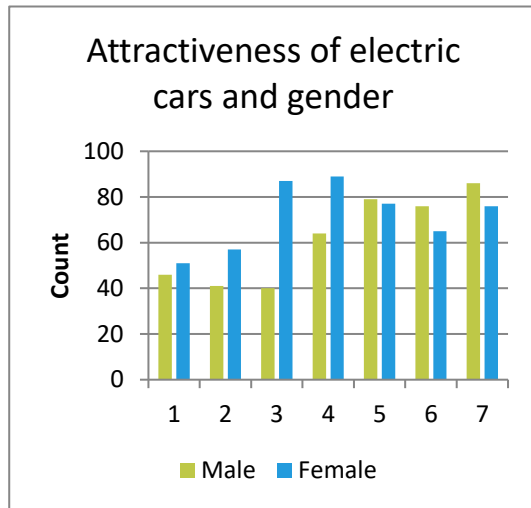


Figure 3.3: Relationship between gender and attractiveness of electric cars



3.2 Hybrid cars

Most respondents had heard of hybrid cars (93.3%) demonstrating a slight increase from the 2016 sample (92.8%), this change is not statistically significant. Of the male respondents, 98% had heard of hybrid cars compared to only 89% of females. This finding indicates a significant difference (almost 10%, $p < 0.000$) in awareness of hybrid cars between genders (refer to Table 3.1). There was no significant difference in awareness levels of hybrid cars between age groups or regions.

Knowledge and attractiveness

When asked about their knowledge of hybrid cars, most respondents were below the midpoint of the *knowledge scale* (3.42). This is slightly less than self-reported knowledge of the 2016 sample (3.52) however the difference is not statistically significant. There was a significant difference between genders with regards to knowledge of hybrid cars ($M = 4.03$, $F = 2.89$). Males averaged 1.14 points higher on the *knowledge scale* than females. The average knowledge of hybrid cars as reported by the female respondents is below the midpoint of the *knowledge scale* whereas the males were above (see Table 3.2).

Aucklanders demonstrated a significant difference in their knowledge of hybrid cars compared to the other regions ($p < 0.04$) with Aucklanders on average reporting greater knowledge compared to other regions (mean of 3.67 for the Auckland respondents and 3.36 for the other regions).

There was also a significant difference in knowledge of hybrid cars between the Waikato region and Bay of Plenty. Waikato participants self-reported greater knowledge about hybrid vehicles compared to the Bay of Plenty (mean difference = 0.866, $p < 0.008$). Attractiveness of hybrid cars remained the same over the 2016 and 2017 sample cohorts at 3.94 (slightly above the midpoint on the *attractiveness scale*).

Correlations

There was a positive correlation of moderate strength between knowledge and attractiveness of hybrid cars ($p < 0.000$, $r = 0.455$). Age was not related to a change in knowledge or attractiveness.

Usage

Over the past month from the time of the survey 90.1% of respondents had not used a hybrid car. Only 1.2% of the sample had used a hybrid car several times a week. Sixty-four respondents (6.8%) had used a hybrid car once or twice in the last month. These figures show a slight increase from 2016 but are not statistically significant enough to report on with confidence at present.

Table 3.4: In the last month, how often have you used a hybrid car?

	Frequency	Percent
Everyday/almost everyday	11	1.2
Several times a week	14	1.5
Once a week	3	0.3
Once or twice in the last month	64	6.8
Not used in the last month	842	90.1

Sample comparison (2016/2017)

Comparing levels of awareness, knowledge attractiveness towards hybrid cars from 2016 to 2017 showed no significant difference. There was also no significant difference in usage of hybrid cars between the 2016 and 2017 sample.

Figure 3.4: Knowledge and attractiveness of hybrid cars

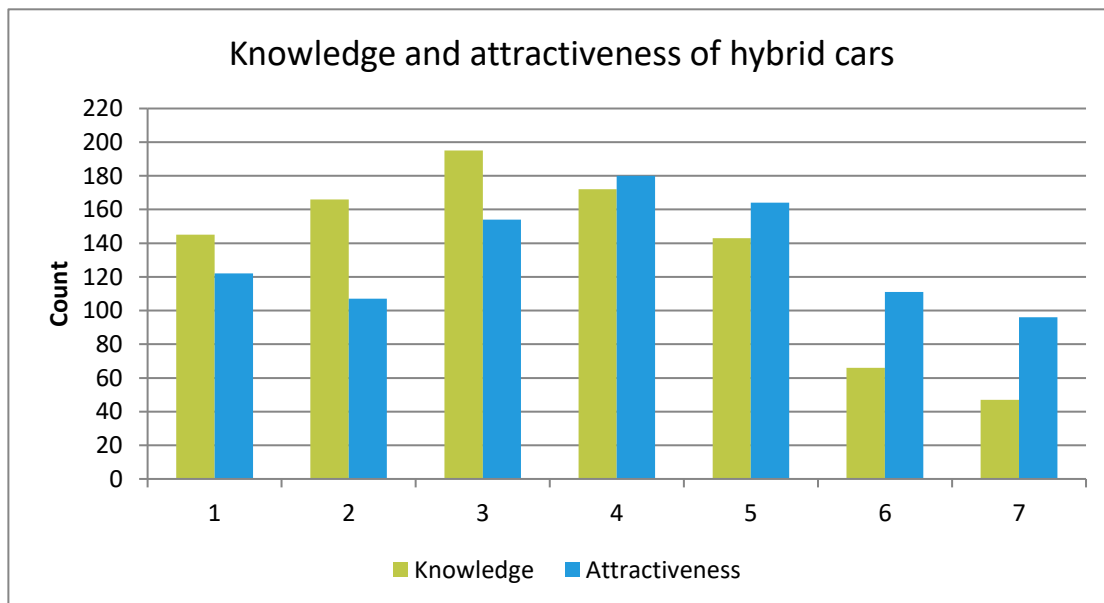


Figure 3.5: Relationship between gender and knowledge of hybrid cars

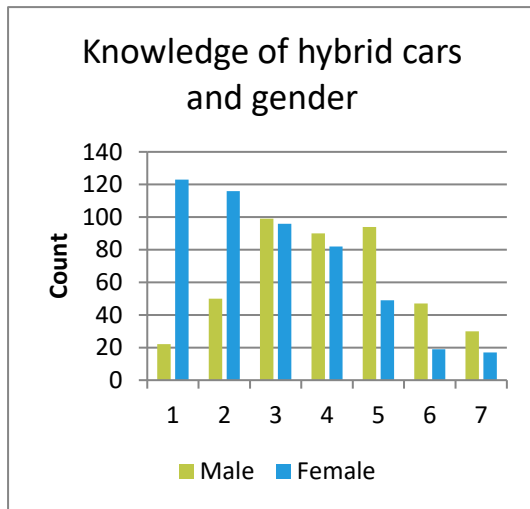
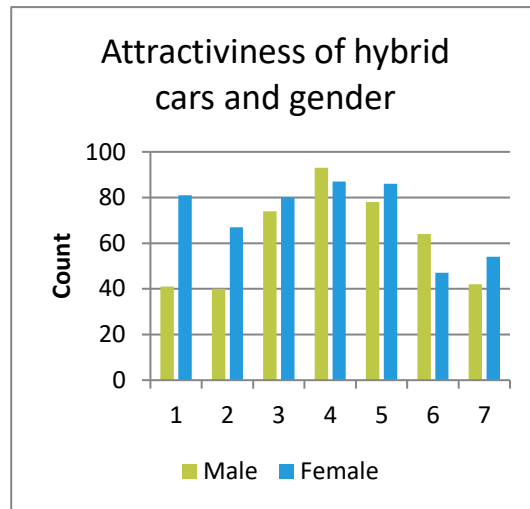


Figure 3.6: Relationship between gender and attractiveness of hybrid cars



3.3 Electric bikes

In 2016 91.8% of respondents were aware of electric bikes and this percentage rose to 95.2% in 2017 (see Table 3.1), indicating a significant increase in awareness over the period of a year ($p = <0.011$). Males (97%) tended to self-report greater awareness of electric bikes than females (94%) ($p = <0.014$). There were significant differences in awareness of electric bikes between age, income and region as will be further discussed below.

Knowledge and attractiveness

With regards to knowledge, most of the respondents were below the midpoint of the *knowledge scale* (3.60) as well as with attractiveness (3.93) of electric bikes. Males tended to have greater knowledge about electric bikes (3.95) than the female respondents (3.31). As with higher awareness levels and knowledge than females, the males in this survey also perceived electric bikes as more attractive on average (4.08) compared to the females (3.80).

Correlations

A relationship between increased knowledge and greater perceived attractiveness was demonstrated most noticeably with electric bikes in this study with a strong correlation ($p = <0.000$, $r = 0.537$). This indicates that greater knowledge of electric bikes was often linked with perceptions of the transport option as more attractive. An increase in age was linked to a slight increase in knowledge ($r = 0.102$, $p = <0.002$). Age also weakly correlated with awareness of electric bikes ($r = 0.110$, $p = <0.001$).

Secondary urban areas (SUA, towns with populations of 10,000 – 29,999 people) tended to have heard about electric bikes more than those from main urban areas (MUA, SUA means were greater by 0.044 compared to MUA) and even more so than those from rural areas (SUA means were greater by 0.074 compared to rural areas, $p = <0.040$). Interestingly, when comparing mean usage, the secondary urban areas had the lowest self-reported use of electric bikes, with a significant difference ($p = <0.044$) between MUA and SUA (the MUA average usage was 0.058 greater than the SUA). Although SUA are reporting a greater awareness of electric bikes than the other area types (MUA and rural areas) this does not align with an increased usage. This finding suggests that while there is an awareness of e-bikes in SUA, there may be a number of barriers facing their uptake – such as accessibility or supply. Alternatively, people living in SUA may not see the need for electric bikes. This is a finding that could benefit from further research.

There were no further significant correlations between the urban and rural areas in terms of attractiveness and knowledge of electric vehicles. There was a weak correlation between those with higher income and greater self-reported awareness of electric bikes ($r = 0.82$, $p = <0.012$).

Usage

The majority of respondents (95.4%) had not used an electric bike in the month from prior to survey completion. Only 2.1% of participants had used an electric bike once or twice in the last month and even fewer (1.2%) cited using an electric bike once a week (see Table 3.5).

Table 3.5: In the last month, how often have you used an electric bike?

	Frequency	Percent
Everyday/almost everyday	5	0.5
Several times a week	6	0.6
Once a week	11	1.2
Once or twice in the last month	20	2.1
Not used in the last month	892	95.4

Sample comparison (2016/2017)

Aside from an increase in awareness of electric bikes (91.8% in 2016 to 95% in 2017, $p = <0.000$), there were no significant differences in knowledge, attractiveness or usage of electric bikes between the 2016 and 2017 samples.

Figure 3.7: Knowledge and attractiveness of electric bikes

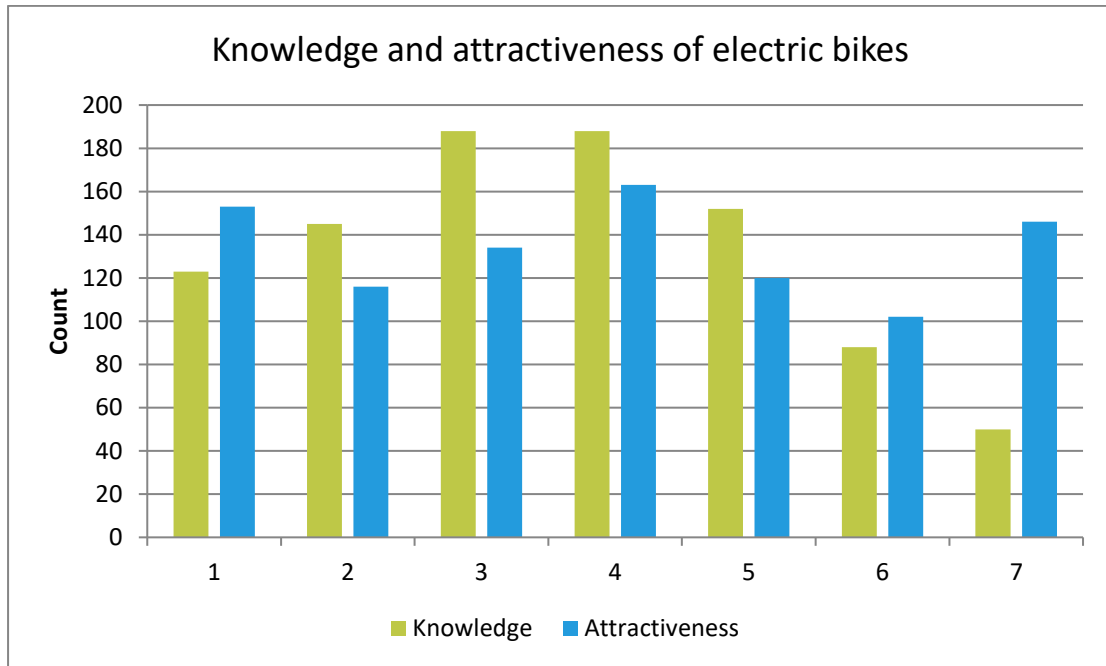


Figure 3.8: Relationship between gender and knowledge of electric bikes

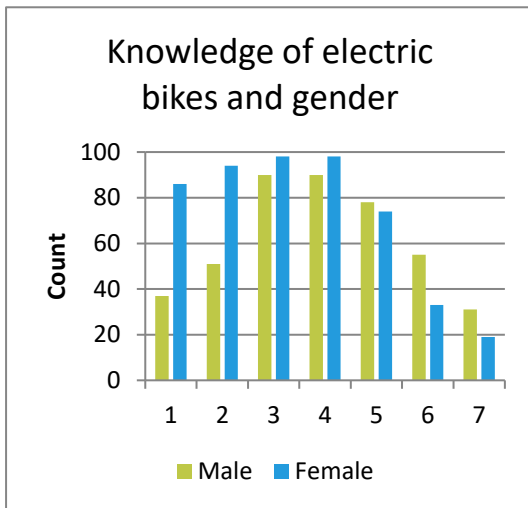
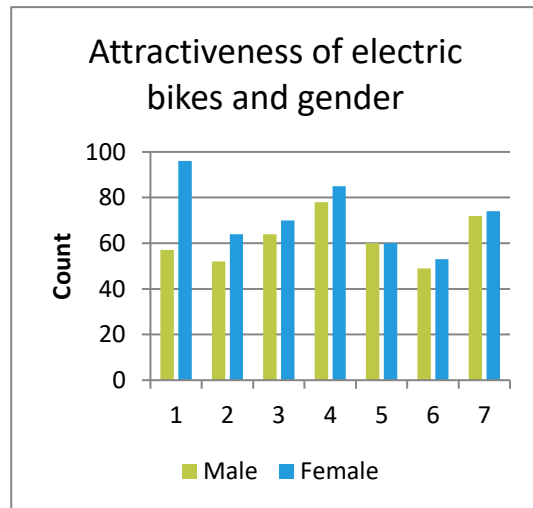


Figure 3.9: Relationship between gender and attractiveness of electric bikes

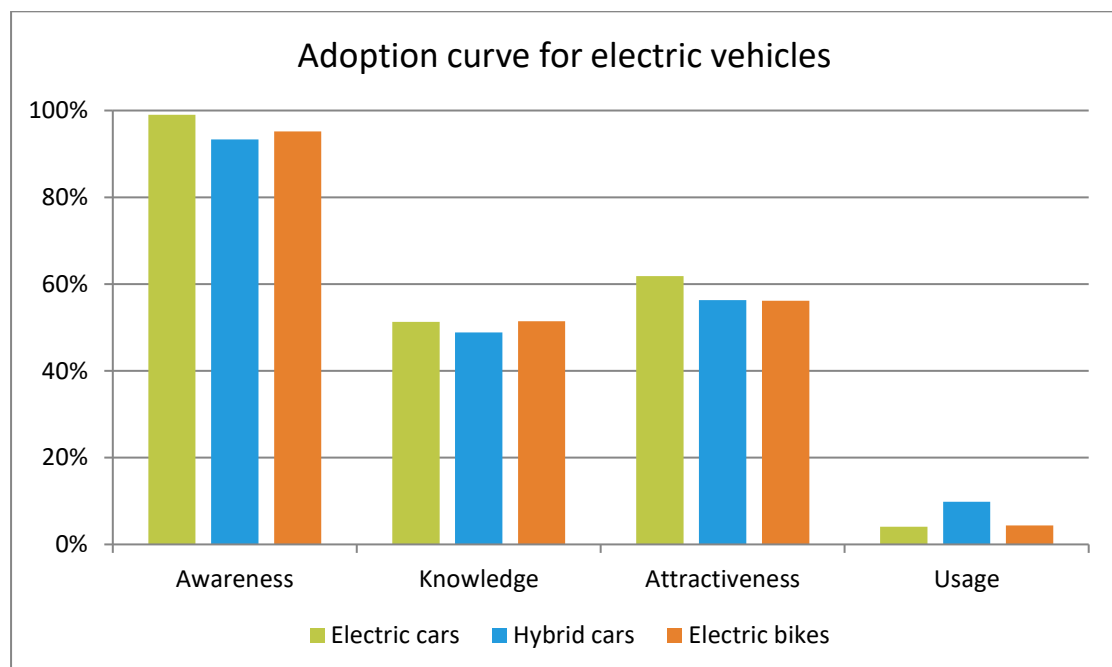


3.4 Adoption curve for electric vehicles

The stages of innovation framework identifies four phases in the adoption of new technology (awareness, knowledge, attractiveness and usage). Figure 3.10 shows the adoption curve for all of the electric vehicles in this report. The adoption curve demonstrates where the majority of respondents sit with regards to understanding a new technology and making a decision to adopt or reject it. The graph shows that while most participants are aware of the three types of electric vehicles, many are not yet using these transport methods. The discrepancy between awareness and actual use of electric vehicles may indicate a need for greater knowledge and perceptions of attractiveness towards the options to the bridge the awareness/usage gap.

Participants in this study tended to view electric vehicles as attractive beyond and perhaps regardless of their level of knowledge of the technology. This finding suggests that the correlation between knowledge and attractiveness may begin with the individual perceiving the vehicle as attractive and then follow with gaining further knowledge on the technology. While the model assumes that perceiving a technology as more attractive follows an increased knowledge of the technology, however the findings in this study contradict this theory.

Figure 3.10: Adoption curve for electric vehicles



3.5 Barriers to EV adoption

As with the 2016 sample, cost was reported as the biggest barrier to EV adoption (53.5% citation). Electric cars not being able to travel far enough was noted as the second biggest deterrent to adopting the vehicle. The order of importance of the barriers to electric vehicle adoption has changed slightly between the 2016 and 2017 studies, however these findings are not yet statistically significantly (Wither, 2017).

Table 3.6: EV barriers' cumulative percentage

	Cumulative Percent	
	2017	2016
Electric cars are too expensive	53.5	61.7
Electric cars cannot travel far enough	26.6	46.1
Electric cars are not visually appealing	25	17.4
The second hand petrol/diesel market is much cheaper	24.1	35.9
There are not enough charging stations available	24.1	55.1

3.6 Enablers to EV adoption

The main enabler to EV adoption was also related to cost with respondents stating that having enough money would help in adopting EVs. The order of importance of the cited enablers remained the same as the 2016 cohort other than an increase in desire to try/test EVs which moved from least important, up three places, to fourth most important closely tied with a subsidy incentive.

Table 3.7: EV enablers' cumulative percentage

	Cumulative Percent	
	2017	2016
If I had enough money	53.9	46.8
If they could go as far and as fast as typical petrol and diesel cars	38	43.6
If purchasing an electric car was subsidised	31.4	40.9
If I could try/test one	30.4	20.6
If charging stations were more available	18.4	41.7
If charging stations were more affordable	14.5	23.1

3.7 Other findings

Around three quarters of the sample (75.6%) stated that they did not intend to use new transport technology within the next twelve months. 12.6% of respondents stated that they did intend to use these new transport technology in the next month which is a greater percentage than the 2016 cohort (8.6%). There was an increase in reported intention to use new transport between 2016 and 2017.

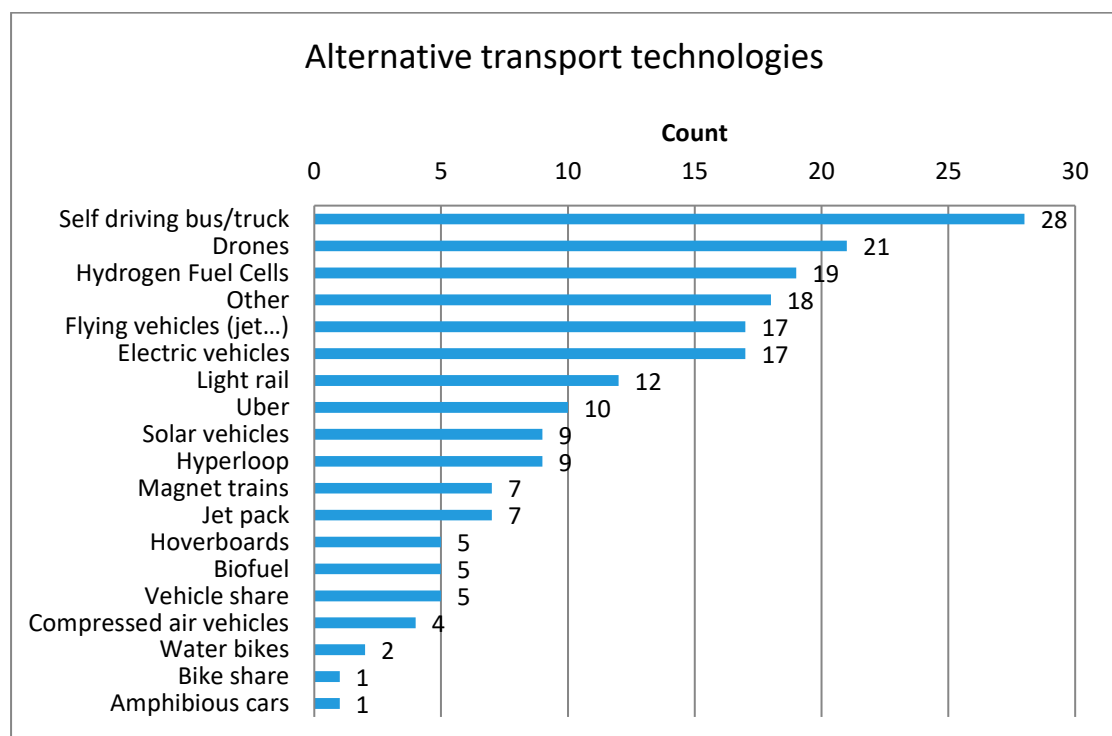
Table 3.8: Intent to use new transport technology in the next 12 months

	2017 Percent	2016 Percent
No	75.6	79.8
Yes	12.6	8.6
Yes and more than the amount I currently use	3.1	3.9
Yes and the same amount as what I currently use	7.6	5.9
Yes but less than what I currently use	1.1	1.8

Awareness of other transport technologies

When asked to provide ideas for alternative transport technologies to that in the survey the three most cited responses were self-driving busses/trucks followed by drones and hydrogen fuel cells. The volunteered responses of the 2017 cohort are similar to the 2016 group with the addition of bike sharing, amphibious cars, water bikes and compressed air vehicles, however these transport options were not widely cited within the sample.

Figure 3.11: What other emerging transport technologies have you heard about?



4 Self-driving cars

As with the previous chapter on electric vehicles, the following analysis looks at attitudes towards self-driving cars in terms of awareness, knowledge, attractiveness and usage. Respondents were also asked to rank perceived safety of self-driving cars on a 7-point *safety scale* as safety is acknowledged as a primary concern in the adoption or rejection of self-driving cars. Enablers and barriers to adoption of self-driving cars are also explored as well as a comparison between the 2016 and 2017 sample to determine attitudinal shifts over the year.

4.1 Stages of adoption for self-driving cars

There was a significant difference in self-reported awareness of self-driving cars ($p = <0.011$) between 2016 (94.5%) and 2017 (91.1%).

Gender showed a significant difference with regards to awareness of self-driving cars. Ninety-six percent of male respondents cited awareness of self-driving cars compared to females (87%, $p = <0.000$).

Knowledge, attractiveness and safety

Self-driving cars saw the only statistically significant difference in knowledge among the 2016 and 2017 respondents ($p = <0.002$). Compared to 2016 (where the mean knowledge of self-driving cars was 2.91), the average self-reported knowledge decreased to 2.66 in 2017. This finding is in line with a decreased awareness of self-driving cars between 2016 and 2017.

It will be interesting to observe attitudes towards self-driving cars and how they develop over the coming years, particularly with increasing media attention and pilot tests. Further research could be useful in identifying any changes in knowledge and awareness of self-driving cars and could help determine whether New Zealand residents are becoming more informed or perhaps more unsure and conflicted by conversation around self-driving cars.

There was a statistically significant difference between Aucklanders and other regions in terms of knowledge of self-driving cars ($p = <0.020$) with Aucklanders reporting greater knowledge than the other regions (2.94 compared to 2.61, $p = <0.020$). All regions are still below the midpoint on the *knowledge scale* indicating a general lack of knowledge of self-driving cars compared to the other transport technologies in this study which were all at, or slightly beyond, the midpoint of the *knowledge scale*.

As with the preceding transport technologies, males reported greater knowledge of self-driving cars (3.05) compared to the females in this study (2.32). Male respondents also tended to perceive self-driving cars as more attractive (3.06 compared to 2.69 for the females).

On average, perceived attractiveness of self-driving cars was placed below the midpoint of the 7-point *attractiveness scale* (2.86), however, this is still slightly above the mean self-reported knowledge and shows that the respondents deemed self-driving cars to be more attractive somewhat irrespective of their level of knowledge of the technology. Self-driving cars were perceived as equally attractive between the 2016 and 2017 respondents (Wither, 2017). Auckland respondents viewed self-driving cars as more attractive than those from Gisborne and Hawke's Bay. Respondents who were 55 years and older viewed self-driving cars as less attractive on average than those who were between 25-44 years old. Unlike the 2016 sample where males perceived self-driving cars as safer than females, there was no significant difference in perceptions of safety between genders.

Correlations

Knowledge of self-driving cars had a moderate positive correlation with attractiveness ($r = 0.431$, $p = <0.000$). There was a weak positive correlation with age and awareness of self-driving cars ($r = 0.068$, $p = <0.038$). There was a negative correlation between age and attractiveness of self-driving cars meaning the older the participant, the less likely they were to view self-driving cars as attractive compared to the younger respondents ($r = -0.173$, $p = <0.000$).

In terms of safety, there was a strong negative correlation between age and perceived safety of driving in an autonomous car ($r = 0.69$, $p = <0.006$) indicating that the older participants tended to perceive self-driving cars as less safe than the younger members. There was also a significant difference in mean reported safety of self-driving cars between Auckland and the other regions ($p = <0.009$) with a mean difference of 0.425. Nelson, Marlborough and Tasman showed the most significant divergence from the self-reported mean for perceived safety of autonomous cars where Auckland (3.21) compared to 2.22 in Nelson, Marlborough and Tasman shows a difference of 0.989 ($p = <0.031$). There were no significant differences in perceived safety between main urban areas, secondary urban areas and rural areas.

Sample comparison (2016/2017)

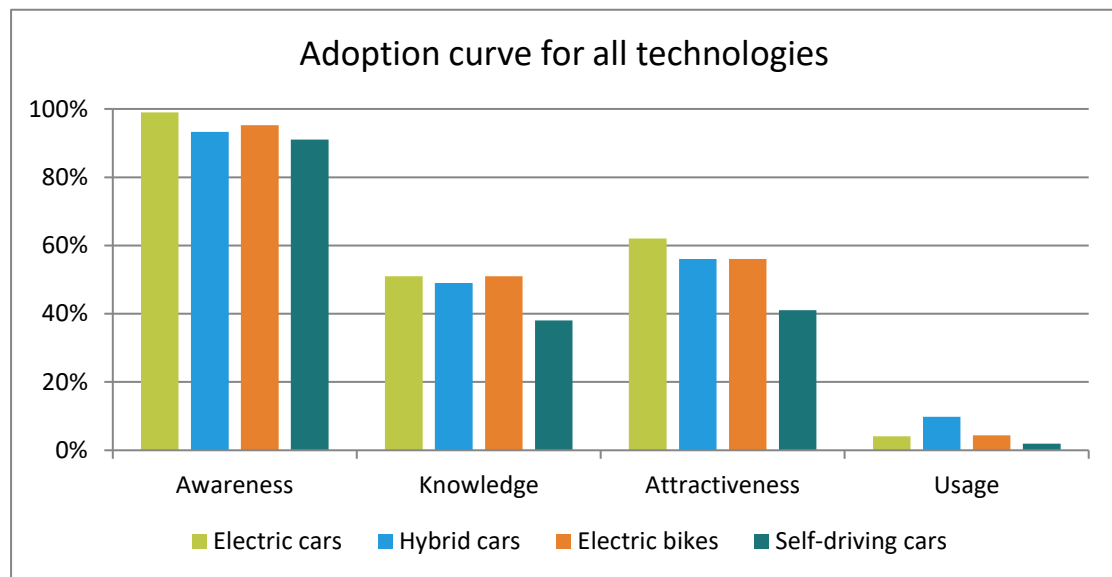
There was a significant decrease in awareness and knowledge of self-driving cars between the 2016 and 2017 sample, as reported by those surveyed. It is difficult to determine why this shift in awareness and knowledge as one would assume that the recent negative coverage of self-driving cars would increasingly put the technology under the public eye.³

³ <https://www.wired.com/story/uber-self-driving-crash-explanation-lidar-sensors/>
<https://www.wired.com/story/tesla-autopilot-self-driving-crash-california/>

4.2 Adoption curve for self-driving cars

Self-driving cars ranked lower than the electric vehicles in the study across all stages of adoption (awareness, knowledge, attractiveness and usage, refer to figure 4.1). This discrepancy can most likely be explained by the fact that self-driving cars are far less common and far less developed than electric vehicles at this point in time.

Figure 4.1: Adoption curve for all transport technologies



Comparisons between the 2016 and 2017 respondents in terms of changes in the stages of adoption framework are then displayed in a series of graphs below (refer to Section 1.2 on reading the Likert scales when reading the figures). While attractiveness and usage have increased across all of the electric vehicle types, there are three interesting changes to note. Firstly, perceptions of self-driving cars have negatively shifted in terms of self-reported awareness and knowledge, as well as there being a decrease in knowledge of hybrid cars. These shifts in knowledge and awareness suggest that increasing public awareness of self-driving cars might improve public acceptance of this technology. This finding presents an area for further research.

Figure 4.2: Comparison of awareness of transport technologies between 2016 and 2017

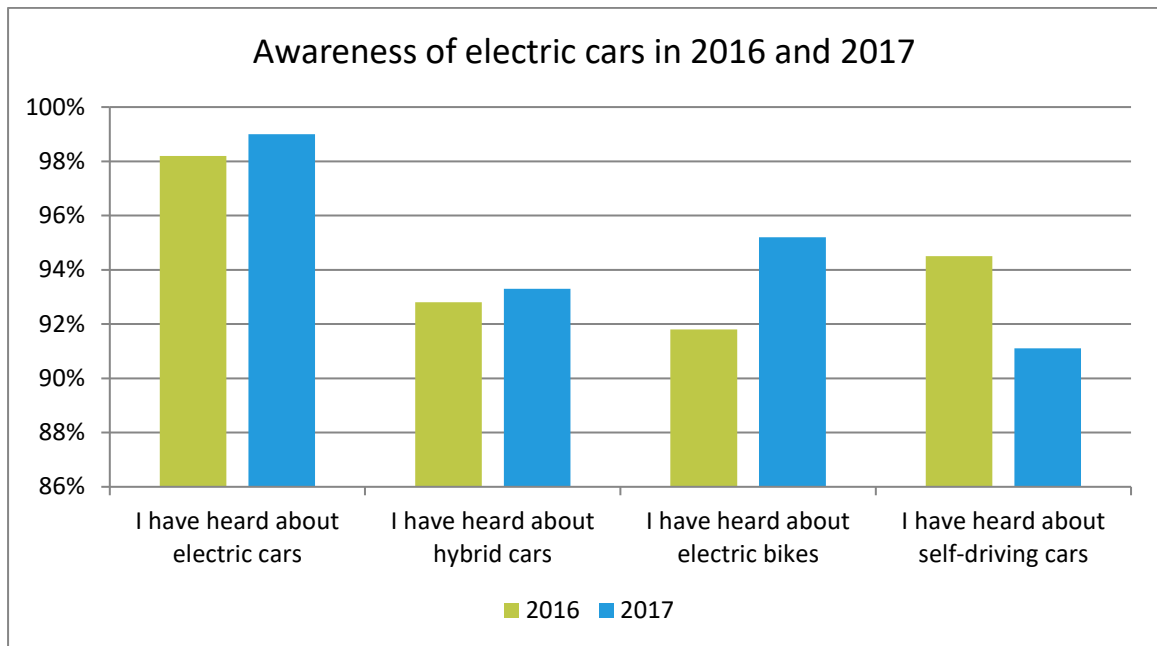


Figure 4.3: Comparison of knowledge of transport technologies between 2016 and 2017

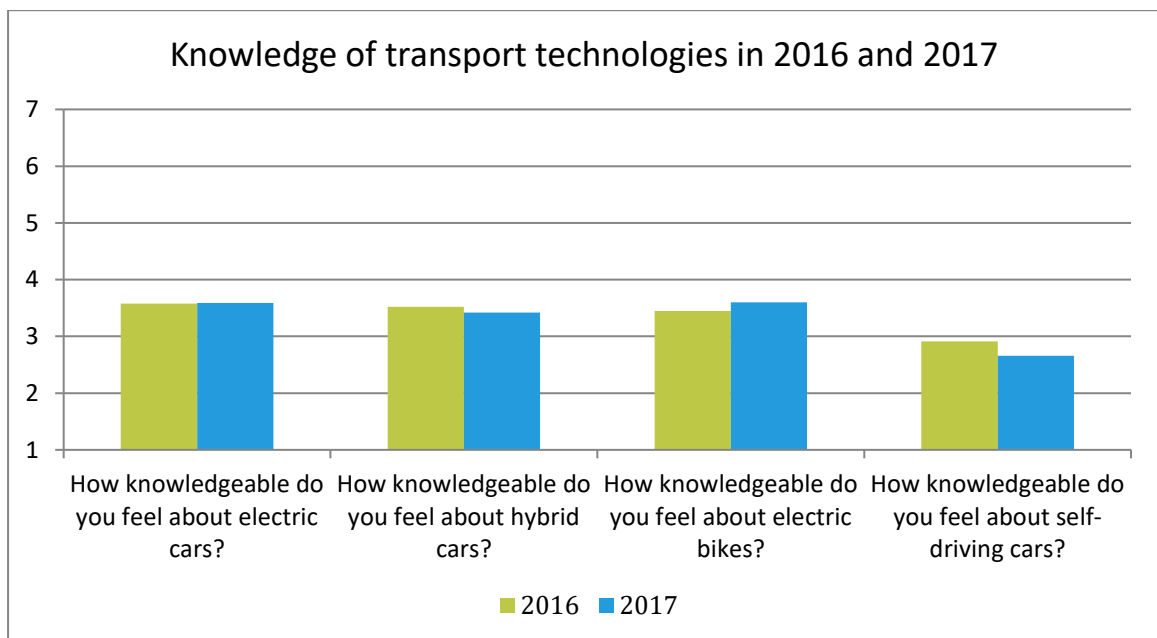


Figure 4.4: Comparison of attractiveness of transport technologies between 2016 and 2017

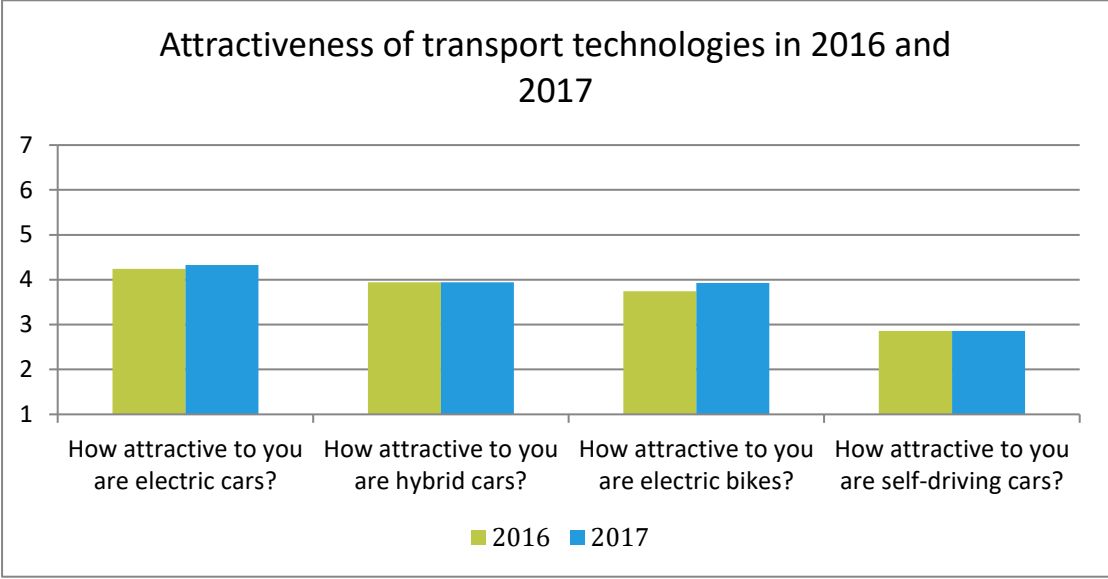


Figure 4.5: Comparison of usage of electric vehicles between 2016 and 2017

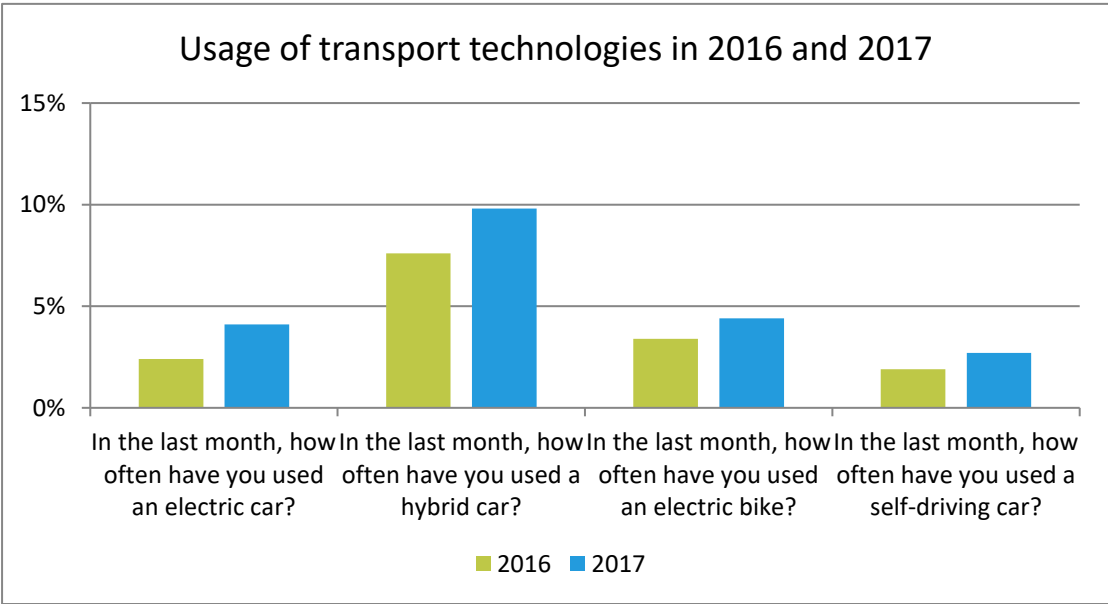


Figure 4.6: Knowledge, attractiveness and safety of autonomous cars

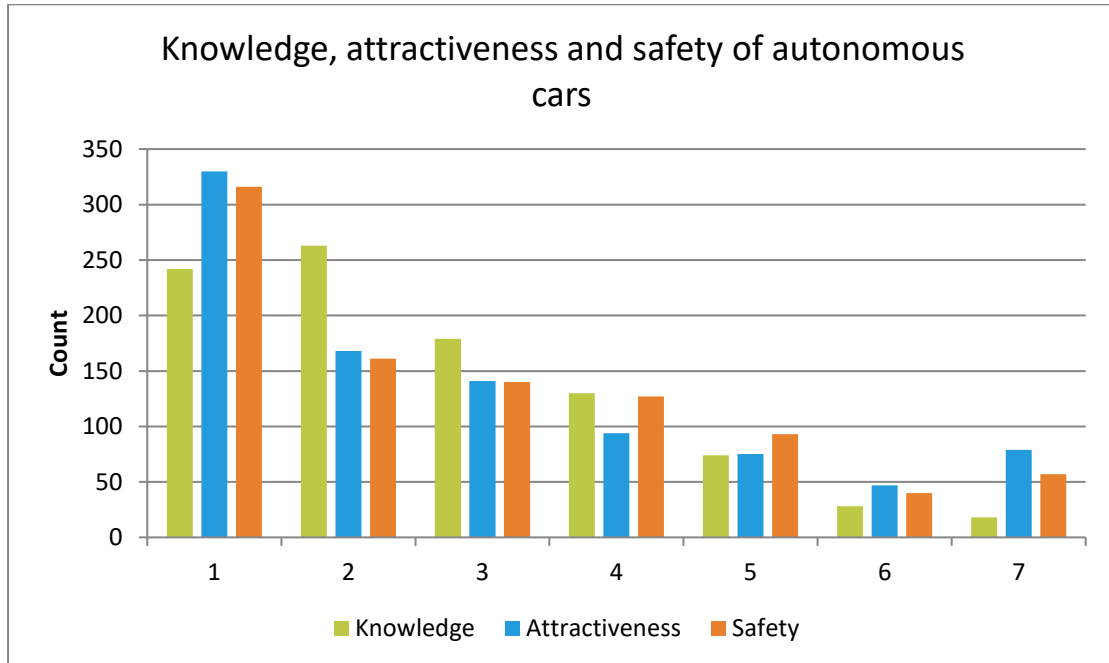


Figure 4.7: Relationship between gender and knowledge of autonomous cars

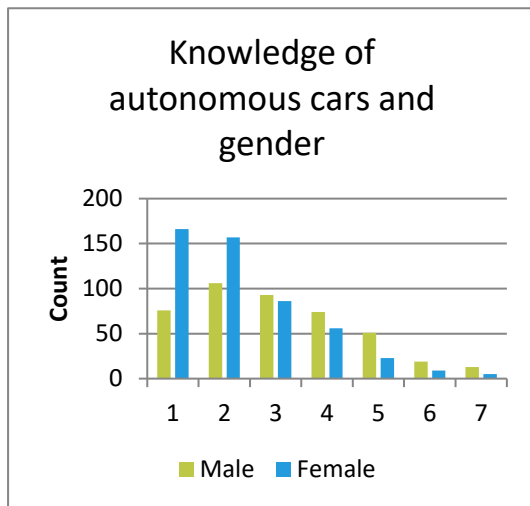


Figure 4.8: Relationship between gender and attractiveness of autonomous cars

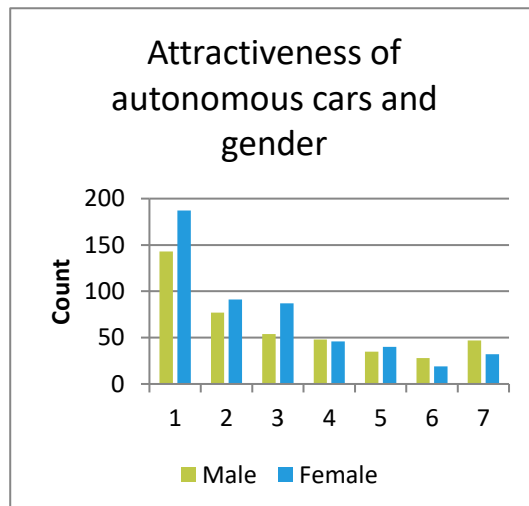
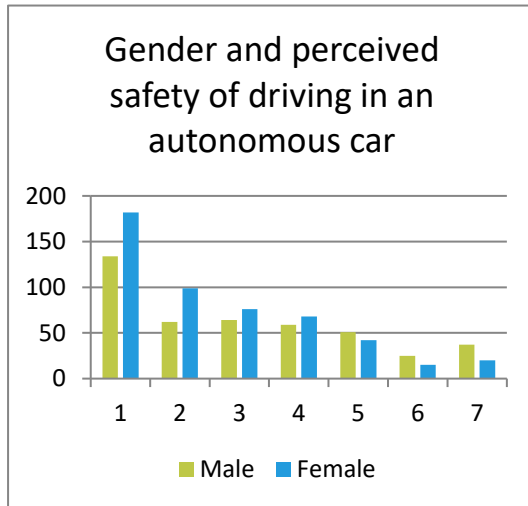


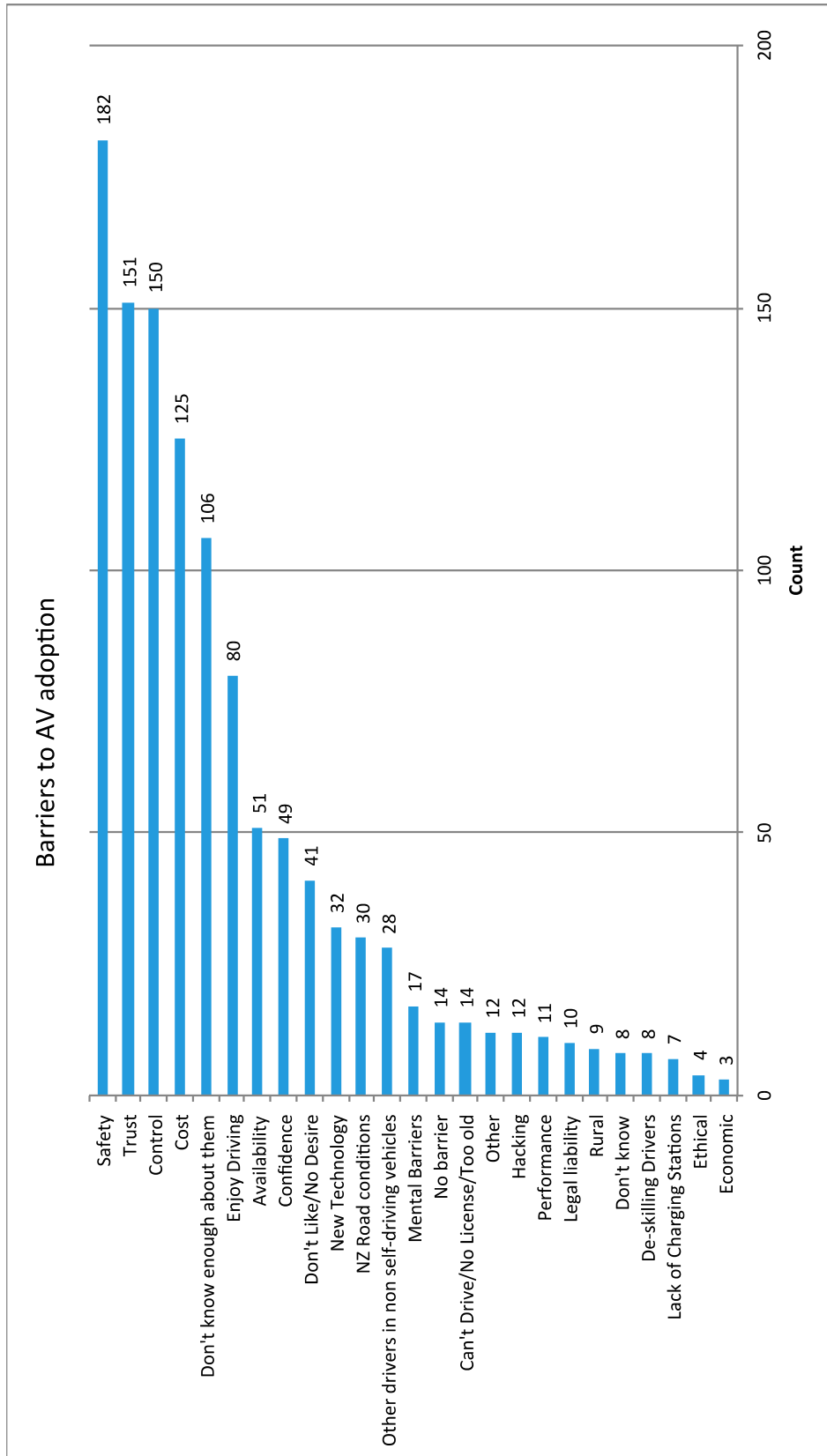
Figure 4.9: Relationship between gender and perceived safety of autonomous cars



4.3 Barriers to self-driving car adoption

When filling out the survey, participants had the choice to select from a pre-determined list of barriers but also had the option to suggest additional barriers. Safety was cited as the main barrier to self-driving car adoption (19.5%) and this finding remains consistent with the primary concern of the 2016 cohort. Trust was also deemed as important (16.1%) and was often linked to safety as many of the respondents wanted to feel comfortable with the technology and know that it would not malfunction. Control was the third greatest concern (16.0%) about self-driving cars with some respondents noting that they would not feel relaxed in a car where they cannot take control of the wheel. As a compromise, some respondents suggested having partial control of the vehicle would make them feel more relaxed. Cost was also a major deterrent in adoption of self-driving cars (13.4%). The fifth most cited barrier was the fact that many people felt that they did not know enough about self-driving cars (11.3%). As noted earlier, knowledge was positively correlated with attractiveness of self-driving cars so raising awareness and understanding of autonomous cars may help with their adoption.

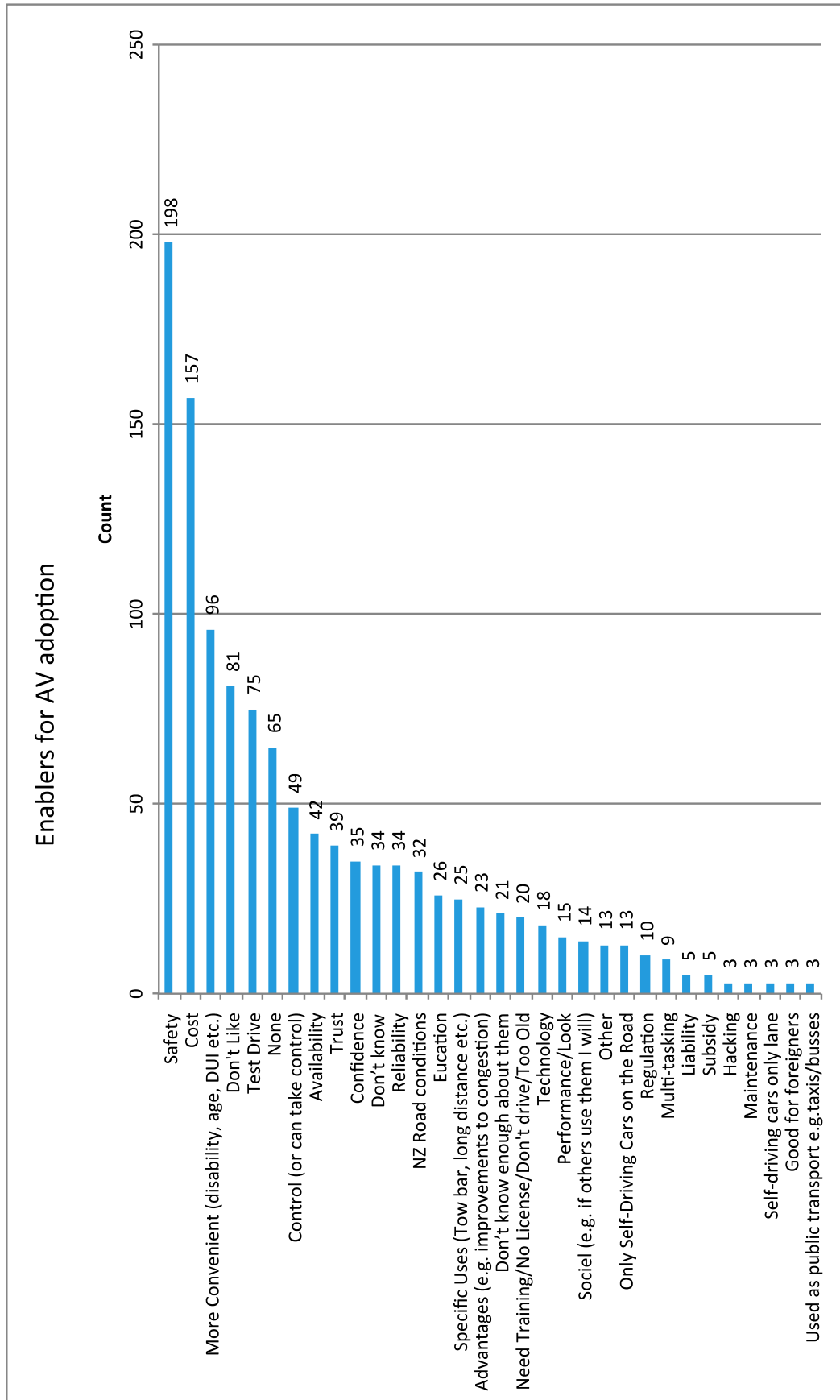
Figure 4.11: Barriers to self-driving car (AV) adoption



4.4 Enablers to self-driving car adoption

The most commonly reported enabler to the adoption of self-driving cars (based on a list provided to the participant as well as the option to add other suggestions) was assurance of safety (21.2%). Respondents' understandably want to know and feel that the vehicle is reliable and safe to be in. Many respondents also noted affordability as an important enabler to self-driving car adoption (16.8%) as well as convenience (10.3%) and having the ability to test-drive one (8.0%). It is important to also note that a significant proportion of respondents simply stated that they did not like the thought of self-driving cars (8.7%) and would not elaborate any further.

Figure 4.12: Enablers for self-driving car (AV) adoption



5 Transport technologies in other countries

The following section is an analysis of the top five countries that have either most readily adopted electric cars or are most ready to adopt self-driving cars. Looking at the barriers and enablers of other countries helps to legitimise the findings of this New Zealand study and also offers insight into any similarities or differences between countries. Hybrid cars and electric bikes are not directly addressed in this section however many of the concerns surrounding electric cars are also applicable to hybrid cars and electric bikes.

5.1 Electric cars

Electric cars are now a feature on the roads of many countries. China, the United States, Norway the United Kingdom (UK) and France are all among the top users of electric cars.

Although China uses the most electric cars in the world, many of the cars are simply designed and less likely to pass the safety standards of other countries or appeal to consumers' tastes (Cobb, 2017). However, one of the main drivers for locals in purchasing electric cars was a desire for positive environmental impact, such as improving air quality (Gu and Wang, 2015 - refer to Table 5.2 for other enablers). The main reason for not wanting to buy an electric car in China was due to lack of knowledge (Gu and Wang, 2015 - refer to Table 5.1 for further barriers).

Rather than seeing environmental concerns as the main priority, cost and performance were cited as the most important factors when considering adopting electric vehicles in America. In fact, some environmentally concerned individuals were not convinced of the clean image of electric cars (Egbue and Long, 2012). Increased efficiency through access to high-occupancy vehicle lanes had a significant impact on bolstering electric car sales in the US (Cobb, 2017). However a major barrier to electric car adoption in America is a fear of the unknown and it was those with more knowledge on technology in general that indicated a greater likelihood of becoming an early adopter (Egbue and Long, 2012).

In Norway the archetypal early adopters of electric cars are highly educated and high income middle aged (30-50 years old) men living in urban areas (Hjorthol, 2013). One of the main concerns around adopting electric cars included the range and charging of batteries or "range anxiety" - the fear of being stranded due to a depleted battery (Hjorthol, 2013). Knowledge and practical experience increased interest in buying electric vehicles (Hjorthol, 2013), and people cited positive aspects to electric car adoption including reduced environmental impact, ease of parking, low noise levels and cheaper running in the long-term (Hjorthol, 2013).

In the UK men were more likely to report having considered buying an electric car than women, as well as more highly educated individuals (Department for Transport, 2016). Barriers to electric car adoption included recharging, distance travelled on a battery, cost and lack of knowledge followed by concern over the reliability of the technology and the specifications of the vehicle (Department for Transport, 2016). The most important factors in encouraging people from the UK to buy electric vehicles were cost, battery and distance travelled on charge, as well as convenience of recharging and the environmentally friendly nature of electric cars. There were 27% of respondents who reported that “nothing” would encourage them to buy an electric car or van (Department for Transport, 2016).

France has a number of financial incentive schemes encouraging drivers to adopt electric vehicles and a growing popularity in electric cars perhaps reflects the importance of cost in vehicle purchasing decisions (Nussbaumer, 2012).

Table 5.1: Barriers to electric car adoption

Country	Source	Lack of Knowledge	Range anxiety	Cost
China	Cobb, 2017; Gu and Wang, 2015	■		
America	Egbue and Long, 2012; Cobb, 2017	■		
Norway	Hjorthol, 2013		■	
The UK	Department for Transport, 2016	■	■	■
France	Nussbaumer, 2012			■

Table 5.2: Enablers to electric car adoption

Country	Source	Cost	Reduced Pollution	Performance	Knowledge	Convenience	Practical experience
China	Cobb, 2017; Gu and Wang, 2015		■				
America	Egbue and Long, 2012; Cobb, 2017	■		■	■		
Norway	Hjorthol, 2013	■	■		■	■	■
The UK	Department for Transport, 2016	■	■	■		■	
France	Nussbaumer, 2012	■					

5.2 Self-driving cars

From a study of over 22,000 consumers in 17 different countries (Deloitte, 2017) the main cited barriers in terms of self-driving car adoption stemmed from an underlying desire for safety. Other factors such as cost and convenience paled in comparison to safety, highlighting the importance of rigorous autonomous vehicle testing as well as finding means of reassuring consumers of the reliability of the technology.

Interestingly however, when asked about the perceived benefits of self-driving cars the majority of respondents noted the potential for reduction in accidents and generally improved safety (World Economic Forum, 2015). While safety is acknowledged as a barrier in the early phases of AV adoptions, once any initial fear is overcome it is quite possible that safety could become a selling point for self-driving cars. These findings are reflected in the New Zealand Ministry of Transport data, as safety was cited as both a major barrier and enabler to self-driving car adoption (see Table 5.3 and Table 5.4).

The following countries: Singapore, The Netherlands, United Kingdom and United States were selected based on likelihood of widespread adoption of self-driving (KPMG, 2018). Factors such as infrastructure, government support and testing are included in this selection, however, in line with the main interest of this research, the focus will be on attitudinal responses from the residents of these countries. New Zealand ranks highly in terms of consumer acceptance at fifth place, so this section will only cover the top four countries in terms of consumer acceptance (as New Zealand attitudes were discussed more in depth throughout this report).

Singapore is poised as the most consumer-ready to adopt self-driving cars, this may in part be due to Singapore's Land Transport Authority placing high importance on ensuring that all self-driving cars are safe. All test vehicles undergo rigorous procedures - including logging travel data to help with accident investigations and liability claims to reassure the general public that self-driving cars are safe (KPMG, 2018).

The Netherlands is slightly less accepting of self-driving car technology however this may reflect the current high standards and satisfaction with transport and less of a desire to change the current transport system. Changing regulations as well as financial support will accompany the introduction of driverless cars by 2021 in the UK (KPMG, 2018). Consumer acceptance of self-driving cars ranks highly in the UK as there are noticeable issues in terms of pollution and congestion that self-driving cars help resolve in densely populated areas. However, it is interesting to note that people living in autonomous vehicle testing areas viewed self-driving cars less favourably than those outside of these spaces.

Trust played a large role in consumer interest in self-driving cars in the United States. There was also an age difference in terms of trust with Gen Y and Z nearly twice as likely as Gen X and five times as likely as Baby Boomers to trust self-driving cars (J. D. Power and Associates, 2016) this is in line with the findings of the New Zealand cohort where the older respondents perceived autonomous cars as less safe than

the younger respondents. Concerns around difficulty in understanding the technology, safety, privacy and the potential for hacking were also commonly raised among the respondents. The American population is geared towards a better chance in consumer acceptance of self-driving vehicles also because of a growing understanding of advanced driver assistance systems (ADAS) (J. D. Power and Associates, 2016).

The following two tables display some of the main concerns surrounding autonomous car adoption in other countries. For comparison refer to Table 5.3 and Table 5.4 that show the barriers and enablers to AV adoption among the New Zealand cohort.

Table 5.3: Barriers to self-driving car adoption

Country	Source	Safety	Hacking	Cost	Privacy	Lack of Knowledge
17 countries	Deloitte, 2017					
10 countries	World Economic Forum, 2015					
Singapore	KPMG, 2018					
The UK	KPMG, 2018					
United States	KPMG, 2018					

Table 5.4: Enablers to self-driving car adoption

Country	Source	Safety	Cost	Convenience	Regulations	Reduced Pollution	Trust
17 countries	Deloitte, 2017						
10 countries	World Economic Forum, 2015						
Singapore	KPMG, 2018						
The UK	KPMG, 2018						
United States	KPMG, 2018						

5.3 Discussion

Looking at the issues and enablers facing other countries in terms of electric vehicles and autonomous trends revealed some interesting patterns that mostly aligned with the findings from the New Zealand studies in 2016 and 2017. While safety and cost were cited as the two main barriers, and also the two biggest enablers to self-driving car adoption in both New Zealand and the other countries, the main difference was a greater emphasis on technological safety e.g. hacking and privacy concerns, as found in the other countries. In terms of electric vehicles, factors such as lack of knowledge, cost, performance and practical experience i.e. test-driving were identified as important factors in adoption, likewise, with the New Zealand cohort. However, the greatest difference was a lack of comment on the positive environmental implications of electric vehicles among the New Zealand samples of 2016 and 2017, compared to other countries. This may be partly due to the closed nature of the questions however there was space for further comment and those who did mention the environment did so only with a negative stance with many sceptical of the true sustainability benefit of electric vehicle technology with regards to the batteries.

6 Conclusion

This report has analysed some of the main issues surrounding the adoption of new transport technologies, including electric cars, hybrid cars, electric bikes and self-driving cars. While these technologies are still in a process of development, it is still important to evaluate people's concerns with using them to understand how this might affect their adoption.

This report analysed data on these four new transport technologies, provided by the Ministry of Transport, in relation to the Stages of Change framework (Prochaska and DiClemente, 1984). This report also discussed self-reported barriers and enablers to adopting new transport technologies. In addition, secondary research was conducted to help establish where New Zealand currently sits in terms of adoption of electric cars and self-driving cars in comparison to the rest of the world.

Overall, the findings from this report were consistent with the findings from the earlier 2016 report (Wither, 2017). One significant difference was the noticeable decrease in awareness and knowledge of self-driving cars in this report. Further research is needed to understand the potential reasons for this decrease.

This research has also found that there are significant positive correlations between knowledge and attractiveness for all of the transport technologies. This finding is in keeping with the Stages of Change framework. This suggests that increasing knowledge about these technologies is likely to be a critical step in supporting their adoption. Many respondents even explicitly cited a lack of knowledge as a barrier to adopting self-driving cars and education as an enabler.

This research found a slight increase in electric car usage since the 2016 report. Age was linked with increased knowledge and awareness of electric bikes, as well as an increased awareness of self-driving cars. Younger participants tended to view self-driving cars as being safer and more attractive in comparison to the older respondents. Further research would be useful in determining how to best communicate the benefits of self-driving cars to older generations.

When viewing the data by gender there was a significant difference, with males reporting both greater knowledge and perceptions of attractiveness towards all transport technologies. Exploring this gender gap further could help establish why the difference in knowledge and attractiveness is occurring in the first place and how to address this issue in the future.

When exploring barriers and enablers to adoption of the transport technologies cost was cited as both the largest barrier and enabler with regards to electric vehicles. This suggests that vehicle adoption can be encouraged by reducing the cost of electric vehicles.

Safety was identified as the most important factor when considering the adoption of self-driving vehicles. Finding ways to reassure the public of the safety of self-driving cars is likely to be an important part in moving the public towards this transport option. Both the barriers and enablers for self-driving cars and electric vehicles remained similar to those reported in other countries.

This research indicates that developing strong communication around these four new transport technologies could be important for supporting their adoption. For self-driving cars, this communication will likely need to focus on reassuring the public of their safety. This research also indicates that reducing the costs associated with purchasing and maintaining electric vehicles is likely to further support their adoption. Further research may be helpful for identifying longitudinal trends and understanding what other factors might influence the uptake of new transport technologies. For example, the role of the media in shifting people's perceptions and shaping attitudes towards these new technologies.

Monitoring developments in public perceptions of emerging transport technologies will be an important task to continue over the coming years. Regardless of all of the technical capabilities of different transport options, if the public is not convinced of the benefits then it is likely to be challenging to integrate these modes of transport into the wider transport system. Attitudinal research could also help with the manufacturing and promotion of these vehicles and ensure that they address people's concerns.

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This work used survey data sourced from the Ministry of Transport, and other sources. The Ministry sponsored the author (a University of Otago summer student) to analyse and report on the survey results. The opinions expressed in this paper are those of the author and do not necessarily represent the views of the Ministry of Transport.

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