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Analysis of the acceptance by Dublin's population of technological innovation by age demographic, using AV and SAV as examples.

Ciara Sugden[1]

School: School of Geography
Email address: sugdenc@tcd.ie

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Abstract: Autonomous vehicle technology is the next frontier of Dublin's mobility sector, with plans formulated governmentally under Smart Dublin initiates for the introduction of this technology in the next 5 years (Department of Transport, Tourism and Sport, 2018). For this change to be successfully implemented and accepted by Dublin's population, it must first be understood what influences acceptance of technological innovation. Within this study, a person's travel priorities, impression of AV technology and level of knowledge of said technology was examined in relation to acceptance. It was also examined across age demographics to garner a more specific understanding of acceptance tailored towards different age populations. It was found that a person's travel priorities and impressions have no strong relationship with acceptance of a technology for both Young and Mature adults. Prior knowledge was found to have a relationship with acceptance in the case of both populations, with less information causing more uncertainty in Young adults, and outright rejection of technology with Mature adults. Ergo, when making future mobility changes, public knowledge should

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be a main priority to allow for the most strategic and successful adaption of Dublin's population to said technology.

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Primary discipline: e.g. Smart urbanism

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Abstract

Autonomous vehicle technology is the next frontier of Dublin’s mobility sector, with plans formulated governmentally under Smart Dublin initiates for the introduction of this technology in the next 5 years (Department of Transport, Tourism and Sport, 2018). For this change to be successfully implemented and accepted by Dublin’s population, it must first be understood what influences acceptance of technological innovation. Within this study, a person’s travel priorities, impression of AV technology and level of knowledge of said technology was examined in relation to acceptance. It was also examined across age demographics to garner a more specific understanding of acceptance tailored towards different age populations. It was found that a persons travel priorities and impressions have no strong relationship with acceptance of a technology for both Young and Mature adults. Prior knowledge was found to have a relationship with acceptance in the case of both populations, with less information causing more uncertainty in Young adults, and outright rejection of technology with Mature adults. Ergo, when making future mobility changes, public knowledge should be a main priority to allow for the most strategic and successful adaption of Dublin’s population to said technology.

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Acronyms

AV	Autonomous Vehicles
SAV	Shared Autonomous Vehicles
LiDAR	Light Detection and Ranging
RADAR	Radio Detection and Ranging
GPS	Global Positional System
TAM	Technological Acceptance Model
TPB	Theory of Planned Behaviour
SEP	Socio-ecological Perspective
PBC	Perceived Behavioural Control
SN	Subjective Norm
PU	Perceived Usefulness
PEU	Perceived Ease of Use
FMLM	First-mile Last-mile problem
FoK	Feeling of Knowing

1. Introduction

Minister for Transport, Tourism and Sport, Shane Ross T.D., announced Dublin's plan to integrate autonomous vehicles and carsharing autonomous vehicles into Dublin's current transport system (Department of Transport, Tourism and Sport, 2018). The idea of autonomous mobility in the public sphere is becoming more of a reality each year, with multiple projects and legislation change in motion within Ireland. We are currently living in the what is known as the Fourth Industrial Revolution due to the speed at which technology is advancing in society (Schwab, 2017), and at the forefront of this technology is artificial intelligence and autonomous driving technology (Yun, 2016). For the implementation of this technology to be accepted by the wider population it must first be tailored to their needs. This technology should be pre-emptively designed to appeal to their consumers to assure successful and broad integration of this technology. To do this their priorities and behaviour of acceptance must first be analysed in relation to autonomous vehicles and shared autonomous vehicles. To analyse this, what first must be established is the definition of 1.1: Autonomous Vehicles and 1.2: Car Sharing Autonomous Vehicles.

1.1 Self-driving cars or Autonomous Vehicles (AV)

Autonomous cars are not a new phenomenon, this technology has been in actuality since 1977 when it was first developed (Forrest and Konca, 2007). Autonomous cars themselves are defined as a vehicle with technology capable of sensing their surrounding environment with technologies such as LIDAR, GPS, and RADAR to help travel between two points (Anderson et al, 2014). The intelligence technology can also allow the vehicles to exchange data which provides them with knowledge to coordinate driving speed, breaking patterns, distance between vehicles, and provides real-time information regarding surrounding traffic conditions and many other characteristics of its environment (Walker, 2017, Ringenson, 2018). The extent of which a vehicle is autonomous can vary, with different systems of autonomy classification and human interference (Kyriakidis et al., 2014). When discussing autonomous vehicles a model is often referred to. This model is one with optimum sensing of its environment, carbon emissions, decision making algorithms and safety for its passengers (Kyriakidis et al, 2014).

Dublin is also one of the pioneering cities implementing autonomous vehicles. In October of 2018, the Minister for Transport, Tourism and Sport Shane Ross T.D. officially announced Dublin's plans to develop guidelines and a national strategy for Intelligent Transport Systems (ITS) (Department of Transport, Tourism and Sport, 2018). The Department of Tourism has recently agreed to introduce legislation to allow for the testing of Autonomous Vehicles on Irish roads and will amend the Road Traffic Bill in the Oireachtas to allow for this testing. Predominantly testing within Ireland had been done either via simulation or within private property.

Research and development of this technology has been a central focus in the west of Ireland. Jaguar Land Rover has opened a research facility in Shannon. As well as this, Lero, the Science Foundation of Ireland, funded research groups in order to develop new sensor technology for autonomous vehicles and is doing this in collaboration with French car technology giant Valeo (Mc Caffrey, 2007). This company has also been collaborating with NUI Galway for many years and has employed over 1000 people in Tuam. The EZ10, an autonomous bus shuttle in the docklands, has been implemented over 1km long section of land to ease travel, and is the first example of autonomous technology being implemented within Ireland (Department of Transport, Tourism and Sport, 2018).

1.2 Shared autonomous vehicles (SAV)

Shared mobility is the shared use of a mode of transportation (Murphy, 2016). The combination of both shared mobility with autonomous vehicles has the potential to greatly improve the viability of shared transportation services and its utilization by the public (Taiebat, et al, 2018). Many aspects account for the increased interest in autonomous shared mobility, also known as shared automated vehicles (SAV). Ride sourcing services, such as Uber, have globalised the idea of carsharing (Rigole, 2014). Ireland have implemented different carsharing modes such as GoCar and Yuka Toyota Car Club, showing the willingness to participate within a sharing mobility economy (Rigole 2014). As well as this, the development of AV, with such companies as Tesla, popularising the idea of automated vehicles, along with the realization that operating costs of mobility services, especially those with automation, may substantially decrease compared to other forms of transport, eg: fuel for private vehicle, increase bus fare etc, have all led to the normalisation and acceptance of SAV's as a practical and advantageous mode of transport (Stocker and Shaheen, 2017).

This SAV service gives access to a fleet of driverless vehicles to use without owning the car(s). One must register for this service and can book a driverless car via an app when needed. When a passenger is driven using automation to a destination, instead of the car sitting idle in a parking space until that passenger returns, it continues to transport other passengers in the meantime (Hars, 2010). With the same technology as self-driving cars, this provides the same benefits without having ownership of the car.

Privately owned cars are, economically, an underutilized asset, due to the amount of time its left unused (International Transport Forum, 2015) and the amount of space it occupies, often in urban centres with limited space (Hars, 2010). Car sharing autonomous vehicles have the potential to become a more economically viable option for people and increase convenience (Hars, 2010). The implementation of these technologies is thought to be able to potentially provide a socially equitable and better valued mode of transport for communities. This would then cause a cascade affect in not only changing how people travel but a change in land-usage patterns in cities and suburban areas, possibly leading to an improvement in the quality of life for the urban and suburban populations (Segal and Kockelman, 2016).

2. Methodology

Introduction

The aim of the study was to gather data on how the acceptance of technological innovation changes depending on age demographic. This change will be due to differencing priorities when choosing transport, differencing impression of said technology and the different level of knowledge held.

2.1 Research Aims and Objectives

The primary research question of this study is to investigate what determines the acceptance of technological innovations, specifically AV and SAV technology. Furthermore, the relationship between an individual's travel priorities, impression of mentioned technology, level of knowledge, and their acceptance. Analysing this in terms of specific demographic contexts, in particular, age, will provide insights into acceptance behaviour and reasoning not yet fully examined. This studies main objectives are to investigate, in the context of AV/SAV technology, 1. if different age groups have different priorities and impressions when accepting technology and 2. if their level of knowledge of technology affects their acceptance.

2.2 Justification

Differing factors and priorities between individuals in a population makes implementing change that caters to all in a society an extremely difficult task. With any new technological innovation, there is a risk that underrepresented members of society will not be considered or socially excluded during decision making processes. Using models such as the Technological Acceptance Model (TAM), the Theory of Planned Behaviour, or the Socio-ecological perspective can give insights into behavioural intention and therefore acceptance (Hutchins and Hook, 2017). Each of these theories and approaches do this, by examining the factors most important to a population, among other factors. However the factors differentiating young people's travel behaviour, attitudes, and perceptions from that of older generations are not completely clear (Herrenkind, 2019). A deeper understanding of the determinants, as well as who prioritises what, and for what reasons, is extremely important for the correct implementation of a more sustainable mobility system, one that includes AV and SAV technologies (Alemi, 2018). Younger generations are known to be those who will make change, that they are the future of mobility (Ha, 2010). For those individuals to happily accept change, this change must be developed pre-emptively for their acceptance. This survey aims to achieve this by creating an age profile in relation to acceptance, the priorities and determinants associated with it, and the role of knowledge in this acceptance.

2.3 *Study Approach and Structure*

Surveys were the core data collection process of this research project. This is a useful method as it allows for the collection of individuals knowledge, beliefs, priorities and attitudes (Boynton 2004), which is exactly what this research study is intending to seek out. It also allows for the collection of demographic information, in this case age was an extremely important aspect to collect. The questions within the survey were a mixture of both closed and open questions. This is beneficial as it allows comprehensive analysis using different approaches, utilizing the advantages and limiting the disadvantages of each type of question (Ostlund, 2011). Within the survey there are three open questions and seventeen closed questions. Closed questions asking about their opinion on a certain factor of AV technology such as "What is your impression of the safety of AV" came with a Likert scale. Closed questions also act as a guide to aid respondents in answering (Clifford, 2010).

The survey was split into three main sections: 1. Demographics and priorities in choosing mode of transport, 2. AV opinions, perceptions and acceptance, and 3. SAV opinions, perceptions and acceptance. This was done so that the participant can think clearly about each technology and consolidate opinions accurately. There are eleven sub-section in total, see Figure 1. The AV and SAV sections were headed with a brief description of the technology for those who answered 'No' to "Have you heard of AV/SAV's before?". These definitions avoided the use of jargon and overcomplicated wording to ease understanding. These descriptions they were written without bias in the language and strictly factual in nature to avoid influencing respondents' opinions. AV and SAV were also rephrased as Self-driving car and Shared self-driving cars for this purpose also. Both AV and SAV sections had the same questions to garner the same information on both technology to be able to get a comparative measure of the opinion of both. Using both quantitative and qualitative approaches allows for triangulation of results, not only getting quickly analysable quantitative data, but also allowing for a deeper insight into personal viewpoints. Graphs were then produced using relevant data collected concerning impressions, level of knowledge and their relationships with acceptance, and these graphs were then used to make data analyses. These were done using Google sheets, and the data was exported directly from Google forms to Google sheets. To find specific quantitative relationships t-testing was done using Microsoft Excel.

Many drafts of the survey questions were completed to ensure the research objective were reached and a pilot survey was administered to a small population of 10 people. Six factors are being assessed in this research topic: cost, safety, ease of access, comfort, efficiency, and environmental impact. Cost, safety, and environmental impact were found to be acceptable factors from the initial draft and pilot. However, to aid in understanding 'Ease of access' was used instead of 'Convenience', 'Efficiency' was used instead of 'Time', and 'Comfort' was used instead of 'Leisure' as it was not entirely clear what was meant. Social aspect was initially a seventh factor to be considered but was then disregarded as too vague. The Likert scaling system was also changed from 1-5 to 1-6, as many participants those 3 when uncertain, which would garner poor results. The pilot survey allowed for the survey to make small but necessary changes to aid in the efficiency of data collection and was a very valuable part of the methodology.

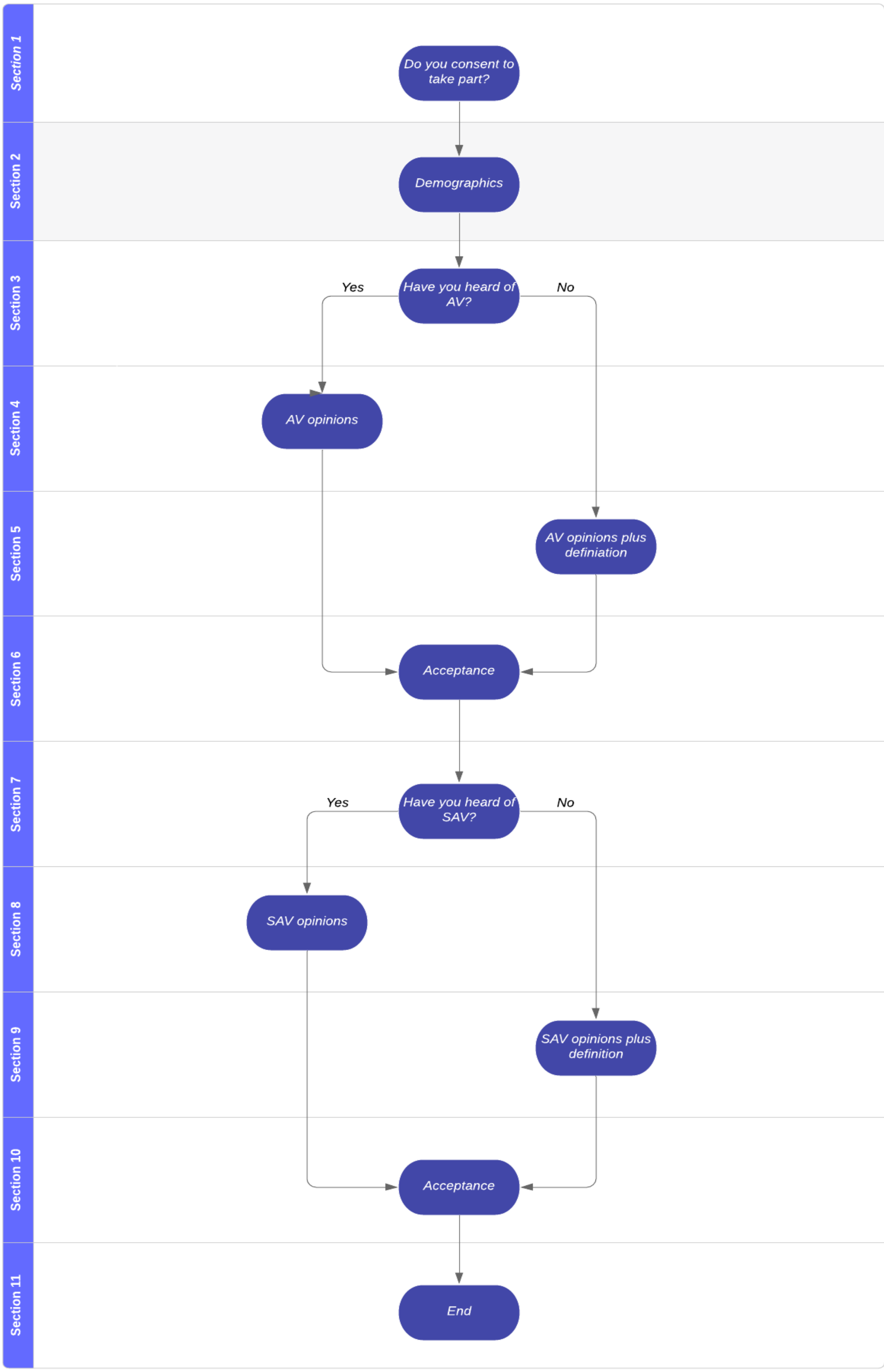

Figure 1: Flow chart of survey structure

2.4 Survey Distribution

The way in which surveys are distributed can affect how representative the sample population will be (Ponto, 2015). Therefore, it is suggested that using "diverse recruitment strategies that can help improve the size of the sample and help ensure adequate coverage of the intended population." After considering this, the survey was distributed online via social media channels such as Facebook, Reddit, Instagram, as well as through additional websites, noticeboard and relevant webpages. It was also sent via email to all contacts available. This was beneficial as it allowed for a quick and cost-effective means of collecting data (Kayam and Hirsch, 2012). The sample was to be from Dublin only, and so a description of the study and of participant description was provided to confine the respondents to that singular geographical area. This allows this study to be representative of Dublin only.

The survey was also distributed to individuals face-to-face at various shopping centres, waiting rooms, and streets. During this process non-probability sampling was used (Marshall, 1996). This was to allow for the specific targeting of older generations. This was done as the online surveys allow for a bias towards people with technological prowess, knowhow and access to social media, which often excludes older generations. This is not to say all online respondent were from younger generations, but to accurately reach a number of respondents that mimic the age profile of Ireland, selective choosing of older generations in face-to-face survey distribution allowed these numbers to become relatively accurate in comparison with Ireland population.

By analysing the population of Ireland, the representative percentage of the population by age was gotten, see Figure 2. The population was then split into two groups 'Young adults' and 'Mature adults', following the precedent set by many researchers and psychologists who class those from 18-24 as having a different development and cognition patterns that those from 25+ (Simpson 2017, JSNA 2017, Teipel 2016). Therefore, using these two groups and classing them Young adult and Mature adult respectively, will allow for the comparison of two different age demographics.

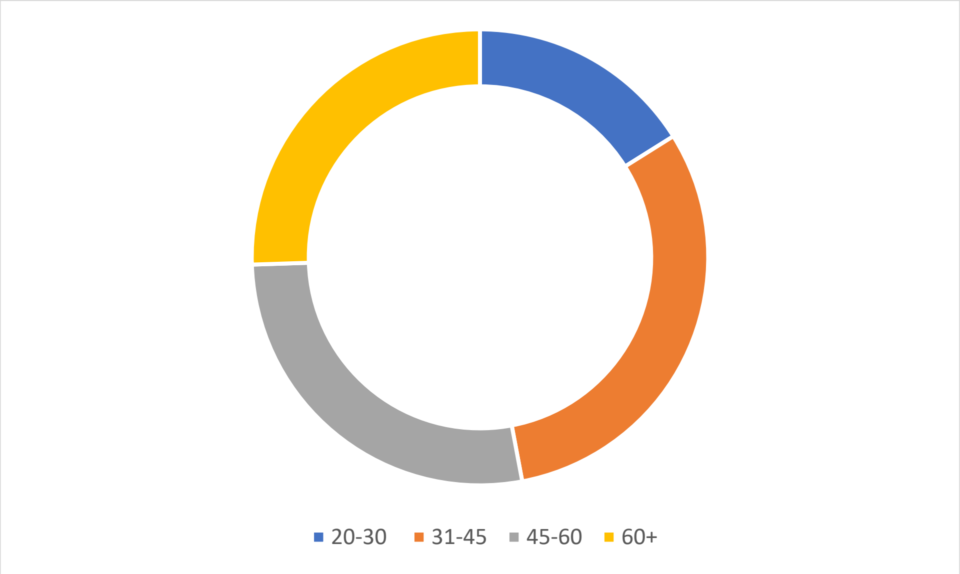

Figure 2: Population of Ireland divided by age. Source: www.worldmeters.info

2.5 Limitations

It is important to consider whether your sample population is truly representative of the population being generalized or studied. If the sample size is not sufficient, it is very difficult to achieve representation (Montello and Sutton 2006). The population of this study is n=100, where 50 are classed as ‘Young adults’ and 50 are classed as ‘Mature adults’. This population is relatively small but still allows for a comparison between populations. Measures have been taken to ensure that the survey respondents are not biased, however a large proportion of the sample population came after posting the survey on the Trinity Noticeboard so there is an unbalanced number of educated individuals.

2.6 Ethics

An informed consent form was shown at the beginning of the survey. This gave the participants the description of the survey, the information that will be used and how the information will be used. It then asks them to give their consent. It also provides them with the contact information of the surveyor to voice any concerns if needed. The survey was also strictly open to members of the population that are eighteen years old and above. The survey was conducted so that all participants are anonymous.

(Montello and Sutton, 2006) outlined three main guidelines for an ethical research project, and they were followed as to assure the rights of the participates were not violated in any way. These guidelines were:

i. Respect for persons: Understanding that individuals are “autonomous agents capable of deliberating about the personal goals and acting according to those deliberations,”
ii. Beneficence: “benefits to individuals should be maximised while potential harm in minimised,”
iii. Justice: “the benefits and burdens of research should be distributed fairly,”

3. Literary Review

Introduction

Technological acceptance by society and individuals encompasses a range of fields of thought. Within discursive landscapes, a multitude of theories of acceptance have been produced as well as in depth research into the neurological factors influencing an individual's decision making. As well as this, a more personalised analysis of an individual's priorities and experience has also led researchers to a more comprehensive understanding of acceptance. This personalised acceptance research also sheds light on how different sociodemographic factors also influence acceptance, such as a person's age, gender, class etc. Each of these factors interlink and both consciously and subconsciously controls a person's willingness to acceptance technological innovations and will be more thoroughly discussed in the following literary review.

3.1 Acceptance of technological innovation

The introduction of new technology, such as AV and SAV, into the public domain and into everyday society will undoubtably trigger changes in traditional mobility practices and could potentially cause fundamental changes in how people travel within space. Therefore, acceptance should be brought into the discourse surrounding the implementation of these technologies. Without the support and willingness of the public to participate, technological innovations will ultimately fail to be successfully integrated (Fraedrick and Lenz 2016). Technology cannot be accurately assessed or seen independent from its "social, economic, and usage-related contexts", its embedment within society must too be analysed (Peterman and Schertz 2005, Husing, 2002).

The populations perspective of these technological innovations is imperative to its implementation. Having a user-oriented view and identifying which factors are prioritized by the public, will make a considerable contribution to the overall success and acceptance of said technology (Khan 2012, Rupp 2010). Researching the acceptance of this technology can allow technology, in this case AV and SAV, to be pre-emptively developed and curated so that acceptance is the likely outcome and issues preventing the acceptance by society, such as cost or environmental impacts, avoided. However, which factors and whom and how those factors impact specific populations, affects AV acceptance has yet to be specifically analysed.

Frameworks have been developed over numerous fields to try quantifying and accurately assess acceptance. Two of the most well-known being: Theory of Planned Behaviour (TPB) and the Socio-ecological Perspective (SEP). TPB assesses how influences can contribute to attitudinal factors of acceptance and how an individual's environmental factors, both physical and social, affects behaviour. It discusses how intention must come before, and dictates, behaviour. An individual's behavioural intention depends on both their attitudinal and environmental factors (Fishbein and Ajzen, 1975). This behavioural intention is measured with three key concepts: 1. An individual's attitude towards behaviour, 2. Their perceived behavioural control (PBC), and 3. Their subjective norm (SN).

PBC encompasses the perception of both the ease and difficulty of enacting a decided behaviour, in this case the use of AVs and SAVs, and the belief that the behaviour in question is under the individual's control (Acheampong and Cugurullo, 2019). The former being referred to as operational and the latter being referred as self-efficacy. Self-efficacy also considers an individual's confidence in being able to carry out the behaviour in extenuating circumstances (Wallston, 1987). SNs are defined as the perceived societal pressures that then influences behaviour and the motivation to succumb to those pressures (Ham, 2015).

SN is also considered within the extended Technological Acceptance Model (TAM) (Davies, 1989). This outlines the two main variables that determines an individual's acceptance: 1. Perceived Usefulness (PU) and Perceived Ease of Use (PEU). PU encompasses the individuals belief that the technology may or may not be beneficial, whereas PEU is the individuals belief that the transition and use of the new technology will not require effort, that the technology will cater to their needs, and is affected by the users level of knowledge of how the technology functions. In the extended TAM, voluntariness: the extent of which a person has the free will to choose or to not choose to use a technology, and internalization: how an individual synthesises the perceived importance of a new technology into their belief system, are discussed (Davies 2000). Both of these mediates the impact SN has on technological integration decisions.

SEP captures the "relationships between individuals and their external environments," (Acheampong and Cugurullo, 2019). Personal factors are considered within this model; sociodemographic characteristics and level of knowledge, perceptions and attitudes, which fits within the structure of this study. It then also analyses the surroundings of individuals and how their surroundings then impact their decision making and acceptance. These aforementioned sociodemographic characteristics very starkly shows a difference in acceptance when it comes to that of age.

3.2 Demographic determinants of acceptance, with a focus on age

Age as a demographic has been found to have a significant influence in many acceptance studies (Herrenkind, 2019). The behavioural intention to accept technological innovation has been proven by (Venkatesh 2003), to decrease as age increases, supporting the claim made by (Hogg, 2010), that said the younger generations will be the ones to shape the mobility patterns of the future. (Herrenkind, 2019) found a stark distinction between different age groups in line with TAM, meaning that the PU was found to directly influence their intention to use more so in older generations than younger. In relation to PU and its relationship with PEU it was found that younger generations found that AV technology had a larger usefulness for them than older generations.

SEP was also used to analyse individuals' attitudes towards the environment and how that affected their acceptance. It found that there was no significant relationship between younger generation and their attitude towards the environment and making a behavioural change to AV technology. However, the opposite is true for older generations. (Herrenkind, 2019, pp. 221) then goes on to state that "to change the travel behaviour of the younger generation, the campaign implemented should not be based on environmental factors but instead focus on other features found to have a significant association with the intention to use."

Recent trends have shown a decrease in the interest of car ownership by younger generations (Millard-Ball and Schipper, 2011, Newman and Kenworthy, 2011). With cars dominating mobility systems and urban planning, AV and SAV is a possible solution and sustainable method to utilize and improve the current automobile centric system. Moreover, the possession of driver's licenses has declined in younger generations, showing a lack of enthusiasm in car ownership or driving (Davis and Dutzik, 2014, Delbosc, 2017). (Fagnant and Kockelman 2014) surmises that ownership of a car is becoming less of a priority for younger generations. (Davis and Dutzik 2014) believed that this could be due to the younger generation's adolescence in the digital age, making constant connectivity a priority, and consider driving a distraction from that connectivity. This has also been found by (Deloitte, 2010), that young generations find driving "burdensome", and that driving prevents them from being able to participate in other activities. (Deloitte, 2010) observed that regulation insists that texting is distracting drivers on the road, but that in reality driving is the distraction from texting, outlining the younger generations priority to being connected and online.

In relation to older generations, (Frost and Sullivan, 2006) have found that the majority of those who use vehicles resist relinquishing control of their car to AI, or any sort of machine operating (Frost and Sullivan, 2006). In contrast, (KPMG & CAR 2012) found that older generations, coined baby boomers, were more willing to give up driving their own vehicles for a more stress-free commute. (Knight 2012), argued that AV and SAV in a useful alternative for the ageing population. This is due to the fact that the older generations may experience poor eyesight or slow reflexes. The comfort and accessibility of this mode of transport is just one factor that may influence a person's choice of transport towards AV or SAV. The next section will go deeper into the main factors that have been proven to influence technological acceptance and how each factor relates to AV technology.

3.3 User Priority and Experience

In line with TPB and SEP, and existing studies of technology acceptance, users' attitude towards a certain behaviour, the use of AV/SAV in this case, will be imperative to the understanding of generations and how they will interact with this technology. To do this the analysis of different factors, priorities and experience has been conducted, using factors such as: i. Safety, ii. Cost, iii. Efficiency, iv. Ease of access, v. Environmental Impact, and vi. Comfort. This is a non-exhaustive list of possible deciding factors when considering behavioural intention, however these factors have been found to be those that influence consumer acceptance the most significantly. Within TPB, factors such as comfort, safety, environmental impact, and ease of access are factors considered to directly influence a person's acceptance (Fishbein and Ajzen, 1975). Efficiency, ease of access, along with cost have also been established as influences by precedent set in previous studies (Anderson 2014, Kelkel 2015, Fraedrick and Lenz, 2016, Bagloee 2016). Ergo, these factors have been used repeatedly to garner the perspective of technology via consumer's most valued factors. The following is a breakdown of each of these factors, using AV and SAV as examples.

i. *Safety*

The safety of autonomous vehicles and AI technology within the mobility sector is one of the most discussed topics within the field, and one that most individuals have concerns about. However, within the literature, the consensus is that AVs and SAVs increase safety. In fact, AV technology is expected to reduce, and perhaps stop, traffic accidents from occurring (Fraedrich and Lenz, 2016). It does this by eliminating human error due to factors such as "age, disability, stress, tiredness, inexperience," (Shanker, 2013). According to NHTSA, 93% of traffic accidents was due to human error (National History Traffic Safety Administration, 2008). Approximately 1.3 million people are killed and approximately 45 million are injured (World Health Organization, 2013). It is the leading cause of death for young people between 16 and 30, and the eight highest cause of death globally (World Health Organization, 2009).

AV is thought to be one of the solutions to decrease traffic accidents due to the technology on board, including LIDAR, RADAR, etc (will be in introduction), to accurately be aware of their surroundings and potential risks. It is also beneficial as it can allow a driver to give full control to the vehicle in times of fatigue or distraction. (Kelkel 2015).

ii. *Cost*

(Litman, 2017) estimated, based on previous vehicle innovations, that the initial implementation of individually owned AV will be available to higher income individuals due to the cost of technology. He also calculated that it may take approximately ten to thirty years until the individual ownership of AVs will be a viable option for the middle- and lower-income households. However, some think that the additional costs of AV ownership may be offset by the large possibility that individual car insurance costs for AV will reduce (Anderson, 2014). This is due to the method of calculating insurance premiums based on penalty points, engine size and so forth, whereas with AV insurance companies can offer differing premiums depending on the level of automation a vehicle is equipped with (KPMG & CAR, 2012). Therefore there is a high chance that insurance premiums will lower due to the lack of human error occurring in AVs. As well as this, the efficiency of this technology can also allow for fuel saving costs. This efficiency will be further discussed in section 3. Iii. of this literary review.

It is believed, however, that SAVs may be the most affordable implementation of AV technology, and most beneficial to the general public. This will allow for households to forgo vehicle purchasing, insurance payments, and any maintenance on the vehicle. It will also allow for a flexible and relatively cheap mode of transport proven to be cheaper than public transport (Lim and Taeihagh 2018). In work done by (Khondaker

2015), it was shown that 25% of participants sold a car, and another 25% forwent the purchasing of a car when SAV services were available.

iii. *Efficiency*

The current paradigm in place in the transport sector is unsustainable in regard to its capacity capabilities. The current pattern of the construction of more infrastructure to allow for more vehicles to be on the road does not solve any mobility issues, such as traffic congestion or travel time (Schiller, 2017). In fact, it creates a positive feedback loop, that further facilitates and exaggerates those issues and many others (Givoni, 2013). (Fagnant, 2015) and (Pakusch 2018), among many others, believe AV and their technology could be the solution to these problems.

AVs reportedly only need a 30% penetration rate to "significantly reduce oscilliation waves" and reduce bottleneck congestion, reducing travel times by 40% (Ngoduy, 2012). Moreover, penetration rates less than 30% still showed a reduction in travel time, allowing for the assumption that even a small uptake could improve traffic conditions (Kesting, 2008). In a mixed traffic situation, where both private owned vehicles and AV were on the road, there was a peak of 5000 vehicles per hour reached (Huang, 2000). In fact, it was found that for each SAV used, it could replace eleven private vehicles on the road (Fagnant and Kockelman, 2016).

Platooning between AVs could optimize the flow of traffic, reduce congestion and avoid stop-and-go traffic (Spieser 2013, Fagnant 2015). An algorithm was developed by (Ferandes 2015) that allowed for symbiotic behaviour between platooning AV that may achieve a traffic capacity of approximately 7500 vehicle per hour, which is more efficient than current public transport and owned car usage, in both capacity and travel time. This can also allow for the exchange of data between vehicles that can then coordinate and communicate different information such as: driving speed, braking patterns, distance between vehicles and so on (Ringenson 2018).

Thus making commutes quicker. This technology also integrates real time information in regard to traffic conditions into its route planning, this not only improves response times and efficiency but can also improve safety, as spoken of before (Fagnant 2013). (Tientrakool, Ho & Maxemchuk 2011) estimates that is all vehicles implemented adaptive cruise control, there would be a rise in motorway capacity from 45% to 275% along with congested traffic speeds increasing from 7% to 14%.

iv. Ease of Access

When commuting, individuals often must travel to their desired mode of transport, and once off their mode of transport, travel to their desired location. This is referred to as the first-mile last-mile problem (FMLM) (Lim and Taeihagh, 2018). The standard agreeable distance expected to be walked to a transit stop is 400m (Chen, 2011), however this being the average, does not mean that all of the population is willing, or capable of walking that distance. SAV technology could eliminate the FMLM problem by implementing a model that collect passengers from any point, their home or elsewhere, and driving them directly to their desired location (Munzel 2018), using the most efficient route available as discussed in iii. This eliminates the FMLM problem and allows for individuals to benefit from an efficient and customisable form of transport. This service could potentially become a strong competitor against MNC's such as Uber or Lyft (International Transport Forum, 2015).

SAV could also improve social equity. Vulnerable groups such as the disabled, elderly, or those from a low sociodemographic background, face limited participation within society, which may lead to social exclusion (Segal and Kockelman, 2016). This occurs due to various factors not accommodating these individuals in mobility planning (Lucas and Jones, 2012). (Harper 2016) found that an estimated increase in the demand of mobility options will occur in the US, primarily for the non-driving, elderly or travel restricted populations. This was found to potentially increase the VMT (vehicle miles travelled) by 15%. In a fully automated, or mixed traffic situation, it was found that these “restricted parties would travel as much as any other cohort of age or ability”.

v. *Environment*

Environmental concern has been found to have a positive relationship with an individual’s intention to use autonomous vehicles (Wu, et al., 2019). AV implementation could reduce dependence on fossil fuels in the mobility sector, as well as lowering emissions on the roads (Ringenson 2018). This is due to the improved efficiency of the vehicles leading optimization of traffic flow leading to shorter and more efficient trips, and less time polluting in traffic. The technology also lessens the use of braking and acceleration processes that increase emissions (Milakis, 2017). Some studies predict that emissions could be reduced by 95% (Greenblatt 2015). This is also due to the fact that SAVs will reduce car ownership levels (KelKel, 2018). Interestingly, in a study done by (Herrenkind 2019) is was found that there was a positive significant relationship between the elderly, the environment and their choice in mobility, whereas this relationship was not found in younger generations. Individuals who prefer to live more sustainably are more significantly likely to use SAV technology and embrace the future of AV sharing (Livieri, 2017)

Contrastingly, increases in car efficiency provided by AV and SAV technology may in fact lead to an increase in energy consuming driving styles and increased mileage (Becker, 2015). As well as this, when AV technology allows for better use of one’s time while travelling, some may be willing to take longer journeys than they have before (Brown, 2014). With the use of SAV being a cheaper option, increase use of this mode of transport will in turn lead to increased mileage as previously stated, but also a possible move from public transport to SAV (Trommer, 2016). Studies have shown that this use of autonomous technology within mobility will led to an increase in number of journeys from 3 to 27 percent (Milakis, 2017). There could also be an 8-17% increase in movement for the relocation of vehicles, their arrivals, and their departure (Bischoff 2016, Davidson 2016).

vi. *Comfort*

Comfort, both physically and psychologically, is a factor that controls individuals' mode of transport and positively influences a person's attitude and purchase intention (Kelkel, 2019). (Beirao 2007) studied this and found that with public transport, comfort was both a benefit and drawback as comfort levels are dependent on time of day and the condition of the public transport in use. It has been found that although the privacy of an owned vehicle is beneficial, the stress caused by navigating through traffic congestion negatively impact the psychological comfort of drivers. The option of being relieved from stressful situations associated with driving increases an individual's likelihood to choose AV technology (Arndt, 2011).

3.4 User Knowledge and its relationship with Acceptance

Acceptance is studied across many fields of expertise and it not limited to technological innovation. However, each of these studies provide insight into the relationship, or apparent relationship, between an individual's knowledge and an individual's acceptance. The findings of these experiments are not always consistent with each other, for example: (Paz-y Mino & Espinosa 2009) found there to be a robust relationship between knowledge and acceptance, but (Sinatra 2003) found no evidence to support that claim. Thus it is evident that the relationship between these two criteria are not straightforward (Ha, 2012). (Ha, 2012), also discusses the neurological perspective on knowledge and acceptance. They surmised that acceptance is both to do with having the "knowledge that enables comprehension and having the feeling of knowing (FoK)," (Burton 2008). The former component, knowledge, is dependent on conscious thought processes, the latter FoK, encompasses intrinsic beliefs formed by unconscious thought, intuitive cognitions. FoK is defined as a 'metathought' that drastically affects how we perceive our world around us (Burton 2008). FoK, due to its intrinsic nature, has the ability to be activated subconsciously and not be reliant on any sort of underlying knowledge. Reasoned thought or certainty, however, arises from the conscious analysis of a situation and thus making judgements and decision based on that (Ha 2012). These two factors interplay as the emotional signal of FoK plays an auxiliary role that makes the reasoning process faster (Damasio 2003).

These two systems produce a duel information processing method, with FoK providing quick, instantaneous responses and the opposite more cognitive system, being slower allowing for conscious thought and abstract reasoning. These two systems have been combined into a dualist approach that unifies these forms of reasoning (Osman 2004). The factors influencing cognitive reasoning have been studied and analysed in section 3, however the factors influencing FoK are harder to quantify (Sinatra, Bream & Evens, 2008). This combined processing approach directly affects acceptance (Ha 2012). It is believed that FoK may have a greater influence on our acceptance of technological innovation subconsciously and that the neural network associated with this system, once established, is difficult to overcome with critical, cognitive reasoning (Burton 2008). (Ha 2012, pp.118) gracefully summarises the implications of this, though in their case they were discussing the acceptance of evolution as a concept;

"the implication for acceptance [of AV/SAV] is that constrained levels of certainty resulting from intuitive feelings may lead to a lowered level of acceptance, even when conceptual knowledge of [AV/SAV] is high, and the level of acceptance will likely be resistant to change,"

(Ha 2012) study ultimately found a weak but significant relationship between knowledge and acceptance and a strong significant relationship between FoK and acceptance. This, therefore, shows that knowledge does in fact influence acceptance but it's the intuitive and intrinsic instincts that truly decide a person's acceptance.

Conclusion

The literature reviewed was a multidisciplinary undertaking. Through exploring different theoretical backgrounds concerning acceptance and garnering the core factors influencing people's acceptance of technological innovations, a comprehensive literary review was produced. Sociodemographic elements, specifically age has been suggested to significantly change a person's acceptance rate of technology, and this aspect in conjunction with the impression, and level of knowledge a subject has, has to potential to shine light on many factors that may influence acceptance and condense it into one study, allowing for a thorough understanding of a wealth of knowledge associated with this type of undertaking that has not been previously produced.

4. Results

Introduction

The aim of this chapter is to find out how travel priorities, impression of technology and level of knowledge affects a person acceptance of AV/SAV, and to analyse this between two different age demographics, Young and Mature adults. This chapter is divided into two overarching categories: 4.1. Population priorities and impression in connection with acceptance and 4.2. Population knowledge in connection with acceptance. Within these two sections graphs surmising the data relating to each research objective will be presented, analysing the difference between user's answers to the survey between both populations, Young adults and Mature adults, and within each population in regard to different technology, AV and SAV. Excel and Google sheets were used to produce graphs and to run significance testing between populations to find the extent of any existing differences and will be used to investigate any patterns that emerge.

4.1.1 *Population's priorities for transport*

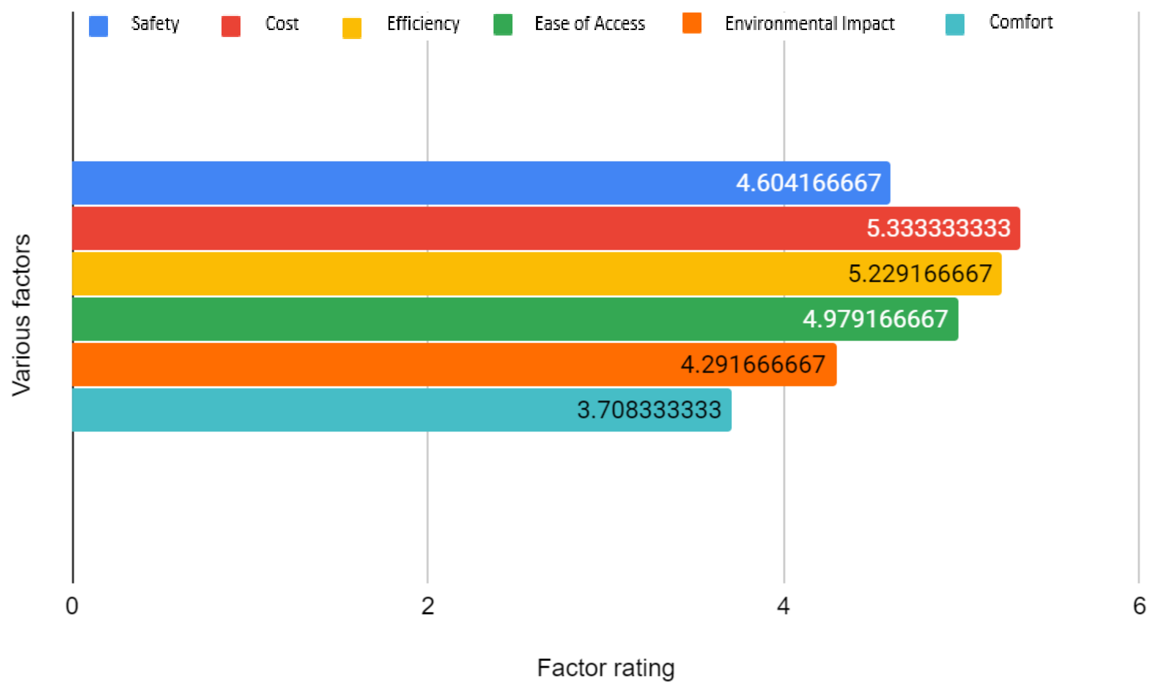

Figure 3: Young adult population answer to Q7 'Ranking these elements 1-6, what is the most important to you in considering your mode of transport?'

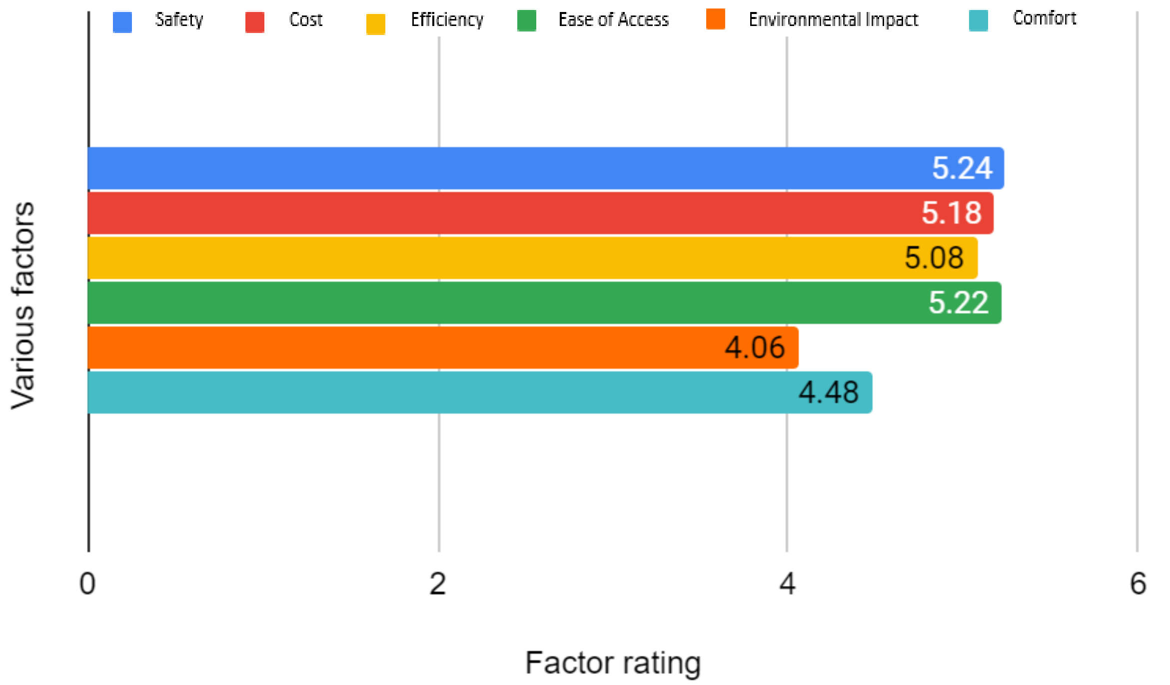

Figure 4: Mature adult population answer to Q7 'Ranking these elements 1-6, what is the most important to you in considering your mode of transport?'

The travel priorities of both Young Adults (18-24) (Figure 3.) and of Mature Adults (25+) (Figure 4.) shows relatively similar results. The only notable difference between them is in the category of Safety and Comfort. Mature adults tend to value safety and comfort more than that of Young adults. Overall, Mature adults most value safety whereas Young adults most value cost. However, there is no statistically significant difference found between any factor when comparing Young adults with Mature adults, (p=0.58).

4.1.2 Population's impression of various factors in regard to AV and SAV

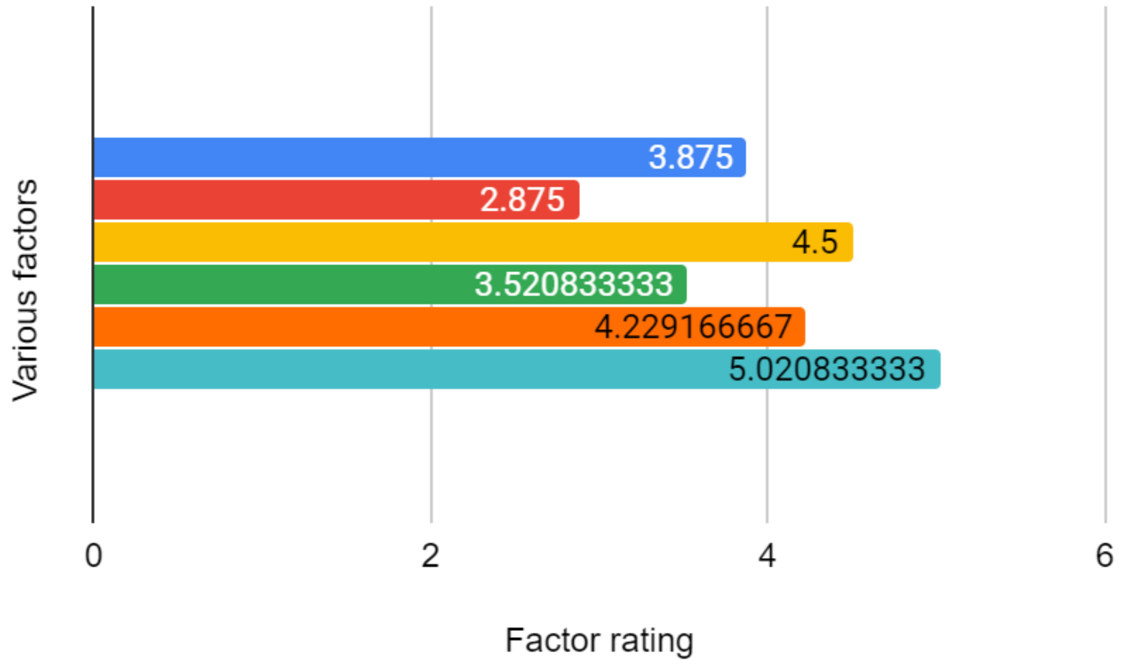

Figure 5: Young adults answer to Section 4, Question 2: 'Rating these elements 1-6, what has your impression been regarding these issues in relation to Self-driving Cars?'

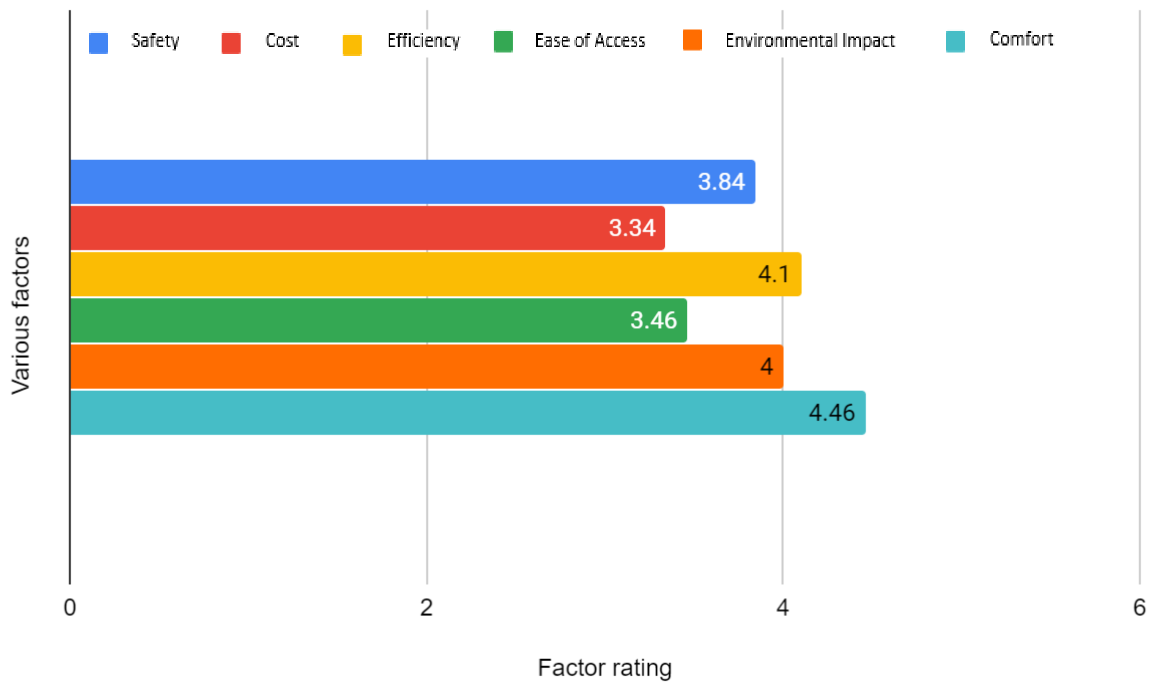

Figure 6: Mature adults answer to Section 4, Question 2: 'Ranking these elements 1-6, what has your impression been regarding these issues in relation to Self-driving Cars?'

Young Adults and Mature Adults impressions of AV mirrors each other's well (Figure 5. and Figure 6.), with a maximum variation of ±0.5. Therefore, it has been found that there is no statistically significant difference between Young Adults impressions of this technology and Mature Adults. When comparing these impressions with user priorities it is clear that the priorities of Mature Adults are believed to not be met by the technology. Safety, ease of access, and cost are the top three priorities for Mature Adults, and are the three lowest ranking factors respectively, when analysing their impressions. Similarly, their three least important factors; Efficiency, comfort, and environmental impact, are the three highest ranking factors in their view of AV. Two of the three top priorities for Young Adults, cost and ease of access, are the lowest ranking factors from their impression of the AV. This shows that user's impression of AV technology is not in line with their priorities, which may lead to lack of acceptance.

Analysing user's impressions of SAV, a very similar pattern occurs again. Both Mature adults (Figure 8.) and Young adults (Figure 7.) impressions of SAV are parallel with a maximum variation of ±0.4, showing no statistically significant difference between the two when it comes to transport priorities. Akin to with AV, user's impressions of SAV does not coincide with their priorities when choosing transport. Mature adults' top priorities are what they rank the least in their impression and for Young adults' as well, two of their top three are what they have ranked the lowest in their impression.

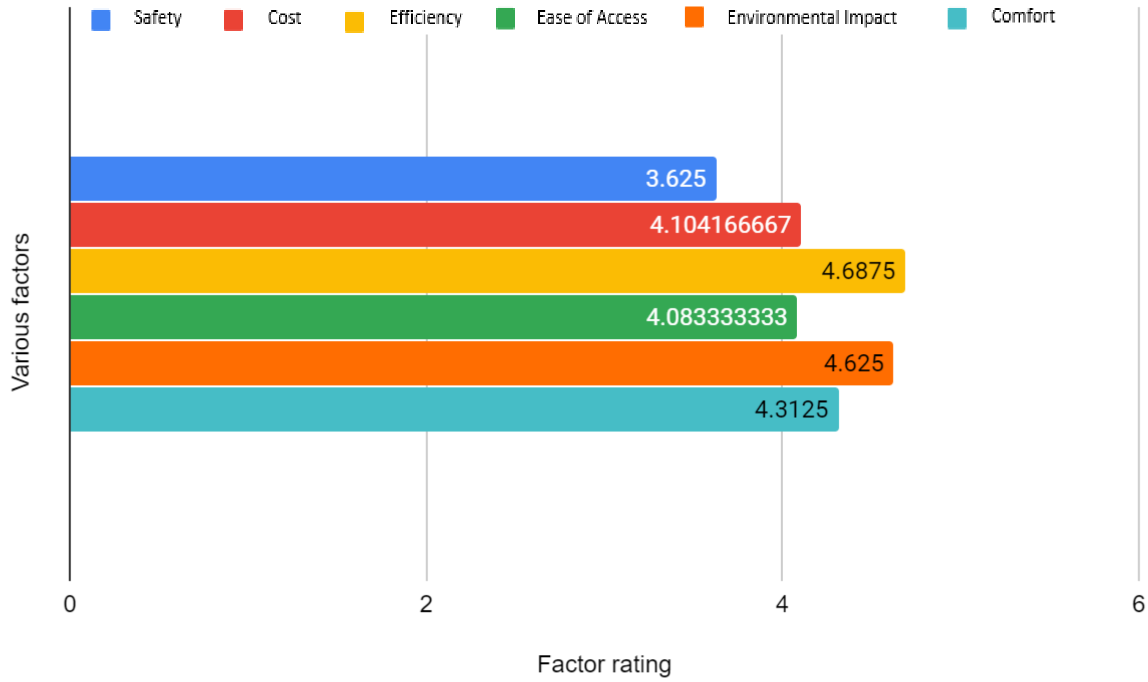

Figure 7: Young adults answer to Section 5, Question 2: 'Rating these elements 1-6, what has your impression been regarding these issues in relation to Shared Self-driving Cars?'

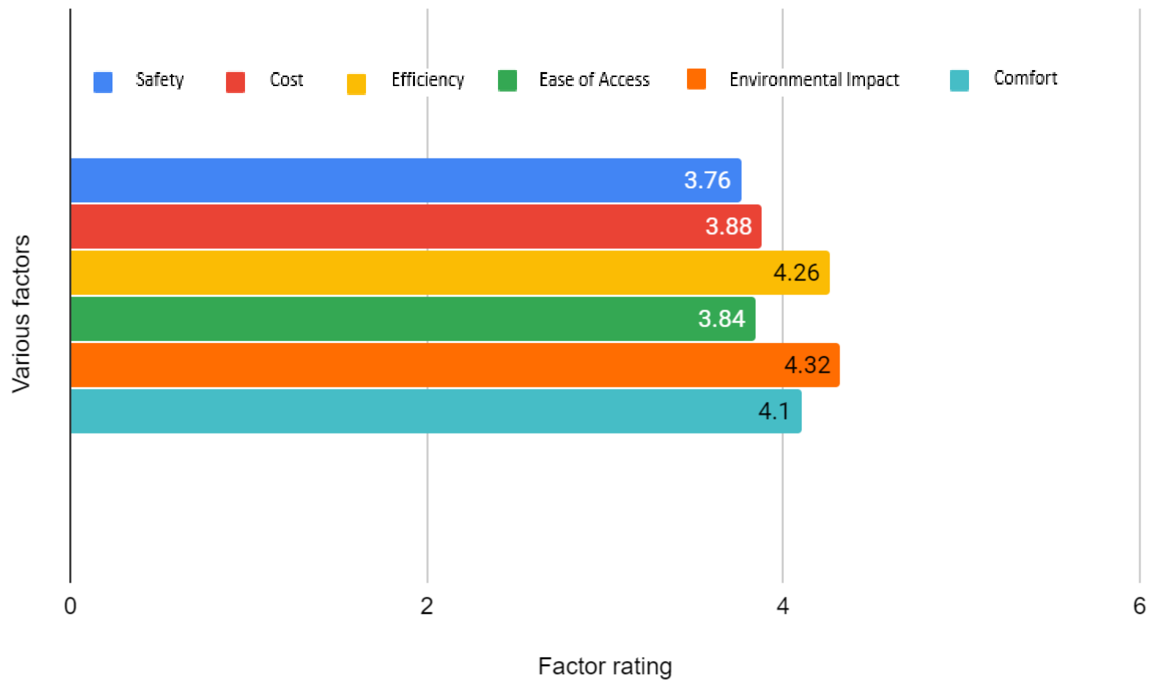

Figure 8: Mature adults answer to Section 5, Question 2: 'Ranking these elements 1-6, what has your impression been regarding these issues in relation to Shared Self-driving Cars?'

4.1.3 Population's rate of acceptance of AV and SAV and relative incentives and preventatives

Of those who answered 'Yes' to if they would switch to the relative technology, the following two questions 'What would INCENTIVISE you to make this switch' and 'What would PREVENT you from making this switch' was graphed together in one figure for both Young adults, (Figure 9.) and Mature adults (Figure 10.) to present the values of those who would consider switching to autonomous vehicle technology, both AV and SAV. When it comes to accessibility it is clear that the accessibility of both AV and SAV technology is considered a negative aspect of this technology by Young Adults and similarly by Mature adults in relation to SAV. However, Mature Adults consider accessibility a net positive for AV technology. Mature adults do not consider efficiency when deciding to switch for AV or SAV, and Young adults do not consider it with SAV. For AV technology, 50% of those who decided to switch within the Young adult population considered the level of safety of an autonomous car to prevent them from using and but also 50% consider the safety level to incentivise them to use it. Therefore, it can be noted that the opinions of Young adults are not uniform between the whole population. This can also be seen when viewing Mature adults' impression of the safety of both AV and SAV. 50% believe it to be an incentive and 50% believe it to be preventative. Young adults seem to be less trustworthy of the technology as only around 15% and 45% of user's believe the safety of AV and SAV respectively, is an incentive. Environmentally, both AV and SAV are considered an incentive for Young and Mature Adults, except in the case of AV with Mature adults. Cost of both AV and SAV is a net negative for both populations, with the highest percentage of those considering it be an incentive being Mature adults with SAV technology. Young adults consider it a preventative factor for both AV and SAV as do Mature adults for AV. Comfort within AV's are seen as a net incentive for the technology for both populations, but a net prevention for SAV by the Young adults. Mature adults do not consider it to be a deciding factor.

In comparison with these populations travel priorities, one would assume that these would align with each other as this population has answered 'Yes' to if they would switch. For Young adults, cost, efficiency, and ease of access are what matters. Of those who answered 'Yes', they found that cost was a prevention in AV technology and 50% incentive and 50% prevention in regard to SAV. Efficiency was not found to be either an incentive or preventive for AV, and was not considered for SAV, and ease of access is 100% preventative for both AV and SAV. For Mature adults, safety, ease of access and cost are what they consider important. Safety for both AV and SAV were evenly split as an incentive and prevention, accessibility was a net positive for AV's but not considered for SAVs, and cost was found to be 60% and 50% preventative for AV and SAV respectively. This shows that even though both the Young and Mature population's main priorities for travel were not met, they still would switch to AV or SAV technology regardless.

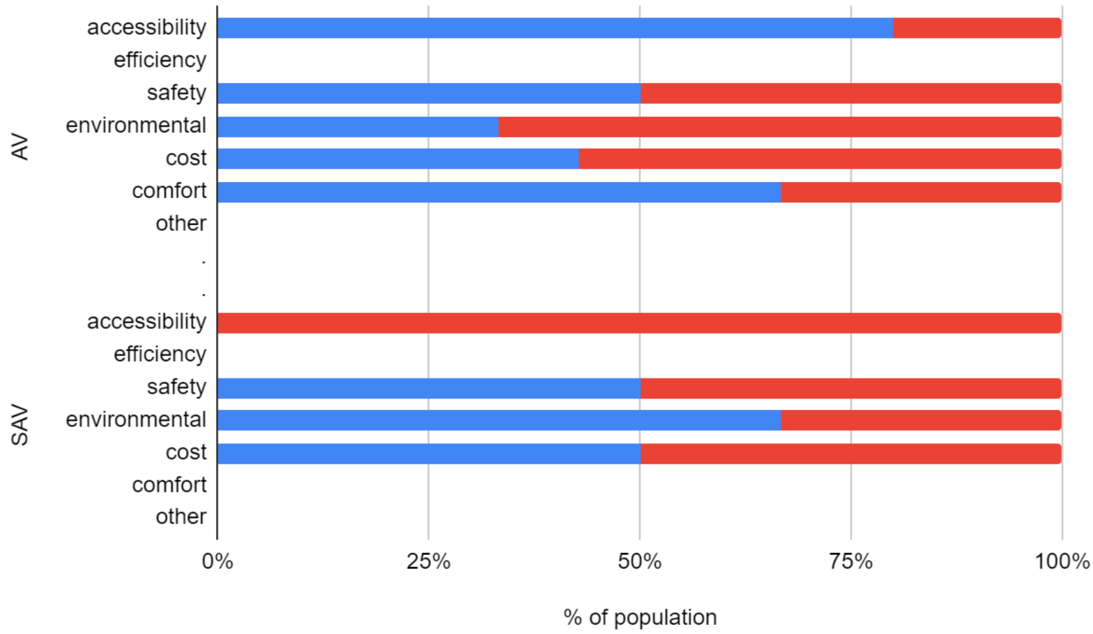

Figure 9. Incentives (blue) and Preventatives (red) of both AV & SAV technology according to the population of Young Adult's population who answered 'Yes' to 'If this technology was implemented, would you be willing to transfer to this mode of transport? (AV/SAV)'

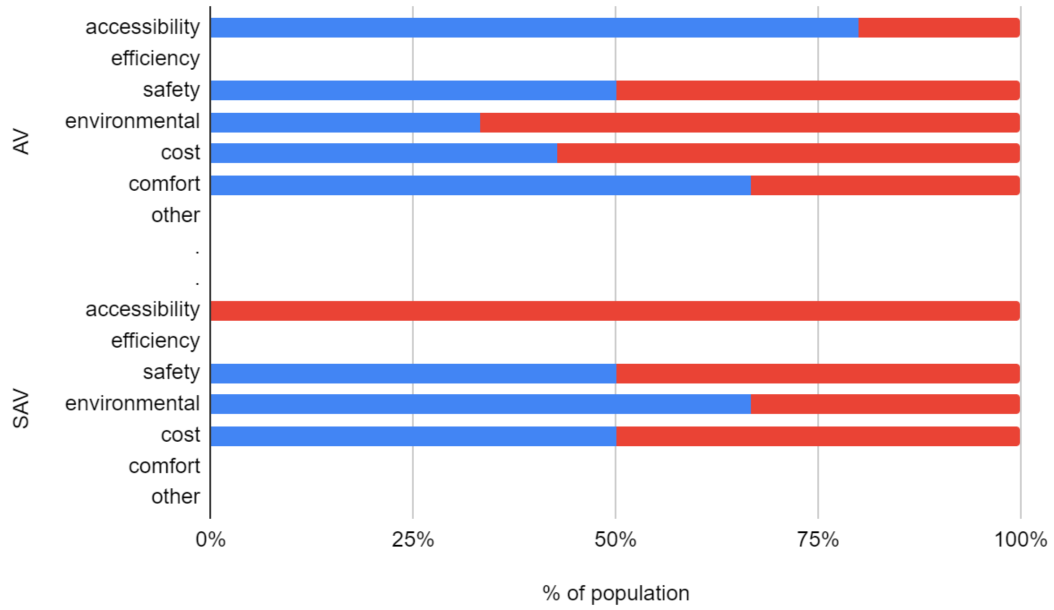

Figure 10. Incentives (blue) and preventatives (red) of both AV & SAV technology according to the population of Mature Adult's population who answered 'Yes' to 'If this technology was implemented, would you be willing to transfer to this mode of transport? (AV/SAV)'

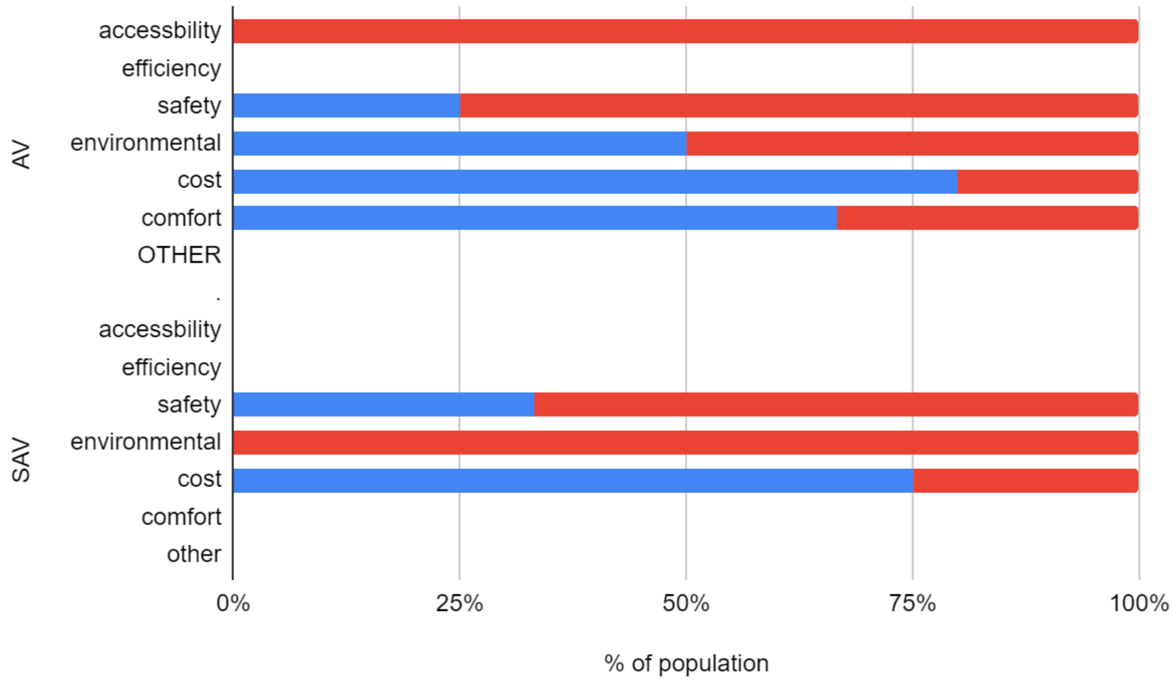

Figure 11. Incentives (blue) and preventatives (red) of both AV & SAV technology according to the population of Young Adult's population who answered 'No' to 'If this technology was implemented, would you be willing to transfer to this mode of transport? (AV/SAV)'

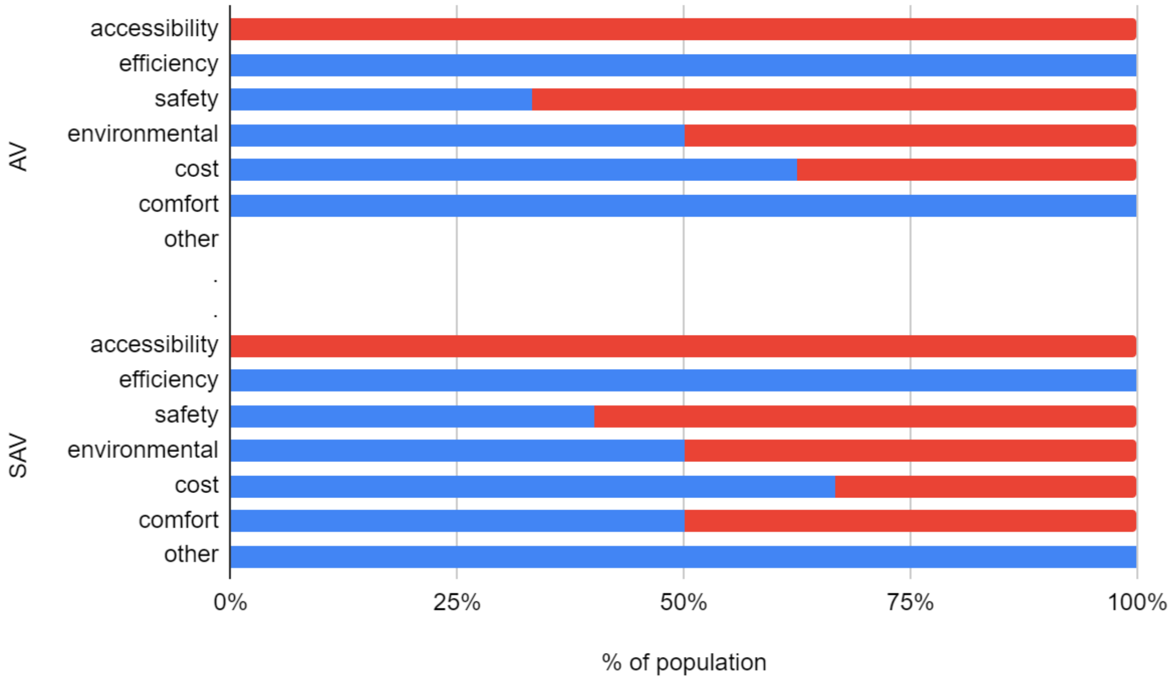

Figure 12. Incentives (blue) and preventatives (red) of both AV & SAV technology according to the population of Mature Adult's population who answered 'No' to 'If this technology was implemented, would you be willing to transfer to this mode of transport? (AV/SAV)'

Young adults' incentives and preventions of AV and SAV are very similar (Figure 11.). Accessibility is 100% a preventative factor, and efficiency is a 100% incentivising factor. Safety is a net preventative factor with it being 30% and 40% incentivising for AV and SAV respectively. Environmentally, half of the population believe it to be incentivising and the other half believe it to be preventative. Cost is seen to be an incentive with 65% and 70% of the population stating this for AV and SAV respectively. The main difference between AV and SAV is comfort, where AV is seen to be fully incentivising and SAV, half the population believe this to be true. With Mature adults (Figure 12.), accessibility and environmental aspects are similar to that of Young adults in relation to AV. Safety is also a net negative for both AV and SAV, similar to Young Adults, however the main preventative reason for not choosing to switch to SAV is environmental aspects, with that being 100% preventative. Cost was found to be a net incentive of SAV for Mature Adults, but accessibility, efficiency, and comfort were not considered when making the decision to not switch to SAV technology.

Once again, when comparing users travel priorities, Young adults in particular seem to be contrary. With cost being their top priority, those who said 'No' to switching found that AV and SAV had an incentivising cost. Efficiency was found to be 100% incentivising for both AV and SAV and was their second most important priority, but also decided to not switch to said technology. Accessibility was found to be their third top priority and both AV and SAV were found to be preventative in their access abilities. Mature adults' top priority was safety, and this was found to be a net preventative for both AV and SAV, as well as accessibility being found to be 100% preventative in AV but not considered in SAV. Cost however, being their third most important factor, was a net incentive. Once again, in the case of Young adults, their priorities do not determine whether they will use the technology or not.

4.2.1 Population's level of knowledge and their impression of SAV

When observing if the level of knowledge links with the overall impression of a technology, SAV is considered. This is due to the fact that 100% of respondents had prior knowledge of AV technology. For SAV, 67.9% of Young adults and 52% of Mature adults had a prior knowledge of SAV mobility (see Figures 13 and 14, respectively). Using SAV will allow analysis of how knowledge may affect a person's impression of a technology.

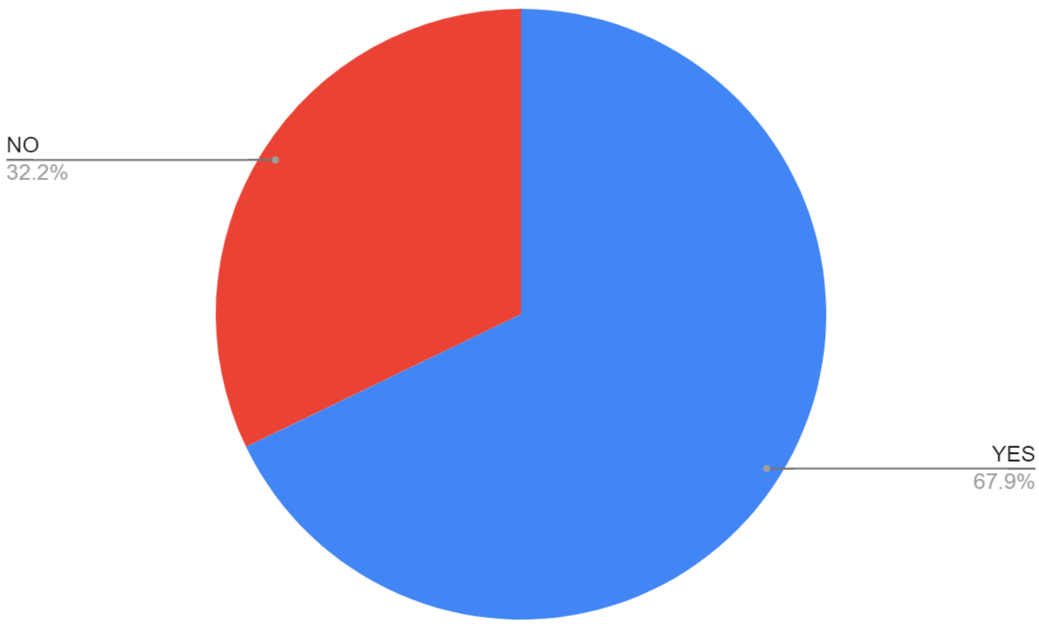

Figure 13. Young adults answer to Section 5, Question 1: 'Have you heard of Shared Self-driving cars?'

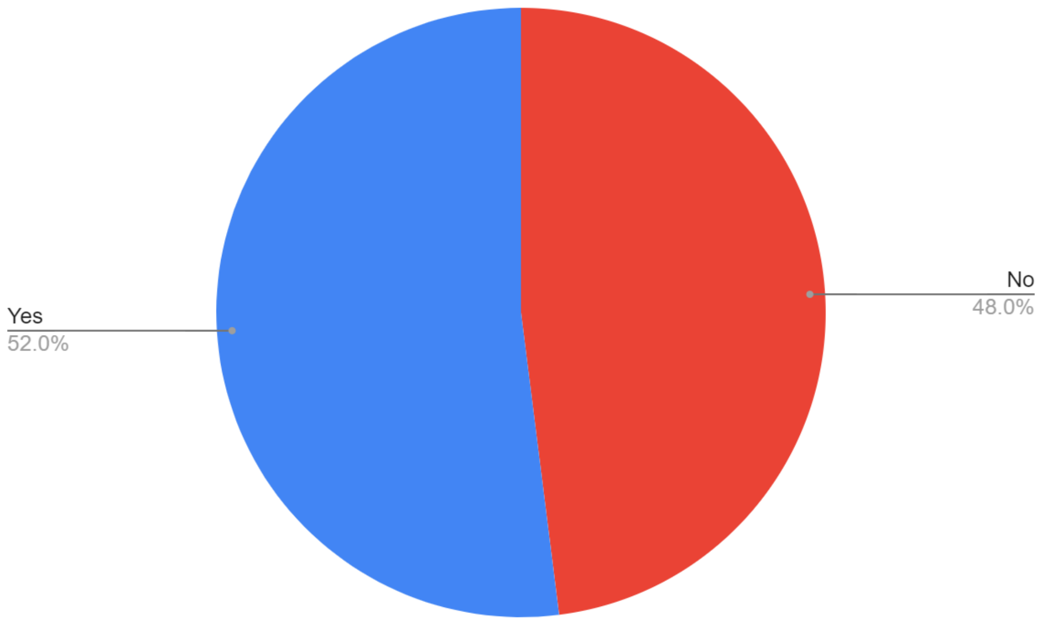

Figure 14. Mature adults answer to Section 5, Question 1: 'Have you heard of Shared Self-driving cars?'

When comparing Young adults with prior knowledge's impression of SAV with Mature adults with prior knowledge's impression of SAV you can see differences between them. Mature adults have a smaller range when it comes to rating priorities, 0.42, whereas Young adults have a range of 1.2. This shows that Young adults impressions fluctuate more considerably than Mature adults. Mature adults' impressions all lie within 0.42 of each other and show relatively high impressions of all priorities, whereas Young adults have distinct preferences. This trend continues for the population who do not have prior knowledge, as the Mature adults' impressions do not fluctuate as much as Young adults, however both do fluctuate, with Mature adults having a range of 1.04 and Young adults having a range of 1.36.

Overall, those with a prior knowledge do have a slightly higher impression of SAV than those who do not have any prior knowledge, with Mature adults with prior knowledge having the highest overall rating of SAV, 25.12 out of 30 (Figure 16.), followed by Young adults with prior knowledge giving a rating of 25.9 out of 30 (Figure 15.). Young adults without prior knowledge (Figure 17.) gave a rating of 25.1 out of 30 and Mature adults without prior knowledge (Figure 18.) gave a rating of 23.1, this being the lowest overall rating. Mature adults seem to fluctuate the most with their opinion of each technology, having scored 25.12 for AV and 23.1 for SAV. This is a relatively stark difference.

In conclusion, there is a slightly higher impression of SAV by those who have prior knowledge than those who do not. This difference is not statistically significant however, but this may show overarching trends that could not be caught by the limited size of the sample population.

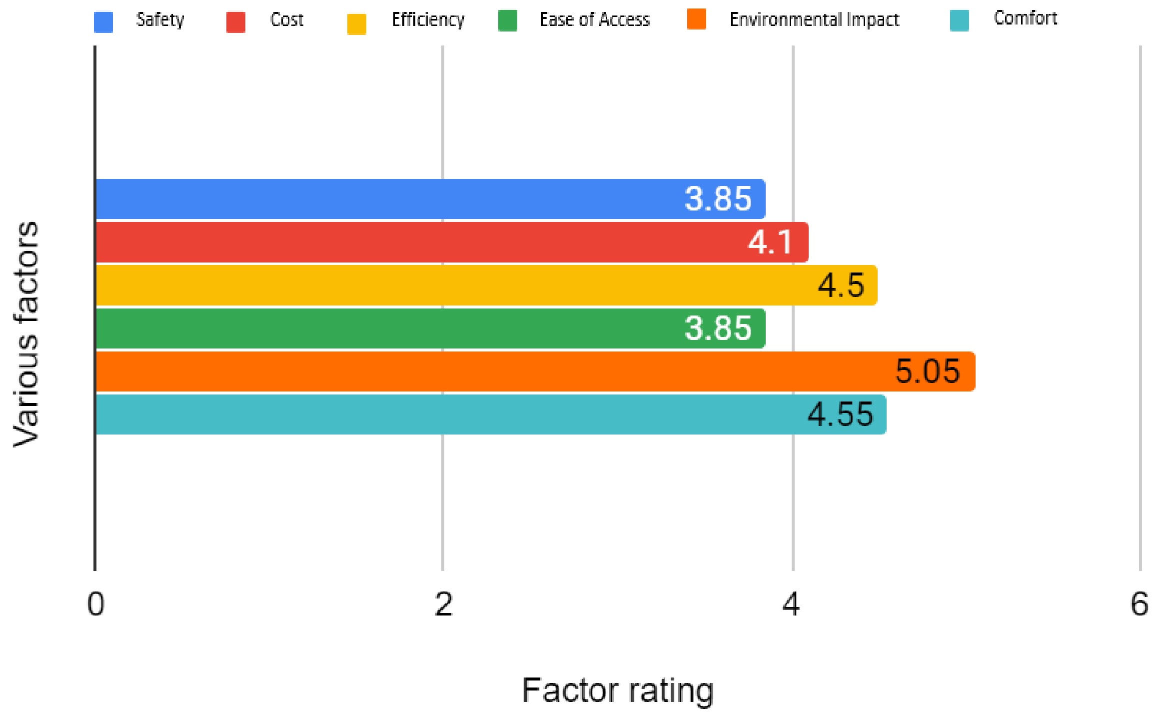

Figure 15. Young adults who have a prior knowledge of SAV's answer to Section 5, Question 2: 'What has your impression been regarding these issues in relation to Shared Self-driving Cars?'

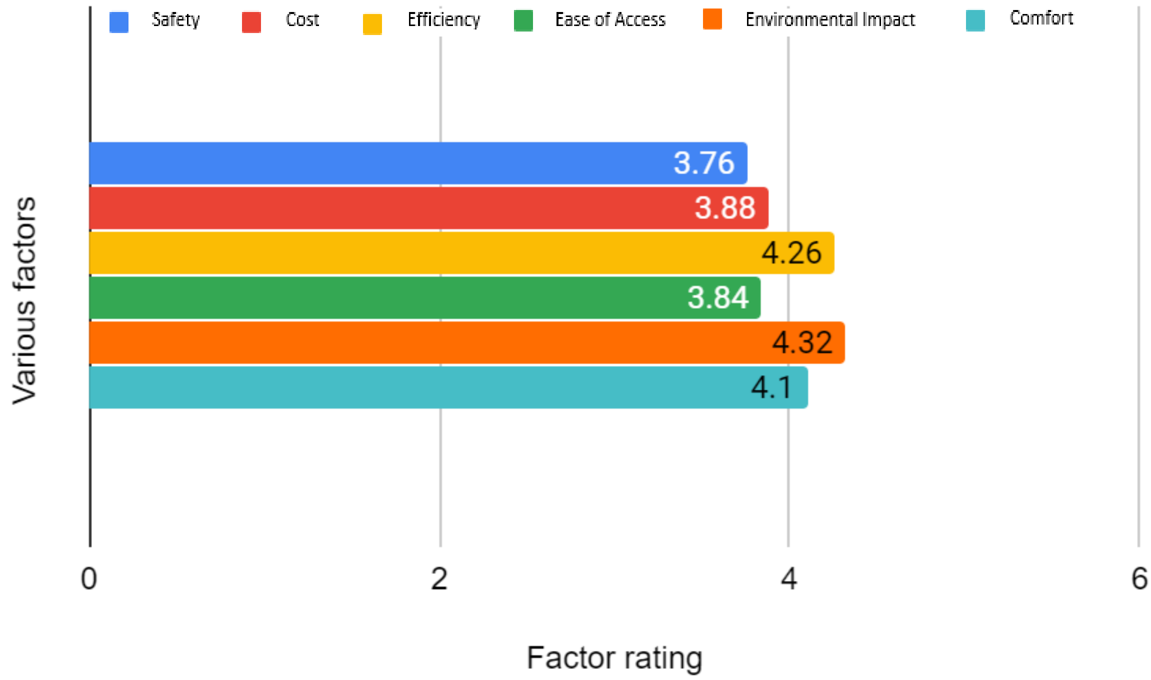

Figure 16. Mature adults who have prior knowledge of SAV's answer to Section 5, Question 2: 'What has your impression been regarding these issues in relation to SAV?'

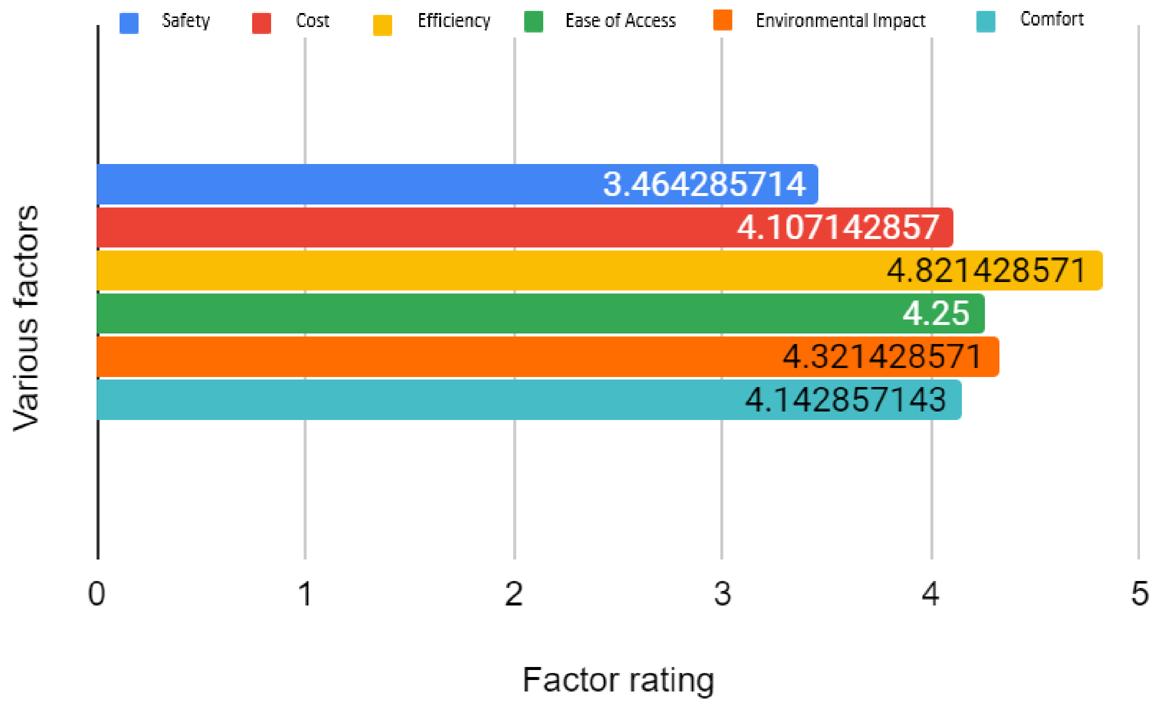

Figure 17. Young adults who do not have prior knowledge of SAV's answer to Section 5, Question 2: 'What has your impression been regarding these issues in relation to SAV?'

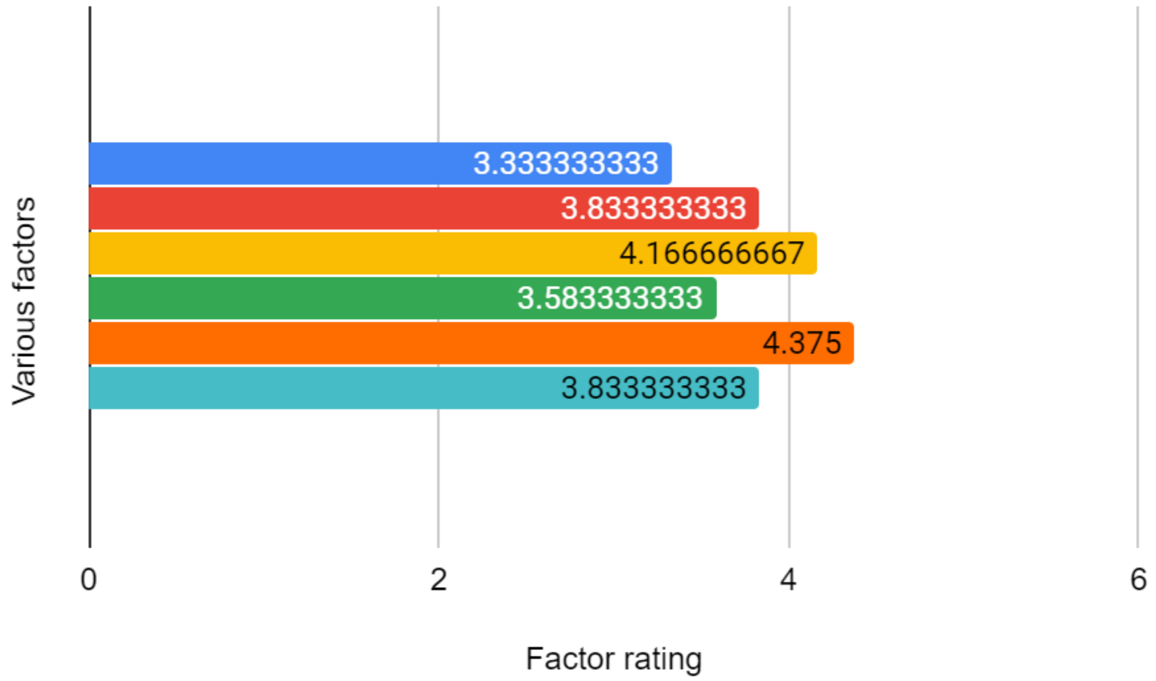

Figure 18. Mature adults who do not have prior knowledge of SAV's answer to Section 5, Question 2: 'What has your impression been regarding these issues in relation to SAV?'

4.2.2 Population's level of knowledge and their acceptance of SAV

To analyse if having a prior knowledge of a technology makes a person more likely to accept a technology, pie charts were made to demonstrate the acceptance rate of those who had prior knowledge vs those who had not. Figure 19. and Figure 20. demonstrate this for the Young adult's population, showing the acceptance rate of those who had prior knowledge of the technology and those who did not respectively. From this, it can be seen that those with a prior knowledge has more 'Yes' answers to switching than those who had no prior knowledge. It also shows that there is more uncertainty to switch by those who had no prior knowledge of the technology.

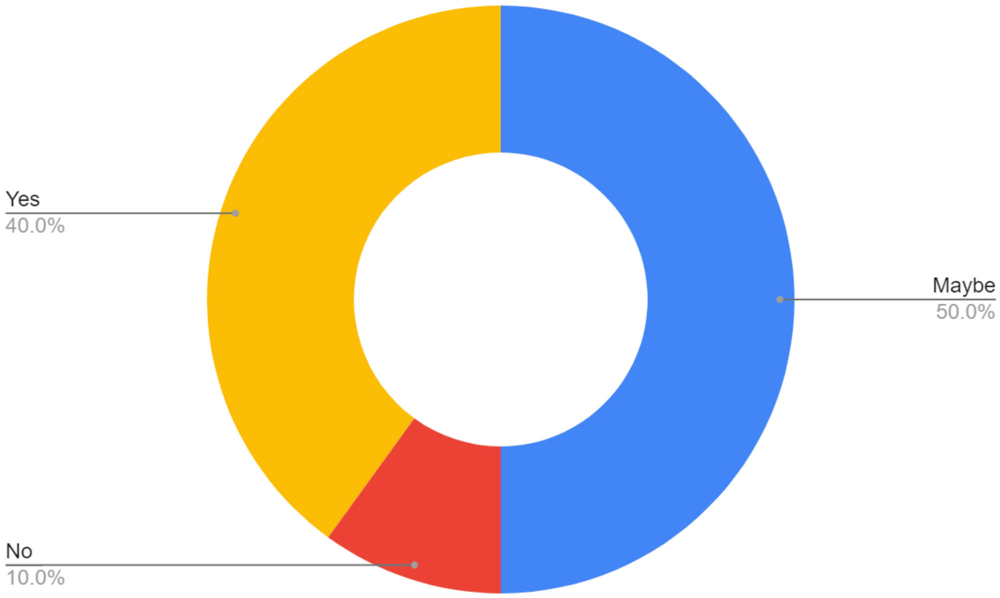

Figure 19. Young adults who had prior knowledge of SAV technology's answer to Section 5, Question 3: 'Would you be willing to transfer to this mode of transport?'

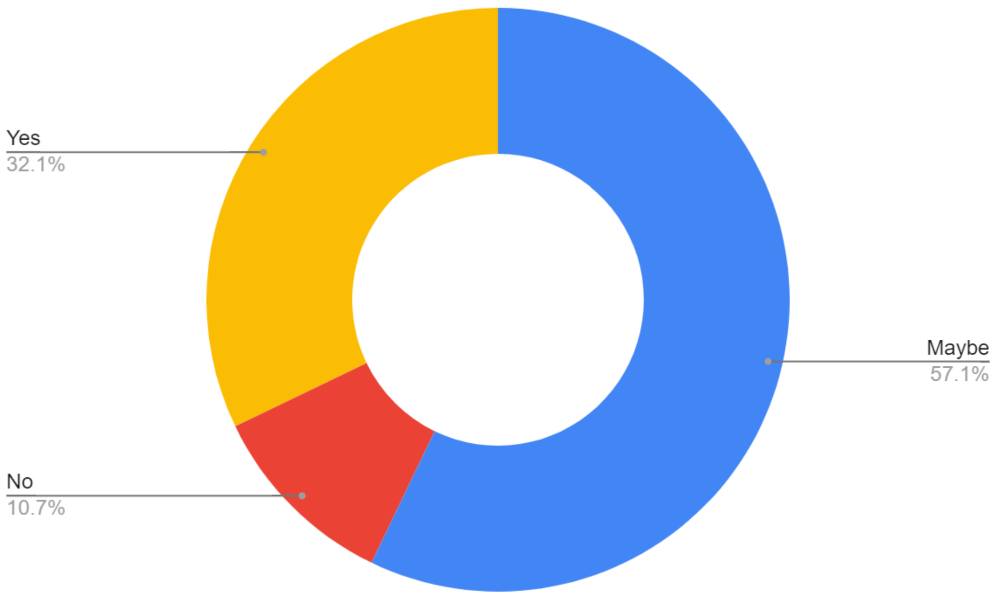

Figure 20. Young adults who had no prior knowledge of SAV technology's answer to Section 5, Question 3: 'Would you be willing to transfer to this mode of transport?'

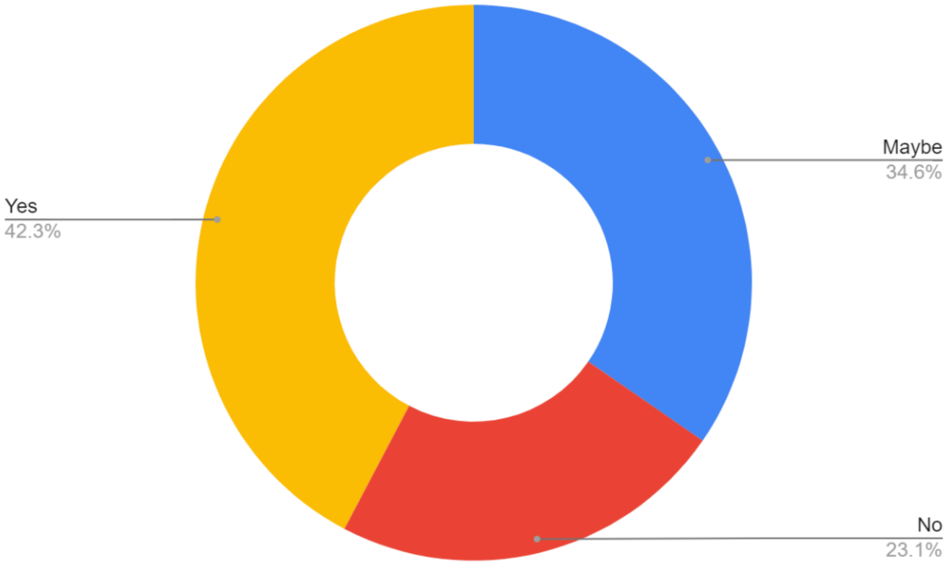

Figure 21. Mature adults who had prior knowledge of SAV technology's answer to Section 5, Question 3: 'Would you be willing to transfer to this mode of transport?'

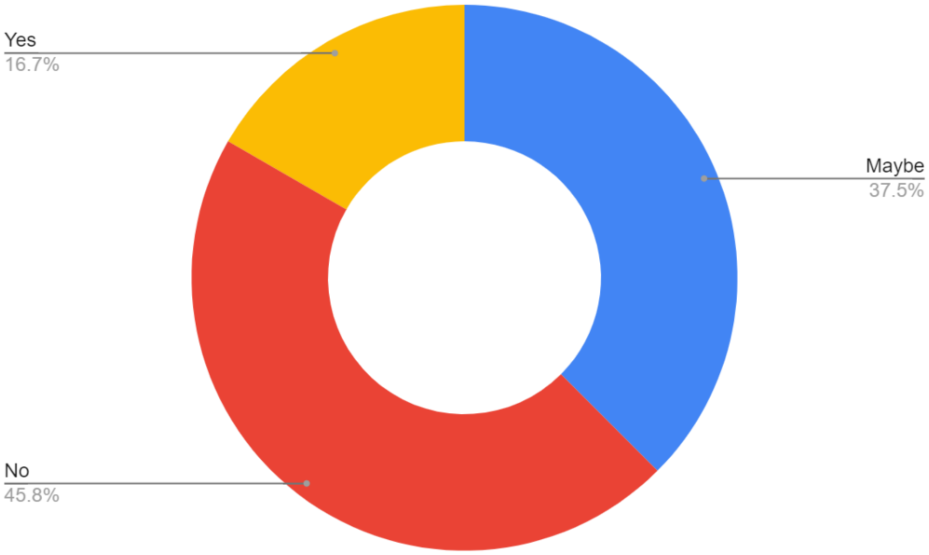

Figure 22. Mature adults who had no prior knowledge of SAV technology's answer to Section 5, Question 3: 'Would you be willing to transfer to this mode of transport?'

With the Mature adult population, the differences are more considerable. For those with prior knowledge (Figure 21.) the majority of them answered 'Yes' or 'Maybe', with the smallest proportion answering no. Contrastingly, those with no prior knowledge

(Figure 22.) the majority of them said ‘No’ to the question of switching. Only 16.7% of that population would consider switching and 37.5% have uncertainty about switching. This shows the Mature population is more inclined to reject a technology if they have no prior knowledge and are less prone to uncertainty.

Conclusion

In conclusion, this study shows that the travel priorities and impression of AV technology of both Young and Mature adult populations do not strongly or directly affect their acceptance, however level of knowledge has an effect on both populations in different ways. Young adults without knowledge having more uncertainty and Mature adults are more likely to reject SAV technology without having prior knowledge. Further analysis of these results and the implications of these within the pre-existing literature will be discussed in the next chapter.

5. Discussion

Introduction

This study aims to gather information regarding people's travel priorities, impression of AV and SAV technology, as well as their level of prior knowledge of said technology and their level of acceptance of it. With this information a comprehensive overview of some of the potential reasons behind a person's acceptance of this technology can be found.

5.1. Populations travel priorities and impressions of AV and SAV

Identifying different factors that are prioritised by the public has been said to aid the success of AV/SAV technology by increasing the chances of the acceptance of the technology (Khan 2012, Rupp 2010). However, within this study it has been found that this may not be the case. Between the Young adult and Mature adult populations for both AV and SAV, it was found that Young adult's value 1. Cost, 2. Efficiency, and 3. Accessibility, the most and Mature adults consider 1. Safety, 2. Accessibility and 3. Cost to be most valuable, in decreasing order of importance. When analysing the details of the population's impression of the three top priorities, Mature adults most valued priorities were ranked the three lowest in their impressions. The same goes for Young adults with two of their top three. Therefore, it was found that AV and SAV technology is not seen to be able to meet the average travel priorities of either population. The fact that the populations impression of the technology is the opposite of their priorities, may be a reason for some not accepting the technology. However, when going further into analysis and examining the core reasons as to why the population were or were not willing to switch to autonomous technology, these priorities were seemingly unconsidered.

By looking at both the incentives and preventatives of SAV by the proportion of both populations that answered 'Yes' to a willingness to switch to SAV if implemented, their priorities did not dictate their acceptance. For example, Young adults most value cost, however those who answered 'yes' to a willingness to switch considered the cost of SAV to be a net negative factor in switching, and yet would still be willing to do so. Similarly, the proportion of the Young adult population that answered 'No' to a willingness to switch to SAV, found the cost of the technology to be a net positive, and yet still decided to not switch. Efficiency was their second most valued priority, and 100% this population found the efficiency of SAV to be incentivising, but still decided to ultimately not make the switch. These findings go against previous studies such a (Efthymiou 2013) where it was proven that when these priorities are met it increases acceptance, (Lane 2015) who found that the stronger the priority the more likely a person is to accept AV technology if it is met, (KPMG 2013) and (Bazilinsky 2015) looking at safety as people's main priority, and results showing that when that strong priority wasn't met the technology was rejected, and many more studies within this field.

This leads to the conclusion that their priorities are not the sole determinant in whether they will use the technology or not and that there are more complicated underlying factors at play into the acceptance of technology that goes beyond priorities being met. Other factors that affect the acceptance are outlined within the Theory of Planned Behaviour, and within this study two out of the three main concepts were found. 1. An individual's attitude towards the behaviour, in this case the use of AV/SAV. This was found when respondents answered questions regarding their impression of AV/SAV and was found to be generally positive. When it was further broken down into incentives and preventatives, the details of these impressions were broken down. Second, is the Perceived behavioural control, or the ease or difficulty of enacting behaviour. Within this study it was found when the population answered the question regarding their impression of 'Ease of Access'. The impression of this factor fluctuated between 3.5 – 5.2 out of 6, showing mixed opinions. The third concept, the one not investigated within this study was their subjective norm, or societal pressures. This could be the underlying reason dominating their acceptance that was not caught in the scope of this study, instead of priorities.

Within the extended version of TAM, two other factors PU and PEU are considered.

Within the Socio-ecological Perspective, perceptions and attitudes are also important in determining acceptance, as well as a person's surroundings, similar to TAM. However within this framework, sociodemographic characteristics are also important, and within this study one of the research aims is to determine whether age plays a significant role in priorities or impressions of AV/SAV in relation to its acceptance.

It has been found that the populations impression of AV and SAV also does not significantly differ between Young adults and Mature adults. However, Young adults and Mature adults' opinions are not uniform within each population. For example: 50% of Young adults believe safety to be an incentive to switching, meaning they believe autonomous technology to be safer than the one they're currently using. The other 50% believe it to be a net negative, not trusting the technology to be able to help them travel in a safe manner. This can also be said for the Mature population, an even divide within the population, and this population most values safety when travelling. Therefore, when trying to cater to a specific population through their impressions and priorities it is a complicated process.

Ultimately, when analysing the relationship between population's priorities and acceptance, the first objective of this study, it can be said that; No, the populations priorities are not the deciding factor in acceptance. It has been theorised and put forward that other factors that had not been investigated such as a person's subjective norm could be the underlying factor determining acceptance. That a person's environment and societal pressures may override a person's priorities and was not captured within the scope of this study.

5.2 Population knowledge and its relationship with acceptance

When it comes to AV, all participants had prior knowledge of this technology. Therefore, investigating level of knowledge and acceptance will be done using SAV, as a large number of subjects had no prior knowledge. This allows for a comparison between groups. Generally, more Young adults had prior knowledge of SAV technology than Mature adults. All subjects who had a prior knowledge of the technology have a higher opinion of that technology than those without prior knowledge. Mature adults with prior knowledge had a slightly higher opinion of SAV than Young adults. This difference is very slight and not statistically significant; however this could show an overarching trend that was not caught within the small sample size used within this study.

Those who have prior knowledge are also more willing to switch to SAV than those without, which echoes findings within (Nees 2016), (Ha, 2010) and others.

Interestingly, when investigating those without prior knowledge a clear difference is seen between Mature and Young adults. Young adults with prior knowledge have 40% acceptance rate with the smallest proportion rejecting SAV, (10%). For those without prior knowledge the uncertainty rises from 50% with prior knowledge to 57% without. However, the no proportion doesn't rise significantly, (10.7%). This shows that Young adults are more likely to be uncertain regarding their opinions than to outright reject an idea. This is certainly not the case with Mature adults.

Overall, the proportion of Mature adults who outright reject the technology is much higher for those without prior knowledge. For those with prior knowledge there is a 42.3% acceptance, which is higher than that of Young adults. Nonetheless, when examining their acceptance without prior knowledge, the majority has rejected that technology (45.6%). Only 16.7% of the population would accept SAV without prior knowledge. It must also be mentioned that those who selected 'No' to the question 'Do you have any prior knowledge of SAV?' was then provided with a brief description of this technology. Even after gaining some insight into the technology the majority still chose to reject the technology. This shows that Mature adults are more likely to outright reject a technology they are not familiar with, this links in with previous studies whose findings were similar such as (Schoettle and Sivak 2014), (Deloitte 2014) and (Wang 2011), all of whom found that Younger populations are more likely to accept AV technology than Mature populations. These studies findings also mirror theories within TAM.

PEU is an important factor within TAM's extended version. This analyses where a technology will cater to the needs of the user. This ease of use and ease of access directly affect acceptance. Within the Mature population without prior knowledge, they rate SAV's ease of access lower than any other proportion of the population. This follows the findings of TAM that say that the opinion of SAV's ability to cater to their needs is directly influenced by their level of knowledge. This also explains why those with more knowledge are more willing to switch.

These results also coincide with some aspects of SEP. It theorises that sociodemographic characteristics directly affect acceptance. Within this study, this was found to be true in relation to acceptance when related to level of knowledge. Level of knowledge is also considered to be a deciding factor within SEP, which is also proven true within these findings. It also reinforces results found by (Vankatesh 2003, and Hogg 2010) when they found that behavioural intention to accept technological innovation declined as age increases. This is true for SAV for those without prior knowledge and is reinforced by theories associated with level of knowledge in both SEP and TAM.

Within the field of acceptance theory, the link between knowledge and acceptance is not straightforward (Ha, 2012). This study reinforces the viewpoint that a subject's level of knowledge directly influences their acceptance, with more knowledge leading to higher rates of acceptance. However, it would be remiss not to mention the multitude of studies that contradict these findings (Sinatra 2002, Paz-y Mino and Espinosa 2009). (Ha, 2012)'s perspective on acceptance is also something to be considered when analysing any acceptance study. As summarised previously, acceptance is a combination of 1. Knowledge, but also 2. Feeling of knowing. This second aspect was not examined within this study but is believed to be a stronger force behind decision making than knowledge. This is because this FoK is not based on any underlying knowledge, its purely intuitive cognition. This could be why in 5.1, that although SAV could meet their needs, a proportion of the population would still reject to switch to that technology. It has also been found that constrained levels of certainty linked with FoK due to instinctual feelings, may lead to lower levels of acceptance even when conceptual knowledge of the technology is high (Ha, 2012). These factors may be underlying influences within this study that was not caught through questions asked and must be acknowledged as such. Nevertheless, the results within this study found that there is a direct link between level of knowledge and acceptance that is noticeably stark within older sociodemographic populations.

6. Conclusion

Introduction

This chapter will outline the main findings within this study as well as suggestions for future research that may be beneficial to incorporate into any proceeding acceptance studies, in relation to AV/SAV, or more generally.

6.1 Main objectives and research findings

The main objective of this research was to investigate the acceptance of AV and SAV technology by surveying a relatively representative proportion of the population of Dublin. Having used a small sample size (n=100), this study found overarching trends within the population. These trends are in relation to 1. Acceptance and its relationship with a person's impression of a technology, and 2. Acceptance and it's relationship with a persons' level of knowledge of a technology.

1. The results of the first objective are that there is no significant relationship between a person's impression of a technology and a willingness to accept that technology. This was found due to the fact that when the main priorities of a proportion of a population were met, that proportion still rejected the technology, and similarly when the main priorities were not met, a proportion of the population accepted the technology. Ergo, impressions are not the deciding factor of acceptance. This was theorised to be due to different aspects not investigated within this study, such as SN or FoK, and is suggested to be incorporated into any future study regarding these topics.

2. The second objective results found a relationship between a person's level of knowledge and acceptance within the Mature adult population. The results found that the majority of those within the Mature adult population who had no prior knowledge of a technology would outright reject it, if implemented. Those with prior knowledge within the Mature adult population were more accepting than those without prior knowledge. Young adults were found to have similar acceptance with or without prior knowledge, but the majority of both populations were uncertain of whether they would accept or not and were therefore less

likely to outright reject a technology. These results were found to coincide with theories within the extended TAM and SEP, as well as previous findings within technological acceptance studies (Ha 2010, Hogg 2013, Davies 1989, Venkatesh 2003).

6.2 Future research

The findings within this study contribute to the growing body of work within acceptance theory and AV/SAV technology research. When moving forward with research, questions unanswered within this study would be a useful endeavour. For example, understanding why when the main priorities of a population are met, some still choose to reject the technology. It has been hypothesised to be due to a possible influence by (Ha, 2012)'s FoK theory, however empirical data investigating this would be needed for confirmation.

As well as this, one aspect used within both SEP and TAM was not investigated within this study, this being a person's surroundings, or better known as subjective norm within TAM. Outside influences such as their environment, social pressures, or other external influences were not considered within the scope of this study. Investigating these factors may allow for a better understanding of acceptance and answer questions posed within this study.

Due to the time frame, resources, and word count available for this study, FoK and SN were not viable for study within this research but would be extremely valuable to analyse in any future research. The time frame and resources available also caused there to be a relatively small sample size. It would be recommended to survey a larger proportion of the population to more easily root out any overarching trends that may not have been caught in the scope of this study.

Conclusion

The relationships at play that determine acceptance are not straightforward or simple to analyse. To fully research this topic one must adapt a multidisciplinary approach to fully encompass the broad spectrum of reasonings behind acceptance, such as the psychology of acceptance, the cognitive background of knowledge as well as having a strong knowledge of the technology and literature surrounding autonomous vehicle technology. For this technology to be accepted by society, these kinds of studies are imperative to the smooth transitioning to this technology that is happening across the world in different mobility sectors. Within Ireland, AV and SAV technology is advancing and will soon become part of our sphere of mobility, how successful this will be is entirely due to how this technology is communicated and developed to and for consumers. This study has shown that a prior knowledge of a new technology will greatly improve the acceptance of said technology, and that this information should be communicated affectively, particularly towards the Mature adult population, for this technology to be fully incorporated and accepted by society.

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7. Appendix

Survey distributed

1. Do you consent to take part in this survey? *

   Mark only one oval.

   - Yes
   - No

Untitled section

2. Age (in numbers) *

3. Gender *

   Mark only one oval.

   - Female
   - Male
   - Other

4. Highest level of education completed/currently enrolled in *

   Mark only one oval.

   - Primary School
   - Junior Certificate
   - Leaving Certificate
   - Apprenticeship
   - Higher Diploma
   - Ordinary Degree
   - Bachalors Degree
   - Masters/Post Graduate Degree
   - Phd

5. Area of living *

Mark only one oval.

- Dublin 1
- Dublin 2
- Dublin 3
- Dublin 4
- Dublin 5
- Dublin 6
- Dublin 6w
- Dublin 7
- Dublin 8
- Dublin 9
- Dublin 10
- Dublin 11
- Dublin 12
- Dublin 13
- Dublin 14
- Dublin 15
- Dublin 16
- Dublin 17
- Dublin 18
- Dublin 20
- Dublin 22
- Dublin 24
- Greater Dublin Area (Meath, Kildare, Wicklow)

6. Area commuting to most frequently (for work/education/etc) *

Mark only one oval.

- Dublin 1
- Dublin 2
- Dublin 3
- Dublin 4
- Dublin 5
- Dublin 6
- Dublin 6w
- Dublin 7
- Dublin 8
- Dublin 9
- Dublin 10
- Dublin 12
- Dublin 11
- Dublin 13
- Dublin 14
- Dublin 15
- Dublin 16
- Dublin 17
- Dublin 18
- Dublin 20
- Dublin 22
- Dublin 24
- Greater Dublin Area (Meath, Kildare, Wicklow)

7. Mode of transport most commonly used *

Mark only one oval.

- Privately owned car
- Carpooling with others in car
- Taxi
- Dublin Bus
- Coach/Bus Eireann
- Dart
- Commuter train
- Luas
- Motorbike
- Bicycle
- Scooter/Electric scooter
- Walk

Ranking these elements 1-6, what is most important to you in considering your mode of transport?

8. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant							Very important

9. Cost *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant	◯	◯	◯	◯	◯	◯	Very Important

10. Efficiency *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant	◯	◯	◯	◯	◯	◯	Very important

11. Ease of access *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant	◯	◯	◯	◯	◯	◯	Very important

12. Environmental impact *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant	◯	◯	◯	◯	◯	◯	Very Important

13. Comfort *

Mark only one oval.

	1	2	3	4	5	6	
Unimportant	◯	◯	◯	◯	◯	◯	Very Important

Self-driving cars

Self-driving cars: a vehicle with technology capable of sensing their surrounding environment with technology such as GPS and RADAR. The intelligence technology within these cars can also allow vehicles to share data between them which can provide them with knowledge to coordinate driving speed, breaking patterns, distance between vehicles, and provides real-time information about surrounding traffic conditions and other characteristics of its environment. With these technologies self-driving cars efficiency and safety is enhanced and environmental impact reduced.

14. Have you heard of self driving cars? *

Mark only one oval.

◯ Yes *Skip to question 15*

◯ No *Skip to question 21*

What has your impression been regarding these issues in relation to AVs?

15. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Bad impression	◯	◯	◯	◯	◯	◯	Excellent impression

What has your impression been regarding these issues in relation to AVs?

15. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Bad impression	◯	◯	◯	◯	◯	◯	Excellent impression

16. Cost *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

17. Efficiency *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

18. Ease of access *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

19. Environmental impact *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

20. Comfort *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

Skip to question 27

After reading the definition, what is your initial impression regarding these issues?	Self-driving cars: a vehicle with technology capable of sensing their surrounding environment with technology such as GPS and RADAR. The intelligence technology within these cars can also allow vehicles to share data between them which can provide them with knowledge to coordinate driving speed, breaking patterns, distance between vehicles, and provides real-time information about surrounding traffic conditions and other characteristics of its environment. With these technologies self-driving cars efficiency and safety is enhanced and environmental impact reduced.

21. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Bad impression	◯	◯	◯	◯	◯	◯	Excellent impression

22. Cost *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

23. Efficiency *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

24. Ease of access *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

25. Environmental impact *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

26. Comfort *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

Skip to question 27

Implementation

27. If this technology was implemented would you be willing to transfer to this mode of transportation? *

Mark only one oval.

- Yes
- No
- Maybe

28. Please state the main reason for this answer (Aspects mentioned or others) *

____

29. What would most INCENTIVISE you to use this technology? *

Mark only one oval.

- More affordable than current option
- Less environmental impact
- Faster journey
- More comfortable journey
- Improved safety
- Easier to access
- Other: _______________________________

30. What would most PREVENT you from using this technology? *

Mark only one oval.

- Less affordable
- Larger environmental impact
- Less efficient
- Less comfortable journey
- Decreased level of safety
- Harder to access
- Other: ______________________

Shared Self-driving Cars	This is a service that gives access to a fleet of driver-less vehicles to use without owning the car(s). One must register for this service and can book a driver-less car via an app when needed. When a passenger is driven using automation to a destination, instead of the car sitting idle in a parking space until that passenger returns, it continues to transport other passengers in the meantime. With the same technology as self-driving cars, this provides the same benefits without having ownership of the car.

31. Have you heard of Shared Self-driving Cars *

Mark only one oval.

- ( ) Yes *Skip to question 32*
- ( ) No *Skip to question 38*

What has your impression been regarding these issues?

32. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Bad impression	( )	( )	( )	( )	( )	( )	Excellent impression

33. Cost *

Mark only one oval.

	1	2	3	4	5	6	
Bad	( )	( )	( )	( )	( )	( )	Excellent

34. Time *

Mark only one oval.

	1	2	3	4	5	6	
Bad	( )	( )	( )	( )	( )	( )	Excellent

35. Ease of access *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

36. Environmental impact *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

37. Comfort *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

Skip to question 44

After having read the definition, what is your initial impression regarding these issues?	This is a service that gives access to a fleet of driver-less vehicles to use without owning the car(s). One must register for this service and can book a driver-less car via an app when needed. When a passenger is driven using automation to a destination, instead of the car sitting idle in a parking space until that passenger returns, it continues to transport other passengers in the meantime. With the same technology as self-driving cars, this provides the same benefits without having ownership of the car.

38. Safety *

Mark only one oval.

	1	2	3	4	5	6	
Bad impression	◯	◯	◯	◯	◯	◯	Excellent impression

39. Cost *

Mark only one oval.

	1	2	3	4	5	6	
Bad	◯	◯	◯	◯	◯	◯	Excellent

40. Efficiency *

Mark only one oval.

	1	2	3	4	5	6	
Bad	⬭	⬭	⬭	⬭	⬭	⬭	Excellent

41. Ease of access *

Mark only one oval.

	1	2	3	4	5	6	
Bad	⬭	⬭	⬭	⬭	⬭	⬭	Excellent

42. Environmental impact *

Mark only one oval.

	1	2	3	4	5	6	
Bad	⬭	⬭	⬭	⬭	⬭	⬭	Excellent

43. Comfort *

Mark only one oval.

	1	2	3	4	5	6	
Bad	⬭	⬭	⬭	⬭	⬭	⬭	Excellent

Skip to question 44

Implementation

44. If this technology was implemented would you be willing to transfer to this mode of transportation? *

Mark only one oval.

- Yes
- No
- Maybe

45. Please state the main reason for this answer (Aspects mentioned or others) *

____

46. What would most INCENTIVISE you to use this technology? *

Mark only one oval.

- More affordable than current option
- Less environmental impact
- Faster journey
- More comfortable journey
- Improved safety
- Easier to access
- Other: ____________

47. What would most PREVENT you using this technology? *

Mark only one oval.

- Less affordable
- Larger environmental impact
- Less efficient
- Less comfortable journey
- Decreased level of safety
- Harder to access
- Other: ____________