



# Electric Autonomous Vehicles in Shared Ownership

- Perceptions of Swedish Consumers

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# Abstract

**Title:** Electric autonomous vehicles in shared ownership – perceptions of Swedish consumers

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Due to the vehicular trends over the last decade, it becomes more and more evident that the future of mobility is electric. According to The European Environment Agency (2020) penetration of electric vehicles are already growing in all European countries and Goldman Sachs (2021) predicts that in 2025, 25% of all cars sold will be EVs, 70% in 2030, 80% in 2035 and 95% in 2040. At the same time of electrification of vehicles, many scholars and experts agree that autonomous vehicles will play a significant role in the future generation of mobility. Additionally with the increasing usage of carpools and shared mobility, a future business model that combines electric autonomous vehicles with shared ownership of cars could drastically disrupt and change the industry. This thesis investigates the case for Sweden, how consumers perceive such a business model. With a consumer survey and interviews with experts in the field, the thesis aims to give insights into what perceived barriers exists for Swedish consumers to participate in said business model, and what inflection points exists for them to overcome their perceived barriers. The paper found already existing issues regarding owning electric vehicles the most powerful ones - limited charge points and price. Further, the main inflection point to overcome the barriers and participate in said shared, electric & autonomous carpool is economic.

**Keywords:** Electric vehicles, Autonomous vehicles, Future mobility, Shared ownership, Disruptive innovation

# Resumó

**Titulo:** Veículos eléctricos autónomos com propriedade compartilhada - Percepções dos consumidores Suecos

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Devido às tendências veiculares na última década, torna-se cada vez mais evidente que o futuro da mobilidade é eléctrico. Segundo a Agência Europeia do Ambiente (2020), o uso de veículos eléctricos (VE) já está a crescer em todos os países europeus e a Goldman Sachs (2021) prevê que em 2025, 25% de todos os automóveis vendidos serão VE, 70% em 2030, 80% em 2035 e 95% em 2040. Ao mesmo tempo de eletrificação dos veículos, muitos estudos concordam que os veículos autónomos desempenham um papel importante na futura geração de mobilidade. Além disso, com o aumento da utilização de carools e mobilidade partilhada, um futuro modelo empresarial, que combine veículos autónomos eléctricos com a propriedade partilhada de automóveis poderia perturbar e mudar drasticamente a indústria. Esta tese investiga o caso da Suécia e a forma como os consumidores encaram um modelo de negócio deste tipo. Com um inquérito aos consumidores e entrevistas com especialistas na matéria, esta tese pretende dar a conhecer quais são as barreiras percebidas pelos consumidores suecos para participarem no referido modelo de negócio, e quais os pontos de inflexão que existem para ultrapassarem as barreiras existentes. O artigo encontrou assuntos já existentes relativamente à posse de veículos eléctricos sendo os de maior importância os postos de carregamento e os preços elevados. Para além disso, o principal ponto de inflexão para ultrapassar as barreiras e participar na referida partilha, eléctrica e autónoma de veículos é económico.

**Palavras – Chave:** Veículos eléctricos, veículos autónomos, o futuro da mobilidade, propriedade compartilhada e inovação disruptiva

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# 1. Introduction

*Chapter 1 introduces the background and topic of the thesis. The chapter will showcase why the topic is relevant, the aim of the paper and the two research questions.*

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The internal combustion engine (ICE) has been the norm for power sources for light vehicles for the past century. However, automakers are now investing and making major commitments towards vehicle electrification (Reuters, 2017). For example, BMW is planning to offer 12 fully electric vehicles by 2025 (Preisinger & Taylor, 2017). Daimler is planning to sell 100.000 electric vehicles by 2020, and FCA are aiming to offer half of all Maserati's as electric vehicles by 2022 (Bailo et al. 2018).

Furthermore, recent transportation trends indicate that increasing electric vehicles sales have an important impact on gas emissions and overall energy use (Chen et al. 2016). At the same time, with rising carsharing, this option is said to be both more flexible and cheaper in the end, than the traditional private ownership of vehicles. However, there are a range of challenges for EV adoption. These include the problem of using EVs in a one-way carsharing model which creates profitability issues for car sharing operators (CSO) (Bailo et al. 2018). However, with the growing research and development of Autonomous vehicles (AV), implementing fully autonomous vehicles would solve many problems for CSOs, such as manual vehicle relocation. In a shared setting, shared electric autonomous vehicles (SEAV) would solve most problems that EVs and carsharing face presently. However, it is still unclear what impediments consumers themselves would have to overcome to adopt a shared ownership model of EAVs. The literature is quite clear on consumer impediments for EV, AV and car sharing as separate phenomena, but matters are not so apparent when these disruptive phenomena are a combined solution. Thus, this poses the questions; what are existing barriers and at what point would consumers be willing to substitute shared EAVs for traditional privately owned vehicles?

## **1.1 Problem statement & research questions**

This thesis seeks to investigate the introduction of electric, fully autonomous vehicles as a disruptor - its perceived barriers and value points for consumers. The scope of the project has also been narrowed to Sweden.

To address the problem statement, two research questions were formulated:

**RQ1:** What barriers exist as impediments for Swedish consumers to accept a shared ownership model of electric autonomous vehicles?

**RQ2:** At what inflection point would Swedish consumers be willing to accept SEAVs?

## **1.2 Scope**

This thesis will investigate Swedish consumers and their perceived barriers to accepting a shared ownership model of EAVs, assuming readily available fully electric and autonomous vehicles.

## **2. Literature review**

Chapter 2 reviews the relevant literature pertaining to the topic. The literature review discusses “next generation mobility”, electric and autonomous vehicles, its challenges and barriers. Further, the chapter will cover the integrated phenomena of electric autonomous vehicles and shared ownership.

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### **2.1 The next generation mobility**

#### **2.1.1 E-mobility**

It is clear that electric mobility is increasing in popularity. In Europe, 2012 electric vehicles made up 0.19% of all newly registered cars, compared to 3.46% in 2019. Battery electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs) made up about 3% of total new car registrations in the EU market in 2019, with BEVs making up about two thirds of the total new EV registrations during that year (European Environment Agency, 2020). With EVs (BEVs & PHEVs) increasing in all EU-countries, including Iceland, Norway and the United Kingdom, it is apparent that there is support for EVs in consumers as a key stakeholder group. This support of EVs seems highest in Nordic countries and the Netherlands where the highest shares of EV new car registrations were found; Norway (56%), Iceland (19%), The Netherlands (16%) and Sweden (12%) according to (The European Environment Agency, 2020).

Furthermore, the forecast of EV sales is predicted to increase. Goldman Sachs (2021) forecasts:

## Europe EV sales ratio

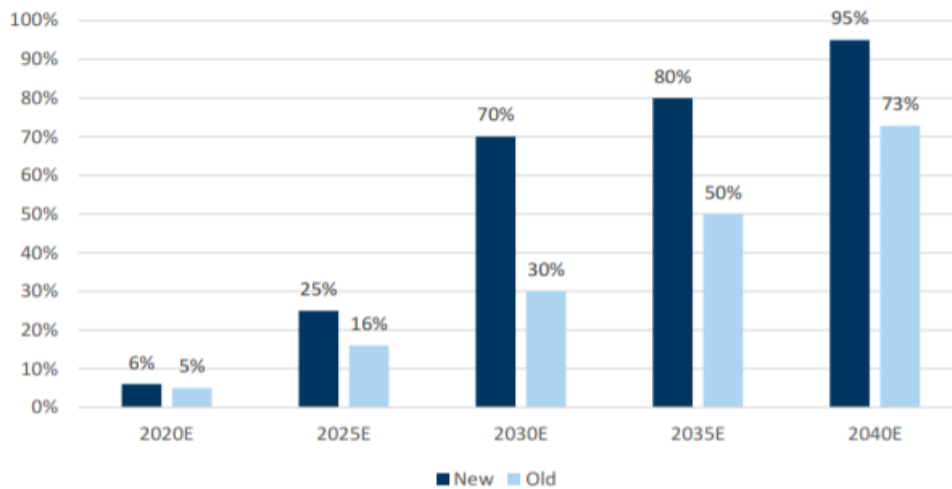


Figure 1 – Europe EV sales ratio

Goldman Sachs (2021) states that due to the CO2 regulations of The European Commission, automakers will substantially increase EV sales from 2025. Hence it is predicted that in 2025, 25% of all cars sold will be EVs, 70% in 2030, 80% in 2035 and 95% in 2040.

Electric vehicles are being introduced as a solution to limit the dependency on fossil fuels. The European Commission (2012), states that road traffic contributes to approximately one fifth of the EU's total CO2 emissions. In response, multiple nations across the globe have implemented different forms of financial incentives for EV's (Sierzchula, Bakker, Maat, & Van Wee, 2014).

Players in the EV business are currently facing profitability issues mainly due to battery costs, which make up 50% of EV input costs (Goldman Sachs, 2021). It is expected that EV battery costs will fall below the price of ICE engine cost in 2030. Goldman Sachs (2021) thus forecasts that excluding government subsidies, EVs will not be profitable before 2028.

To evaluate policies implemented by governments, various research themes help us understand consumer preferences. This is a key issue, since consumers, as the buy side for alternative fuel vehicles (AFV) such as EVs are the final decision-makers, and thus a key stakeholder group (Byrne & Polonsky, 2001). Existing research suggests that EV adoption will be predicated on understanding consumer preferences, since mass adoption depends on this (Schuitema et al.

2013).

Byrne & Polonsky (2001) outline key barriers for success as regulation, resources, infrastructure and vehicular characteristics. Byrne & Polonsky outlines these as the most pressing challenges for EV adoption, allowing electric vehicles to become mainstream.

### **2.1.2 EV Regulatory barriers**

Government incentives are key for driving consumer demand. Citi GPS: Global Perspective & Solutions (2018) describes the current demand for EVs as push demand rather than pull demand, meaning it is created from government incentives.

For both automobile players and consumers, government policy has potential positive effects (Byrne & Polonsky, 2001). Government incentives such as tax credits, vehicle subsidies and fuel subsidies could lower adoption costs and hence induce adoption. Currently, government incentives for EV adoption have had mixed results, suggesting that the effectiveness of current incentives could be improved (M, Coffman. P, Bernstein & S, Wee. 2017; O,Egbue & S,Long. 2012)

Furthermore, research suggests that policies themselves have the potential to be effective, but people's education and knowledge about EVs is the key issue. This suggests that policies are not showing the results they were intended to bring about (Egbue & Long, 2012), since there has not been significant change in consumer perceptions regarding EVs.

### **2.1.3 EV Resources**

An issue critical for the success of AFVs concerns whether stakeholders are inclined to commit needed resources. This entails, willingness of consumers, manufacturers and the entire exchange network to commit financially to the product? (Byrne & Polonsky, 2001).

Sustainable products are often priced higher than their counterparts (Olson et al. 2016). A slight price premium can translate into thousands of dollars, resulting in AFVs losing competitiveness compared to traditional vehicles (Byrne & Polonsky, 2001). Hence, price is a barrier since

ethical products are often relatively more expensive and perceived as such creating a hurdle that must be overcome (Hughner et al. 2007).

#### **2.1.4 EV Infrastructure**

Another critical issue for mass-adoption of AFVs, is that any alternative needs to be as available as gasoline (Byrne & Polonsky, 2001). According to market research conducted by EVBox, a key player in EV infrastructure, half of European citizens are worried about the availability of charging stations which is also a key barrier for the adoption of AFVs (EVBox, 2020).

#### **2.1.5 EV Vehicle characteristics**

AFVs have problems pertaining to consumer acceptance (Ewing and Sarigollu, 2000). Some key characteristics are cost/price of vehicle, safety, sociocultural considerations, refueling and emissions (Byrne & Polonsky, 2001). Thus, as noted before, the willingness to pay a premium for sustainable products can lead to less competitiveness. This indicates that pricing AFVs at competitive market prices may be the only way to solve the pricing issue (Byrne & Polonsky, 2001). Another challenge for mass scale adoption is the limited range of AFVs compared to regular vehicles (Mak et al. 2013). The battery range of EVs is one of the main problems and causes what is commonly referred to as “range anxiety”. This phenomenon describes consumer fear of being stranded with a discharged battery and limited options for recharging (Bartlett, 2012).

This further emphasizes the point about lack of charging infrastructure mentioned previously.

#### **2.1.6 Autonomous vehicles**

New technologies affect most aspects of society, and mobility and transportation are no exception. Like EVs, autonomous vehicles are being introduced to reduce energy consumption and pollution. Although the concept of driverless vehicles has been around for a while, there has been an acceleration in research and development in an effort to start commercializing the technology.

Many scholars agree that AVs will play a significant role in the next generation of mobility. Manyika et al. (2013) named vehicle automation on a list of the top ten most disruptive technologies of the future. One of the main reasons for this is because AVs are considered

connected vehicles. This refers to “the wireless connectivity-enabled vehicles that can communicate with their internal and external environments i.e., supporting the interactions of vehicle-to-sensor on-board (V2S), vehicle-to-vehicle (V2V), vehicle-to-road infrastructure (V2R), and vehicle-to-Internet (V2I)” (Lu et al. 2014). These functions, creating levels of data to in-vehicle systems, expand the awareness of vehicles and provide accurate real time information on the environment (Lu. et al. 2014). Today, V2I vehicles have already hit the road and although the Covid-19 pandemic has slowed down growth of the V2I market, Fortune Business Insights (2021) forecast a CAGR of 21.3% in the 2021-2028 period.

Further advantages of AVs apart from connected cars are safety and psychological benefits. For example, 90% of traffic crashes are due to human error (Maddox, 2012). Thus, AVs should be able to prevent a large portion of these crashes that would also in turn largely improve traffic delays (Anderson et al. 2014)

Another key psychological benefit of AVs is that they effectively lower the opportunity cost of travel because of time saved. A completely self-driving car would need no human interaction, and thus frees up time for other activities while travelling (Anderson et. al 2014).

The different dimensions of vehicle connectivity have their pros and cons, and technological feasibility. Due to this, there are still many uncertainties associated with AVs making it hard to predict when we will have fully connected and autonomous vehicles. Although it remains to be seen exactly how AVs will gain traction, experts regularly attempt to give estimates. According to experts from Institute of Electrical and Electronics Engineers (IEEE) 75% of all vehicles will be autonomous by 2040 (IEEE, 2012). Furthermore, Litman (2017) projects market penetration of AVs to be 80-100% by 2060.

It is important to note that levels of automation can vary from zero to complete autonomy. Fully commercialized AVs most likely need to be at least at level 3 automation. NHTSA (2013) released a policy classifying the different levels as follows:

No automation (Level 0)

*The driver is in complete and sole control of the primary vehicle controls – brake, steering, throttle, and motive power – at all times (US Department of Transportation, 2019).*

### Function-specific automation (Level 1)

*Automation at this level involves one or more specific control functions. Examples include electronic stability control or pre-charged brakes, where the vehicle automatically assists with braking to enable the driver to regain control of the vehicle or stop faster than possible by acting alone (US Department of Transportation, 2019).*

### Combined function automation (Level 2)

*This level involves automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering (US Department of Transportation, 2019).*

### Limited self-driving automation (Level 3)

*Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control. The driver is expected to be available for occasional control, but with sufficiently comfortable transition time. The Google car is an example of limited self-driving automation (US Department of Transportation, 2019).*

### Full self-driving automation (Level 4)

*The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles (US Department of Transportation, 2019).*

## **2.1.7 Future of mobility - Sweden**

In Sweden, roughly 30% of greenhouse gas emissions comes from the domestic road-based transport sector (The Swedish Transport Administration, n.d.). To combat this problem, Sweden has set a target of a complete fossil independent transport fleet by 2030 (SOU, 2013:84). This optimistic goal, bolstered by the many government grants given to households and companies using EVs, has led to a rapid increase of EV numbers in Sweden. The neighbor of Sweden, Norway, has achieved much more rapid adoption of EVs (Citi GPS, 2018). With very generous government incentives (Figure 2) including exemption from purchase tax, VAT, toll road fees, and free charging and parking in the capital of Oslo (Citi GPS, 2018) Norway is the clear leader of EVs in Europe (Figure 3)

The Norwegian government further provides “public funding in order to reach its target of having at least one fast charging station per 50 KM of main road”. This has led to Norway having the 2nd most publicly available charging points per million inhabitants (Citi GPS, 2018)

## **2.2 Electric autonomous vehicles**

Although EVs and AVs have different challenges and levels of technological advancements, they are not necessarily separate phenomena nor are they developing independently. Furthermore, for EAVs to be a next generation form of mobility and a disruption, these two technologies should be combined and developed together (Underwood et al. 2014). Integrating both separate technologies might even be crucial to attaining a sustainable system of mobility in the future, since electrification without automation and shared mobility may even negatively impact the environment (Mohammadzadeh, 2018).

## **2.3 EAVs and shared ownership**

Many players in the mobility space suggest that there are “three revolutions” - in electric, automation and shared mobility - that will be transformative (Sperling, 2018). Over the past decade shared mobility as a phenomenon has grown in both real-world relevance and in academic interest. Fundamentally, vehicle sharing is as much a data-driven digital technology service as it is a service dealing with the mobility of physical objects. Studies of household vehicle ownership show that there has been a trend towards declining vehicle purchases, especially for the younger generations (Kuhnimhof et al. 2013; Metz, 2013; Millard-Ball & Schipper, 2011). There is increasing evidence that even without AVs, ridesharing is leading to lower levels of household vehicle ownership (Martin et al. 2010; Elliott & Shaheen, 2011). Chen et. al (2016) states that SEAVs have the potential to replace 3.7-6.8 privately owned vehicles, and still cover the same demand for automobile mobility.

There are a few factors to explain this decline, namely increased transit use, the preference for urban habitation, increased environmental awareness and shifting economic circumstances (McDonald, 2015).

Regarding the need for synergy between AVs and EVs, shared fleets of AVs can solve many of the practical issues of EVs mentioned previously. This can resolve range anxiety and access to charge points (Melis, 2014).

Some research indicates that fleet-managed AVs relieve said concerns with real-time travel demand and established charging station locations (Chen TD, 2015). Chen (2015) provides a financial analysis suggesting that the costs of purchasing vehicles and maintenance, charging infrastructure, electricity, registration and insurance for shared EAVs is at the equivalent per-mile traveled cost of private vehicle ownership for low-mileage households. They further state that SEAVs are significantly cheaper than on-demand human-driven services. Hence, there is support for the idea of shared EAVs being competitive with existing manually driven ridesharing services and significantly cheaper than on-demand driver-operated services. Additionally, by adding the autonomy dimension to ridesharing, the dispatching issue for one-way carsharing systems gets completely resolved (Masoud & Jayakrishnan 2016).

Furthermore, there is very limited research outlining potential business models for SEAVs. Jaynes (2016) presents a scenario where you combine owning and sharing a vehicle. This model is referred to as “own - share” and entails that you own an EAV and get the option to opt into a car sharing program. This might be manufacturer-affiliated, state-sponsored, or business-based, such as a ride-sharing organizations.

This subject is also discussed by experts in Sweden. Anna Pernestål, manager of Integrated Transport Research Lab at KTH Stockholm, states;

*“If we are to have a sustainable transport system, we must share. And we must have a sustainable transport system if we want the earth to survive”* (Lindström, 2018).

Additionally, in Kalmar, Sweden, an initiative called dELbil was launched in 2013 where a handful of companies and the municipality created a carpool with shared ownership. The initiative opened the possibility for local businesses to include their own EVs in the pool, to be used by all parties in the pool. Additionally, during non-business hours, they added the possibility for households to use the pool, in exchange for a subscription of 124 SEK/month. Today they have 8 local businesses participating in the carpool and have found that each car

replaces 6 privately owned cars. Moreover, the initiative also concludes that in 2016 alone, the total range for the cars was 3 laps around the globe, saving 12.5 tons of greenhouse emissions yearly (Sveriges Miljömål, n.d., Kalmar Energi, n.d.). Therefore, small scale experimentation of these types of business models has occurred, however, the technology of autonomy has not yet been implemented in these own-share models.

Ridesharing systems are quite well covered in academia (Masoud & Jayakrishnan 2016) and are in use by multiple companies today. However, there is a paucity of material on this type of own-share mobility. Masoud & Jayakrishnan (2016) also support the concept of own-shared mobility, defining it as a cluster of households that jointly own a set of vehicles. In their study, they found that if a cluster of about 1200 households in San Diego were to implement this type of model, the number of vehicles needed to cover transportation needs would see a 4-fold decrease. This indicates the degree of electric autonomous vehicles in a shared ownership model, as a future disruptor. Conclusively, insights and datapoints into these phenomena from the supply side are accessible and recent. However, datapoints from the demand side, the consumer view, is less so.

## 2.4 Technology S-Curve

The technology S-curve is a modern centerpiece in conceptualizing technology development and strategy. It captures a derivation of the potential for a specific technological improvement. It describes improvement of a technology's performance in a given time spectrum, where the rate of improvement differs along the timeline.

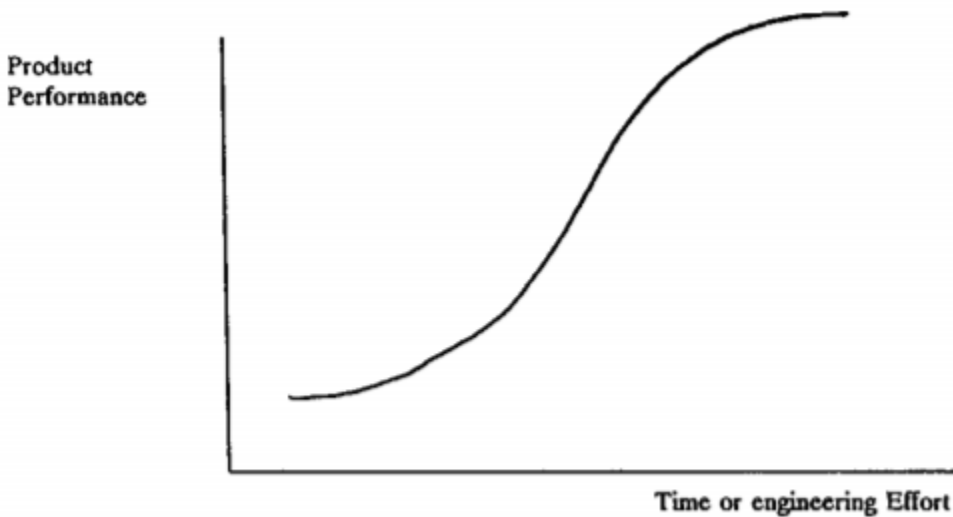


Figure 4 – Technology S-Curve

Figure 4 shows the illustrated S-curve. As described by Sahal (1981), as the technology becomes more understood the rate of improvement to the technology increases. Further, Adner & Kapoor (2016) argues that traditional literature of innovation “*has tended to take a static view of the technology itself*”. Meaning, researchers does not take into account that when an innovative new technology are competing with an old one, both technologies keep changing – they are not static. They add:

*“Thus, while the diffusion literature focuses on the question of how fast the new technology gains market share, it does so without consideration of the evolution of the new and the old technologies”*

Adner & Kapoor (2016) argues that new innovative technologies are a reaction to challenges in the old technology. Thus, to understand progress in a specific technology one needs to acknowledge progress in the entire ecosystem of that technology. An appropriate way to approach the s-curve is that new and old technologies are not static, they are constantly evolving

(Adner & Kapoor, 2016). This is the reason why, as mentioned previously, future substitution and adoption of autonomous vehicles is difficult to predict - the performance progress of both autonomous and traditional vehicles are not static.

## **2.5 Disruptive innovation – Technology Acceptance Model**

The technology acceptance model (TAM) is a framework for investigating user acceptance of new technology. The model focuses on two objectives:

1. Improving understanding of user acceptance processes
2. Providing a basis for a practical way of “user acceptance testing” to allow an evaluation of proposed new systems (Davis, 1985)

According to the TAM, a potential user’s general attitude and perceptions of a specific system or technology, are the major determinants for acceptance. The model states that the attitude towards accepting a technology, is a function of two key beliefs: perceived usefulness and perceived ease of use (Davis, 1985).

Although the original TAM has been cited more than 7000 times, there have been multiple adaptations and extensions to date. The various extensions and adaptations of TAM have been subject to criticism in academia. Most commonly, criticism falls into 3 categories: “1) The methodology used for testing the TAM model, 2) the variables and relationships that exist within the TAM model, 3) the core theoretical foundation underlying the TAM model” (Chuttur, 2009).

## 3. Methodology

Chapter 3 reviews the chosen methodology for the thesis, the outline of the research was conducted, conducted pre-studies and main studies.

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### 3.1 Research design

Autonomous vehicles and shared ownership of vehicles are two relatively new phenomena. The areas are not very well covered in academic research, even though their potential is considerable. This thesis seeks to understand Swedish barriers to accepting SEAVs and at what point the scale tips in favor of acceptance. This thesis will base its primary data gathering in qualitative methods in forms of interviews and surveys. To answer the first research question “*What are the barriers for Swedish consumers to accept a shared ownership of electric autonomous vehicles?*” Information from the literature review, survey results and conducted interviews will be used.

For the second research question “*At what point would Swedish consumers be willing to accept SEAVs?*” consumer surveys will primarily be used, with findings in the literature reviews and insights from expert interviews to validate the conclusion.

### 3.2 Data collection

The discussion section of this thesis will be based on findings from the various types of data collection used in this thesis: the literature review, the consumer-survey and expert interviews. The data collection methods will have some reliance on TAM; however, the methods will go beyond the original TAM to more accurately answer the research questions posed. Primary data collection will be from the survey interviews, and the secondary data collection will be obtained from the literature review.

Since this thesis is about the perceptions of SEAVs by Swedish consumers, inputs from consumers themselves in the survey will be the most substantive aspect. These consumers will be randomly selected, considering people over 18, the legal driving age in Sweden. The interviews

are with experts in the field of electric, autonomous and shared-owned vehicles, to attain insights to validate the results of the dissertation.

The expert interviews will be semi-structured. In semi-structured interviews, questions are standardized with smaller adaptations to be provided to guide the conversation to appropriate topics of interest. This style of interviewing is conversational and usually “*delve deeply into a topic and to understand thoroughly the answers provided*” (Harrell & Bradley 2009). This format allows for free and open discussions where the experts can explore scenarios or plausible options not covered by the other data-collection methods

### **3.3 Pre-studies**

To test the two different data collection methods and the format of those, two pre-studies were conducted. The first one with a sample size of one, had a wider range of questions. The purpose was to validate different formulations and options of the questions, and to better understand how the future experts would act and answer during the interviews. The findings of this pre-study helped in structuring the base scenario used in the main study as well as formulating questions for the interviews and finally finding the most appropriate perceived barriers used in the main survey.

The second pre-study was a smaller survey, conducted with a sample size of 15. This pre-study follows a 5-point Likert scale, with the primary purpose to check understandability of the formulated questions. Since this topic can involve new and complex terms and some participants might not be familiar with the topic, this pre-study enabled the final survey to become more intuitive for the survey participants. This pre-study was conducted in Qualtrics, which was decided to be the most appropriate tool to use for this purpose.

### **3.4 Main study**

For the expert interviews, a total of 5 in-depth interviews were conducted. All interviews were formulated in an open-ended manner to allow interviewees to freely explore the respective topics. The participants could comment, answer, question or explain their responses and therefore lead the conversation to what they perceived to be the most important areas to discuss.

All 5 interviews were conducted over the software Zoom and Google Hangouts. The experts worked for various companies related to electric or autonomous vehicles, or EV infrastructure. The positions of the experts varied greatly - they work in consulting, development, marketing and sales, some being more senior managers than others.

The data gathered from the interviews was analyzed using thematic analysis as suggested by Braun & Clarke (2006). Thematic analysis is “a method for identifying, analyzing, and reporting patterns (themes) within data”. Additionally, “one of the benefits of thematic analysis is its flexibility”, thus the process of analyzing the data followed steps suggested by Braun & Clarke (2006), but the main difference was approaching themes as keywords instead of set codes.

Further, since the target of this study is primarily Swedish consumers, to gather consumer-side insights an online survey was conducted. Due to the nature of the topic, some terms were potentially new and complex to understand, therefore the survey was carried out in Swedish. The survey followed a 5-point Likert scale. The mode of analyzing data gathered focused on analysis of means. By analyzing means in answers for different consumer groups, insights could be gained on pain points, perceived barriers etc.

## 4. Result analysis

Chapter 4 presents the results of data from the survey and interviews. It states sample size and demographics, the mean analysis of the survey, keyword analysis and key quotes from interviews and finally the main step of thematic analysis which is deriving themes from transcripts of interviews.

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### 4.1 Survey - Sample demographics

For the survey, a total number of 128 individuals participated. Out of those participants, 101 were considered. 36.6 % of those are men and 63.3% are women. All participants were Swedish nationals. Further, the distribution of other demographics and descriptors can be shown in the figures below:

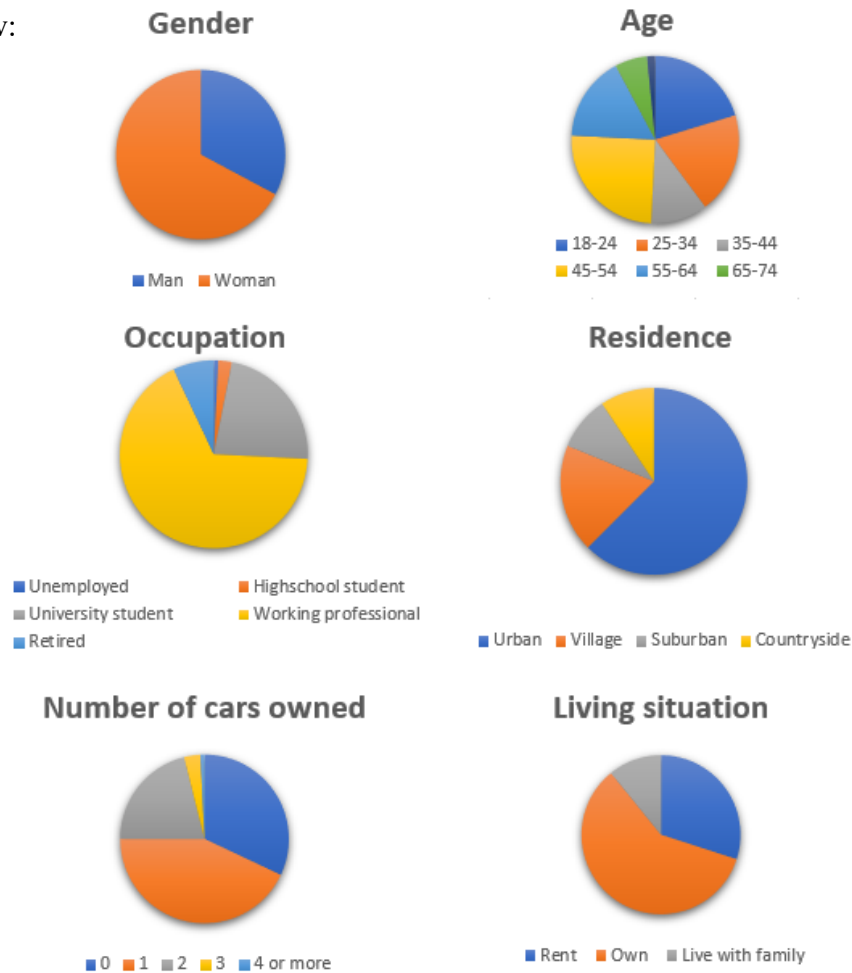


Figure 5 – Survey demographics

## 4.2 Mean analysis - Perceived barriers

Further, aligned with the barriers identified from literature and interviews, participants were asked which barriers they perceived as most impactful:

1. I am concerned with the range of EVs
2. EVs are too expensive
3. I am concerned about limited charge points
4. I would be comfortable using other people's cars
5. I would be comfortable with others using my car

The 5-point Likert scale followed the following rankings: 1. (Strongly agree), 2. (Agree), 3. (Neither agree nor disagree), 4. (Disagree), 5. (Strongly disagree)

Observing figure 6, that total mean for:

Barrier 1 (I am concerned with the range of EVs) is 2.44

Barrier 2 (I think EVs are too expensive) is 2.24

Barrier 3 (I am concerned about limited charge points) is 2.2

Barrier 4 (I would not be comfortable using other people's cars) is 2.98

Barrier 5 (I would not be comfortable about others using my car) 2.44

		<b>Barriers - Gender</b>					
<b>Gender</b>		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my</b>	<b>Aggregate mean</b>
Man	Mean	2.58	2.19	2.37	3.20	2.53	<b>12.86</b>
	Std. Deviation	1.107	0.995	1.090	1.067	1.198	
	Mean	2.36	2.27	2.11	2.87	2.40	
Std. Deviation	0.945	0.859	0.810	1.109	1.061		
Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>	
Std. Deviation	1.005	0.907	0.921	1.102	1.106		

Figure 6- Barriers / Gender

By observing this table and the total mean, the barriers can be ranked following in regard to importance to consumer perceptions:

1. Barrier 3 (I am concerned about limited charge points)
2. Barrier 2 (I think EVs are too expensive)
3. Barrier 1 (I am concerned with the range of Evs)
4. Barrier 5 (I would not be comfortable about others using my car)
5. Barrier 4 (I would not be comfortable using other people's cars)

Further, looking at the gender of the participants, the mean for the different genders does not vary drastically. However, slight differences indicate that men are more concerned with current EV prices (Barrier 2). On the other hand, women are more concerned with barriers 1, 3, 4 and 5. The aggregate mean for all 5 barriers for the different genders are men (12.86) and women (12.00), indicating that women could be slightly less optimistic about participating in the suggested shared mobility model.

Furthermore, by looking at figure 7, the various ages for the participants, there were clear differences. For the 2 youngest age groups (18-24 & 25-34) the biggest barriers were barrier 2, 3 and 5. For group 35-44 barrier 1 & 5. For groups (45-54, 55-64 & 65-74) barriers 2 and 3 were the largest.

		<b>Barriers - Age</b>					
<b>Age</b>		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	<b>Aggregate mean</b>
18-24	Mean	2.48	2.62	2.29	3.13	2.29	<b>12.81</b>
	Std. Deviation	1.163	0.921	1.042	1.191	1.160	
25-34	Mean	2.57	2.33	2.21	3.25	2.42	<b>12.77</b>
	Std. Deviation	1.080	0.856	1.062	1.152	1.018	
35-44	Mean	1.92	2.00	2.00	2.62	1.85	<b>10.38</b>
	Std. Deviation	0.669	0.632	0.853	0.768	0.689	
45-54	Mean	2.32	2.07	2.19	3.00	2.70	<b>12.29</b>
	Std. Deviation	0.909	0.997	0.910	1.174	1.236	
55-64	Mean	2.38	2.13	2.19	3.00	2.61	<b>12.30</b>
	Std. Deviation	0.957	0.885	0.750	0.907	1.037	
65-74	Mean	3.13	2.00	2.25	2.57	2.71	<b>12.66</b>
	Std. Deviation	0.835	1.000	0.886	1.134	1.254	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

Figure 7 – Barriers / Age

Overall, the aggregate means indicates that the most skeptical age group might be 35-44 and the most positive groups were 18-24 and 25-34.

Looking at differences between different occupations figure 8, the data indicated that the most skeptical group was working professionals and the most positive ones were younger generations of students, high school and university students. Curiously, the most positive one however was unemployed, but this is not statistically relevant since for the unemployed N=1. Overall, between the different barriers, the survey indicates that students are less concerned with all 5 barriers compared to working professionals and almost all 5 compared to pensioners.

		<b>Barriers - occupation</b>					
Occupation		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	Aggregate mean
Unemployed	Mean	3.00	3.00	3.00	4.00	4.00	<b>17.00</b>
	Std. Deviation	-	-	-	-	-	
Highschool student	Mean	3.33	2.33	2.00	3.33	3.00	<b>14.00</b>
	Std. Deviation	2.082	1.528	1.732	0.577	1.000	
University student	Mean	2.44	2.54	2.14	3.39	2.39	<b>12.91</b>
	Std. Deviation	1.013	0.884	1.008	1.066	1.066	
Working professional	Mean	2.35	2.13	2.24	2.83	2.36	<b>11.91</b>
	Std. Deviation	0.966	0.873	0.907	1.098	1.105	
Retired	Mean	2.88	2.00	2.00	2.75	3.00	<b>12.63</b>
	Std. Deviation	0.835	1.155	0.500	1.165	1.195	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

Figure 8 – Barriers / Occupation

Looking at figure 9, the consumer's location of residence was found to be important. Overall, all 4 segments indicated concern with charging points, although the lowest mean was for countryside residents. Regarding aggregate mean, the most skeptical groups in order were people living in villages, urban, countryside & suburban.

		<b>Barriers - Residence</b>					
Residence		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	Aggregate mean
Urban	Mean	2.37	2.27	2.19	3.03	2.38	<b>12.23</b>
	Std. Deviation	0.975	0.872	0.923	1.113	1.080	
Village	Mean	2.38	2.11	2.14	2.87	2.39	<b>11.89</b>
	Std. Deviation	0.973	1.197	0.964	1.100	1.033	
Suburban	Mean	3.09	2.56	2.42	2.83	2.67	<b>13.56</b>
	Std. Deviation	1.300	0.726	0.900	1.115	1.155	
Countryside	Mean	2.36	2.00	2.09	3.09	2.73	<b>12.27</b>
	Std. Deviation	0.809	0.632	0.944	1.136	1.421	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

Figure 9 – Barriers / Residence

Finally, in table 10 we have the last consumer segment, number of cars owned.

The people that owned 0 cars indicated that the biggest barrier was barrier 3, whilst the people that own 1, 2 or 3 cars indicate that EV prices are the biggest barrier. Furthermore, the aggregate mean could indicate that the more cars you own, the more skeptical you are to accepting a model suggested in the research. The most skeptical group is 3 cars owned, and the most accepting group is 0 cars owned. Since the group that owns 4 or more cars, N=1, this group is disregarded.

		<b>Barriers - Number of cars</b>					
		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	
Ncars							Aggregate mean
0	Mean	2.47	2.74	2.28	3.38	2.69	<b>13.57</b>
	Std. Deviation	1.033	0.815	0.905	1.206	1.104	
1	Mean	2.57	2.09	2.13	2.64	2.17	<b>11.59</b>
	Std. Deviation	1.068	0.921	0.924	1.092	1.167	
2	Mean	2.16	1.87	2.20	3.07	2.56	<b>11.86</b>
	Std. Deviation	0.850	0.694	0.957	0.829	1.013	
3	Mean	2.00	1.67	1.75	2.50	2.50	<b>10.42</b>
	Std. Deviation	0.000	1.155	0.500	0.577	0.577	
4 or more	Mean	4.00	3.00	4.00	3.00	2.00	<b>16.00</b>
	Std. Deviation	-	-	-	-	-	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

Figure 10 – Barriers / Number of cars

### 4.3 Inflection points

According to Byrne & Polonsky (2001), some key barriers of success for AFVs are regulation, resources, infrastructure and vehicular characteristics. Thus, with insights gathered from the completed pre-studies and the literature review, scenarios where consumers would be willing to oversee their perceived barriers with participating in a SEAV model were formulated:

1. If ChargePoint's were as frequent as gas stations
2. If the revenue from participating in this carpool covers my average monthly cost for the vehicle
3. If the range of EVs were as long as regular cars
4. If in Sweden the following benefits existed:

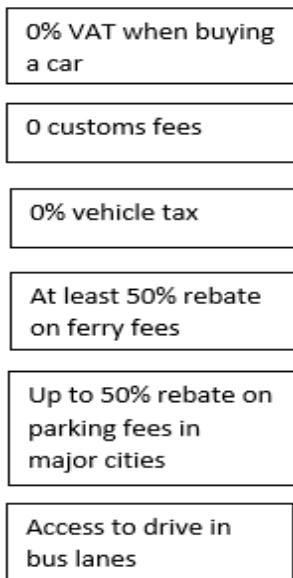


Figure 11 – Government incentives

The 4th scenario is based on benefits currently in place in Norway (Citi GPS, 2018). Participants were asked to rank these 1 to 4, indicating which scenario would be more impactful for them to be willing to participate. The findings show the scenarios ranked as shown by figure 12:

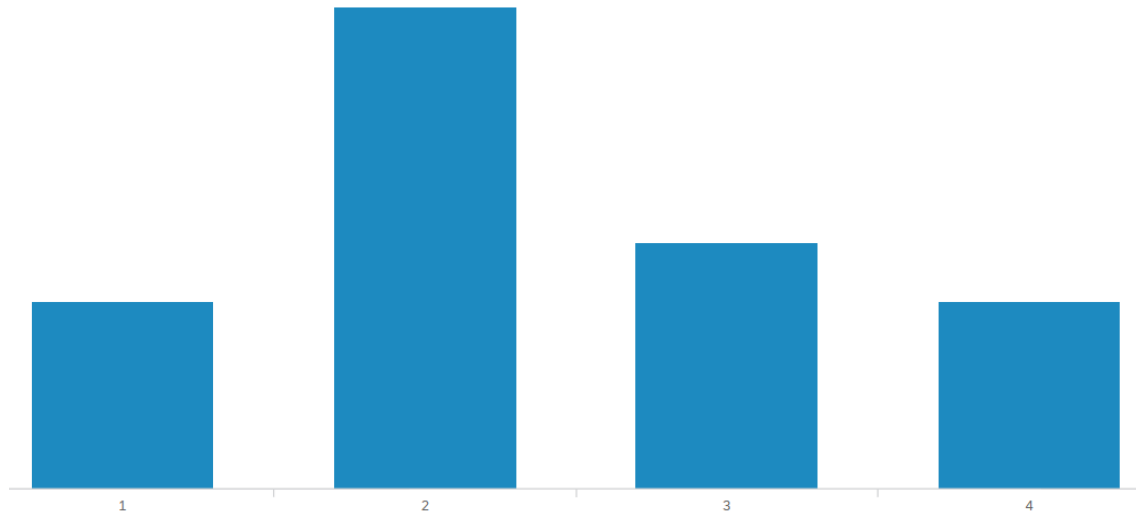


Figure 12 – Scenario ranking results

As shown above, revenue for participating in the carpool was the strongest motivator followed by improved range on EVs. Lastly, least motivating was implementing Norway's incentives and having higher frequency of charge points.

#### 4.4 Expert interviews

For expert insights, 5 individuals were interviewed. All individuals had varying positions, and the individuals represented 3 different global companies. The interview length varied slightly however the average interview was 31 minutes. In figure 13, additional information can be found regarding the experts but also their assigned “Expert ID”.

Expert ID	Name	Title	Company market cap	Industry / Sector
1	Anonymous	Marketing & Growth manager	\$4.54 B	Charging infrastructure
2	Anonymous	Experience Business manager	\$4.47 B	Consulting

3	Anonymous	Technical lead	\$4.47 B	Consulting
4	Anonymous	Machine learning specialist	\$80 B	Manufacturing
5	Anonymous	Chief growth officer	\$4.54 billion	Charging infrastructure

Figure 13 – Expert IDs

#### 4.5 Keyword analysis and key quotes

Through the keyword analysis of transcripts for the 5 interviews, the most frequent perceived barriers, inflection points and suggested model feedback were found:

Barriers	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Expensive	2		1	1	1
Chargepoints				1	
Range				1	
Sharing	2	1			2
<b>Point to accept</b>					
Profit	1		5	2	2
Flexibility			1		1
More incentives					
Social pressure					1
More chargepoints					
Car range					
<b>Run my whom</b>					
Business	1	1		1	2
State				1	1
Households					1
<b>Other forms of SEAVs?</b>					
Yes					
No	1	1	1		1

Figure 14 – Key word frequency table

According to the keyword analysis for the experts, the most suggested barrier for consumers was mainly the price of EVs followed by the inconvenience of sharing personal vehicles.

Expert 1 explained the problem of prices for EVs:

*“The main barrier is an economic one. The long-term value of participating in this model must be greater or similar to the down payment of the car”.*

With regards to the issue of sharing vehicles, the expert stated:

*“Another barrier is that they need to almost “give up” their own personal vehicle. This is something they need to give up in this scenario, for example their own personal items cannot be stored in the cars etc. They have to give up personal attachment to the vehicle to some degree”.*

Expert 2 adds to this:

*“People see this (vehicles) as a part of their “household” so to speak”.*

Furthermore, regarding the most frequently mentioned inflection points for consumers to be willing to accept this model, making individual profits was by far the most suggested point.

Expert 5 conceptualized this and suggested pitching the model itself:

*“I would pitch it: it is great, I pay my monthly electricity bill and my car gets used more, it is paying me for my investment even when I’m not using the car and I will get my total investment back in let’s say 5 years”.*

Expert 4 expanded on this:

*“If people notice that they will generate an extra income through participating, so that it covers costs and, in this example, depreciation of the vehicle. I think this is key for the operators of the carpools to showcase.”*

Expert 1 mentioned the role of the financial inflection point to overcome a perceived barrier:

*“It is like when you rent out a room. You give up some privacy in your own home, but there is a financial incentive for you to still do it. “*

Additionally, through the keyword analysis, the experts were asked if the suggested form of SEAV is a likely scenario. When asked, not one expert mentioned other scenarios, but added different optional details to the scenario. Conclusively, it was found that businesses are the most likely capitalizers on these models, followed by states. Expert 4 hypothesized regarding the suggested scenario:

*“On this point of view, the enabling one by the companies – OEMs, automakers, they are definitely looking at this subscription model as a path of future revenue. The scenario you base this on is not an exception, it is most definitely an expectation and will be coming out sooner than we think”.*

## **4.6 Theme analysis**

As suggested by Braun & Clarke (2006), thematic analysis derives themes from transcripts. When analyzing the transcripts of interviews, two main themes could be found. Theme 1 captured the issue of EV prices, the opportunity for solving, benefits and incentives derived from solving the perceived barrier. Theme 2 captured the suggested model itself, format and likeliness, a social incentive to participate and why the model is multi-beneficial for all.

### **4.6.1 Theme 1**

The roots of theme 1 were from the experts, the most mentioned perceived barrier for consumers. However, a common identified theme was that most of the experts felt that this would indeed be why this shared ownership model would be successful. Expert 2 stated:

*“I think that there is a huge demand for this. This initiative would simplify a lot of issues connected to car ownership and costs. I think in the big picture, owning a car is a big threshold for many people and primarily younger people will see this as a potential solution to that threshold. In my experience, the business case for this is very strong”*

Expert 4 took a similar position:

*“Using EVs as a service, and that would include not only providing the actual vehicle but also giving the “beginning to the destination” kind of delivery. There is definitely a lot of push for that, because it is a very lucrative business”.*

Since the main barrier seemed to be price according to experts, the incentives for players to solve is great. Thus, a good way of doing that is a model as suggested in this paper.

Additionally, solving the issue of price with a SEAVs makes sense since participants will have a further source of revenue:

*“The average cost for an EV is very high, and if I’m an EAV owner, I would want to make a little bit of that back. And this is not in the form of services like Uber or Lyft, I’m talking about that when I’m not using my own vehicle, I can lend it out and make some of the initial investment back” - Expert 4.*

The experts agreed this would be key since it would be needed to oversee the barrier of having to share vehicles:

*“Thus, broadly, the incentives need to be greater than the inconvenience of sharing the vehicle. It is like when you rent out a room. You give up some privacy in your own home, but there is a financial incentive for you to still do it. This is how you could think about it.” - Expert 1.*

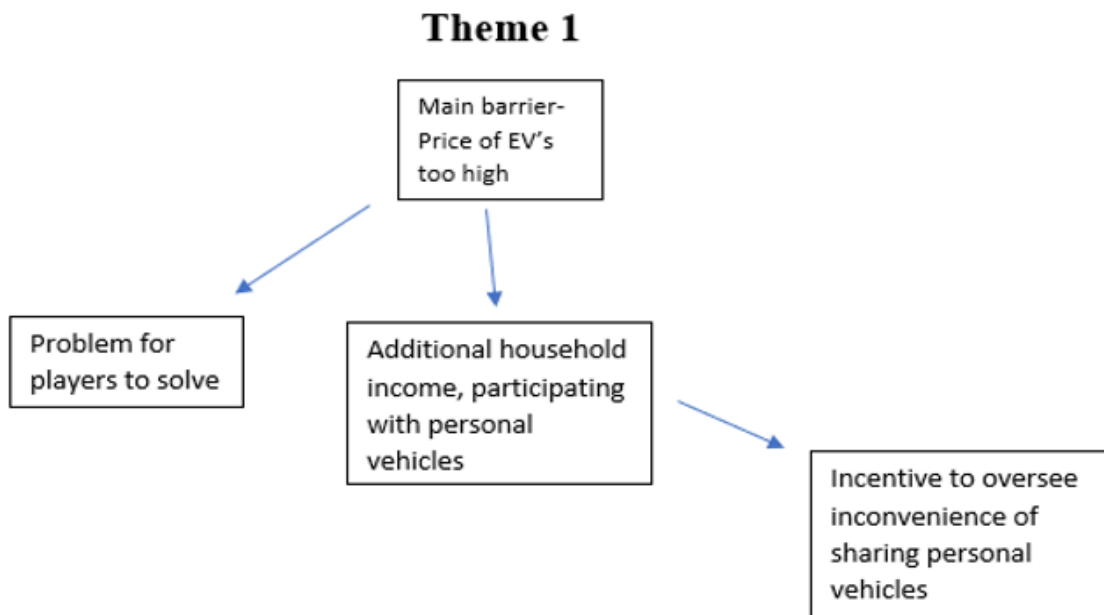


Figure 15 – Theme 1

## 4.6.2 Theme 2

Theme Two is derived from the format and probability of a SEAV model like this to take place. According to expert insights, the format suggested as base scenario is quite probable. When asked about other options for SEAV models, Expert 5 stated:

*“There will indeed be the model of, you own the car and you want to capitalize on it by lending it out in the format you stated”.*

Expert 4 went even further by adding:

*“This is not an exception, the scenario that you are basing this on, it is definitely an expectation and will be coming out sooner than we think”.*

Although the exact format of a model like this e.g, revenue structure, platforms and the ecosystem itself is up for debate. Expert 4 explained:

*“There are enormous expectations on this industry as a whole and I think the entire vehicle industry will be involved in developing these mobility models. There are obviously a lot of combinations that could result from this”*

However, experts mostly agreed that a subscription-based model is quite probable. A subscription method where individuals, households or businesses subscribe to the carpool to get access to EAVs: *“I think having a subscription fee for this carpool seems like a probable scenario”* - Expert 1.

Expert 4 explained the reason why this would be the case:

*“The companies – OEMs, automakers, they are definitely looking at this subscription model as a path of future revenue”.*

Once found that the scenario is a valid one and according to the experts even quite a probable one, yet another reason why people would participate in this shared EAV carpool arose. Expert 5 called this a social reason:

*“I think this (participating) will be when consumers see the social pressure to participate”.*

Expert 4 explained this further in depth:

*“They (people) would be inclined to participate. Let us say for example an EV owner, when they buy a vehicle especially today, the cost of ownership of an EV is quite a bit more than a conventional vehicle. Although over the age of the vehicle it is less, initially it is higher because of the average prices usually being higher. So, when they buy these vehicles, it is an acknowledgement, from a customer point of view, that they are doing that for a greater purpose. And that is not to be an EV enthusiast or to impress their neighbor, but I think of it as underlying reasons we have to acknowledge: they are saving the environment or because of sustainability preferences. When a customer tends to be more inclusive of the broader environment and the globe, the assumption we can have is that they would be interested in loaning it (their vehicle) to other people to use, so that the carbon footprint of the manufacturing of all other vehicles actually goes down”.*

Hence, experts indicated that due to today’s EV owners already accepting a higher initial investment of EVs compared to traditional vehicles, they are already indicating that they are willing to oversee other barriers due to the greater good of society.

To conclude this theme, the above reasons show why the SEAV carpool model would be multi-beneficial for society. For households or individuals, it is a financial incentive to get an additional revenue source. For companies, it is a “lucrative business” to invest in. For society in large, it reduces the overall carbon footprint, which is in line with what Chen et. al (2016) and Masoud & Jayakrishnan (2016) suggest.

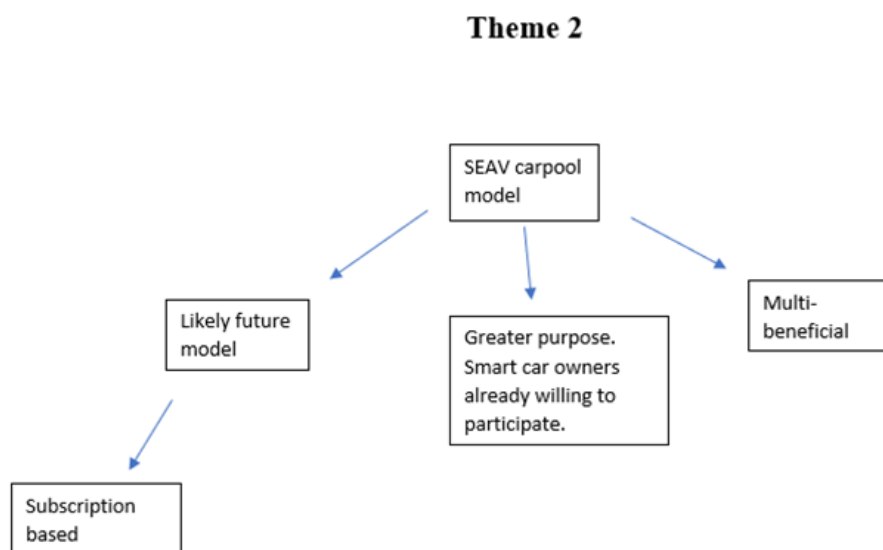


Figure 16 – Theme 2

## 5. Discussion

Chapter 5 presents the discussion of the results, limitations, implications, suggested future research and finally a conclusion.

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### 5.1 Discussion of results

Electric and autonomous vehicle technology is undoubtedly increasing rapidly, making it hard to predict precisely when it will be adopted on a large scale. Electric vehicles have been present in the market for some time, and the technology itself could arguably be placed in the increasing trajectory of the technology S curve as described by Sahal (1981). On the other hand, the technology of autonomy in vehicles is in a much earlier stage of development, and thus it is even harder to predict the point of commercial adaptation. A relevant description as to why is captured by Adner & Kapoor (2016), describing that the development of new technology (AVs) and old technology (traditional vehicles) are not static, and thus constantly changing. This is also something mentioned in the gathered interviews, experts agree that when AVs will be commercially adopted is especially hard to predict as well as the way the technology will be used. However, experts agree that the base scenario of SEAV presented in this paper is a likely scenario in the future.

This paper extends insights into the phenomena of using EAV's in a shared ownership context in the future. The findings indicate what the consumers are primarily concerned about, in order, limited charge points, the price of current EVs and the range of EVs. The results indicate that consumers are more concerned with existing issues of owning EVs and less so sharing vehicles in a shared ownership context. At the same time, experts hypothesize regarding this issue as presented in Theme 1, namely that these current perceived barriers create an opportunity for players to solve. As found, the incentives for players are great since there could be significant ROI to be reaped, while at the same time it would be in consumers interest to participate with their EAVs since it would generate an extra income, when others in the carpool are using their vehicles. According to findings in the survey, the key inflection points for consumers to overcome their perceived barriers is that this model would be able to generate money for them.

Thus, this is why SEAV carpooling could be successful, indicating that consumers are willing to participate in initiatives like this when they get money back in return.

According to the expert insights, the base scenario of the model for SEAV used in this paper, is quite a likely one. One expert even went as far as saying “*The scenario you base this on is not an exception, it is most definitely an expectation and will be coming out sooner than we think*”.

Furthermore, it seems likely OEMs and other players could operate these carpooling and households provide the vehicles for it, in exchange for money. This finding extends insights of Melis (2014) and Jaynes (2016) providing a possible scenario to solve range anxiety and access to charge points. If this model becomes the next standard of mobility, it has the potential to solve dispatching issues for one-way carsharing systems (Masoud & Jayakrishnan 2016), lower the levels of household vehicle ownership (Martin et al. 2010; Elliott & Shaheen, 2011) and drastically lower carbon emissions (Sveriges Miljömål (n.d); Kalmar Energi (n.d.); Chen et. al (2016) while at the same time being a good business opportunity for big industry players.

The findings also indicate concerns and possibilities for different types of consumers. The key one which to some degree supports findings of Kuhnimhof et al. (2013); Metz (2013); Millard-Ball & Schipper (2011), is that younger generations would be more willing to participate in this model. This idea is something the experts support as well:

*“It is important to note that younger people would probably have an easier time to accept”*-Expert 5

*“Especially younger generations, they are often more likely to participate in shared mobility programmes. Younger people are more willing to do sustainable things”* -Expert 1

*“Owning a car is a big threshold for many people and primarily younger people will see this as a potential solution to that threshold.”* -Expert 2

## **5.2 Limitations**

The main limitation of this paper is the method of analyzing data from the survey. Mean analysis was an appropriate tool for this thesis, since some of the independent variables were categorical data, e.g., occupation and residence location. This brings a clear limitation to the method of

choice, since a regression model would have been much more substantial, allowing stronger claims to be made. Furthermore, a larger sample size would also improve the representativeness of the data set. For the conducted survey  $N=128$  and for the interviews  $N=5$ . Having a larger sample size for the survey, and more interviewed experts would greatly improve the accuracy of the findings. Additionally, data from the survey tended to be slightly skewed, for example only including 1 person currently unemployed, 8 people being in the age group 65-74 and only 2 people 75+.

### **5.3 Implications & future research**

The implications of the findings are twofold. The first is that these findings provide a guideline of how to base SEAV models in the future. Namely, creating a platform to operate and allow households to participate with their EAVs in exchange for money. A good option would be to have a revenue structure in the form of a subscription, where people can subscribe to get access to the carpool. With these insights, managers can understand the dynamics of said model, developing it in their own manner by adapting technicalities and details of the model appropriately. Secondly, it gives decision makers and players insights into consumer barriers and inflection points but also how these differ between consumer groups.

To further extend the degree to which players and decision makers can reap these benefits, it would be appropriate to perform a more robust regression analysis instead of a mean analysis. The elements needed to do this are present in the thesis in that appropriate consumer segmentations and perceived barriers are already presented. The only thing to change would be to only use nominal data and exclude categorical data. Furthermore, a natural improvement would be to increase sample size for both survey and expert interviews. A relevant improvement to make would be to include a broader range of experts, including various new positions and experts from different companies. A major part of this paper bases conclusions on expert insights, to explain and connect results from the survey. Thus, by extending the number of experts, more key takeaways could possibly be drawn.

## 5.4 Conclusion

This paper sought to extend current knowledge of the phenomenon of electric autonomous vehicles in a shared context, specifically for the Swedish market. It sought to understand how willing Swedish consumers would be to accept this initiative, and what would be needed for them to overcome their perceived barriers. The base for the data gathering methods was a scenario derived from literature and pre-studies. The scenario was formulated as a shared ownership model of EAVs where EAV owners could participate with their own vehicles in a carpool in exchange for a financial return. A key validation this paper found, was that experts agree that this is a likely if not the expected scenario in the future. Regarding RQ1:

*What barriers exist as impediments for Swedish consumers to accept a shared ownership model of electric autonomous vehicles?*

Through the survey pre- and main study, it was found that consumers perceive the existing problems of owning EVs as the most important ones, mainly, limited charge points and the price itself. This is in accordance with what the experts anticipated, but they also emphasized the perceived inconvenience for consumers to share their EAVs. This is something consumers themselves indicated to be less impactful, possibly suggesting that experts who are more knowledgeable on the topic are better at foreseeing issues when these models are launched or it might be that experts are not fully in touch with consumer sentiment. To conclude, through surveys and interviews it was found that the main barriers for consumers are:  
Limited charge points, price, range and sharing vehicles.

Furthermore, regarding RQ2:

*At what inflection point would Swedish consumers be willing to accept SEAVs?*

This paper found that appropriate inflection points were:

If charge points were as commonplace as gas stations

If the revenue from participating in a carpool covers average monthly costs for the vehicle

If the range of EVs were as long as regular cars

If incentives provided by Norway existed in Sweden

The survey found that the main dimension for consumers to be willing to overcome these barriers is economic, as suggested by the 2nd inflection points statement. This is something experts also strongly suggested, with almost all of them saying this would be the key fact to convince consumers. Hence this paper was able to identify key perceived barriers, differences between these for different consumer groups and the most important points of inflection. Secondly this paper was also able to rank these in accordance with their importance for consumers. Thirdly, with the aid of expert interviews this paper was able to some degree to explain findings and derive themes that could be used in future research or by stakeholders to guide future decisions.

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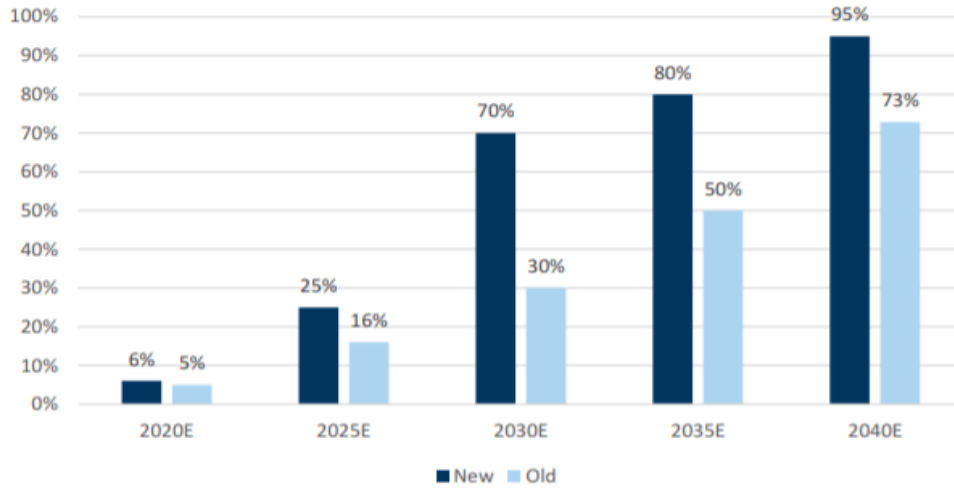
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# 7. Appendix

**Figure 1**  
Europe EV sales ratio



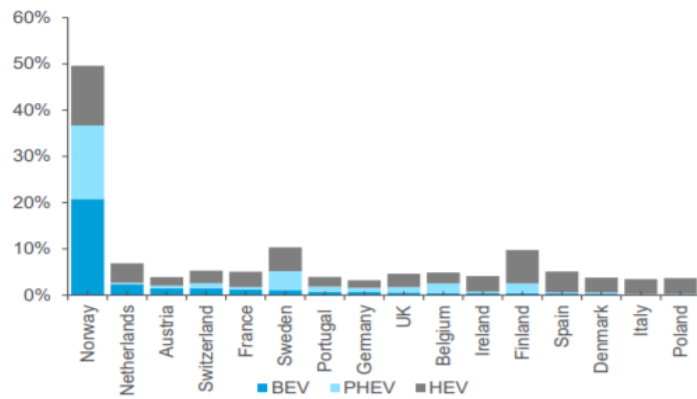
**Figure 2**

	Purchase Subsidies	Registration Tax Benefits	Ownership Tax Benefits	Company Tax Benefits	VAT Benefits	Other Financial Benefits	Local Incentives	Infrastructure Incentives
Austria	✓	✓	✓	✓	✓		✓	
Belgium	✓	✓	✓	✓				
France	✓	✓	✓	✓			✓	
Germany	✓		✓	✓		✓	✓	
Netherlands		✓	✓	✓				
Norway		✓	✓	✓	✓	✓	✓	✓
Spain	✓	✓	✓	✓	✓	✓	✓	✓
Sweden	✓		✓	✓				
Switzerland			✓			✓		
UK	✓	✓	✓	✓			✓	✓

Source: Citi Research, EAFO

**Figure 3**

Figure 110. Penetration in Norway is Miles Ahead of the Rest



Source: ACEA, Citi Research

Figure 4

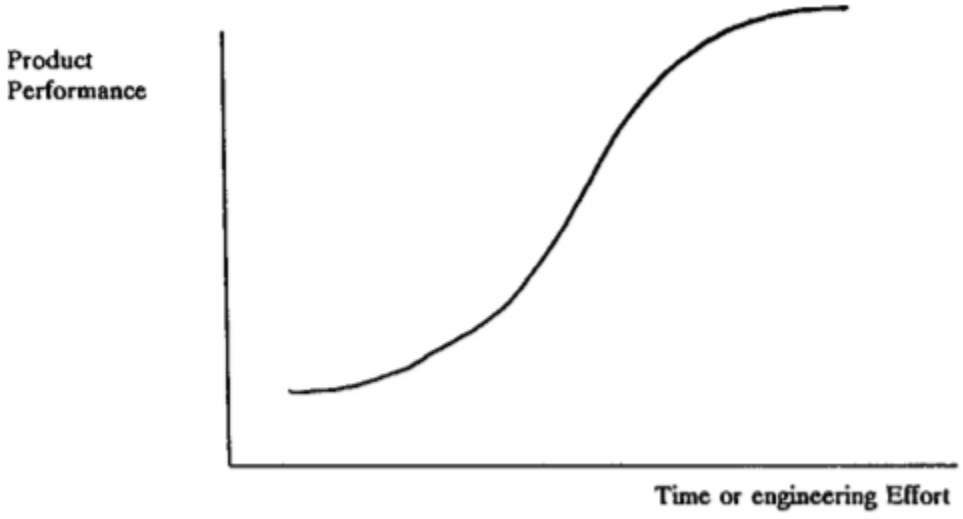
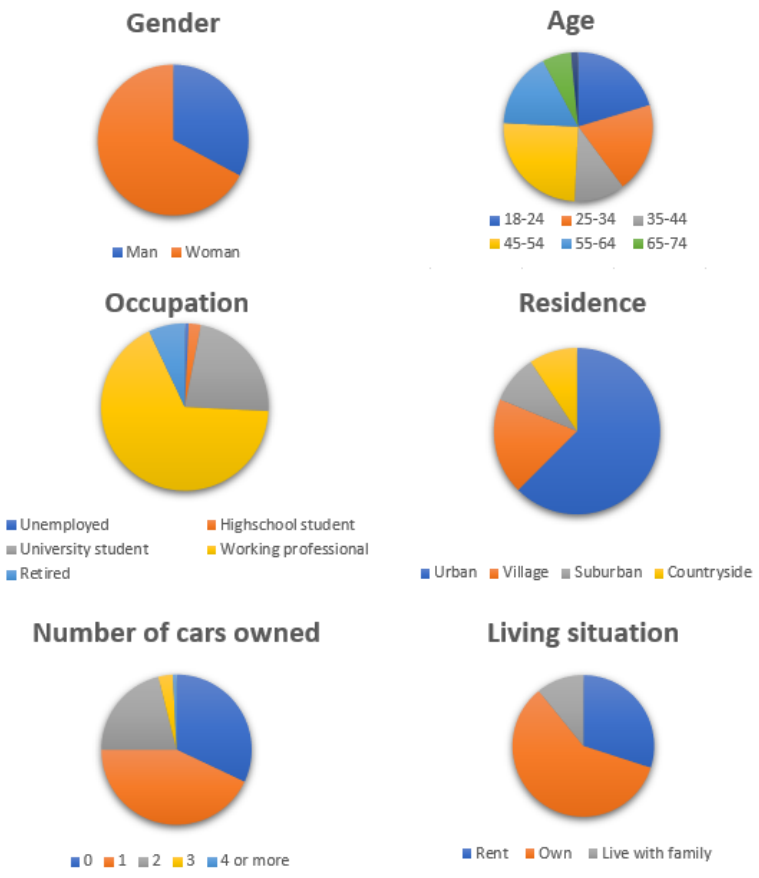


Figure 5



**Figure 6**

		<b>Barriers - Gender</b>					
Gender		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my</b>	<b>Aggregate mean</b>
Man	Mean	2.58	2.19	2.37	3.20	2.53	<b>12.86</b>
	Std. Deviation	1.107	0.995	1.090	1.067	1.198	
Woman	Mean	2.36	2.27	2.11	2.87	2.40	<b>12.00</b>
	Std. Deviation	0.945	0.859	0.810	1.109	1.061	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

**Figure 7**

		<b>Barriers - Age</b>					
Age		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	<b>Aggregate mean</b>
18-24	Mean	2.48	2.62	2.29	3.13	2.29	<b>12.81</b>
	Std. Deviation	1.163	0.921	1.042	1.191	1.160	
25-34	Mean	2.57	2.33	2.21	3.25	2.42	<b>12.77</b>
	Std. Deviation	1.080	0.856	1.062	1.152	1.018	
35-44	Mean	1.92	2.00	2.00	2.62	1.85	<b>10.38</b>
	Std. Deviation	0.669	0.632	0.853	0.768	0.689	
45-54	Mean	2.32	2.07	2.19	3.00	2.70	<b>12.29</b>
	Std. Deviation	0.909	0.997	0.910	1.174	1.236	
55-64	Mean	2.38	2.13	2.19	3.00	2.61	<b>12.30</b>
	Std. Deviation	0.957	0.885	0.750	0.907	1.037	
65-74	Mean	3.13	2.00	2.25	2.57	2.71	<b>12.66</b>
	Std. Deviation	0.835	1.000	0.886	1.134	1.254	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

**Figure 8**

		<b>Barriers - occupation</b>					
		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	<b>Aggregate mean</b>
<b>Occupation</b>							
Unemployed	Mean	3.00	3.00	3.00	4.00	4.00	<b>17.00</b>
	Std. Deviation	-	-	-	-	-	
Highschool student	Mean	3.33	2.33	2.00	3.33	3.00	<b>14.00</b>
	Std. Deviation	2.082	1.528	1.732	0.577	1.000	
University student	Mean	2.44	2.54	2.14	3.39	2.39	<b>12.91</b>
	Std. Deviation	1.013	0.884	1.008	1.066	1.066	
Working professional	Mean	2.35	2.13	2.24	2.83	2.36	<b>11.91</b>
	Std. Deviation	0.966	0.873	0.907	1.098	1.105	
Retired	Mean	2.88	2.00	2.00	2.75	3.00	<b>12.63</b>
	Std. Deviation	0.835	1.155	0.500	1.165	1.195	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

**Figure 9**

		<b>Barriers - Residence</b>					
		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	<b>Aggregate mean</b>
<b>Residence</b>							
Urban	Mean	2.37	2.27	2.19	3.03	2.38	<b>12.23</b>
	Std. Deviation	0.975	0.872	0.923	1.113	1.080	
Village	Mean	2.38	2.11	2.14	2.87	2.39	<b>11.89</b>
	Std. Deviation	0.973	1.197	0.964	1.100	1.033	
Suburban	Mean	3.09	2.56	2.42	2.83	2.67	<b>13.56</b>
	Std. Deviation	1.300	0.726	0.900	1.115	1.155	
Countryside	Mean	2.36	2.00	2.09	3.09	2.73	<b>12.27</b>
	Std. Deviation	0.809	0.632	0.944	1.136	1.421	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

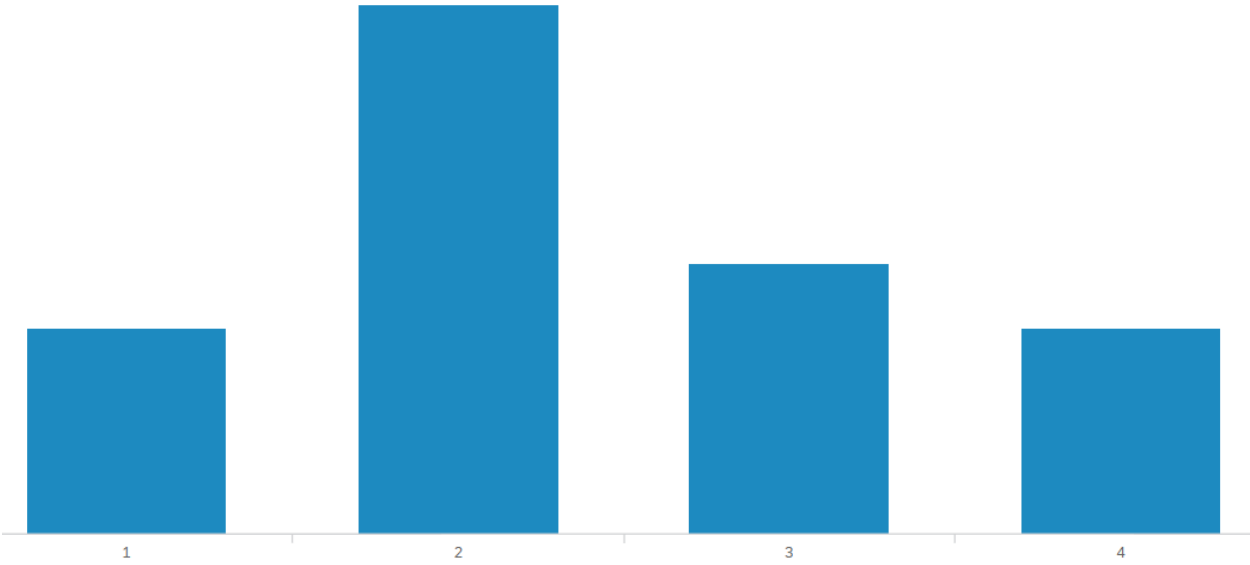
**Figure 10**

		<b>Barriers - Number of cars</b>					
		<b>B1 I am concerned with the range of EVs</b>	<b>B2 I think EVs are too expensive</b>	<b>B3 I am concerned about limited chargepoints</b>	<b>B4 I would not be comfortable using others cars</b>	<b>B5 I would not be comfortable about others using my car</b>	
Ncars							Aggregate mean
0	Mean	2.47	2.74	2.28	3.38	2.69	<b>13.57</b>
	Std. Deviation	1.033	0.815	0.905	1.206	1.104	
1	Mean	2.57	2.09	2.13	2.64	2.17	<b>11.59</b>
	Std. Deviation	1.068	0.921	0.924	1.092	1.167	
2	Mean	2.16	1.87	2.20	3.07	2.56	<b>11.86</b>
	Std. Deviation	0.850	0.694	0.957	0.829	1.013	
3	Mean	2.00	1.67	1.75	2.50	2.50	<b>10.42</b>
	Std. Deviation	0.000	1.155	0.500	0.577	0.577	
4 or more	Mean	4.00	3.00	4.00	3.00	2.00	<b>16.00</b>
	Std. Deviation	-	-	-	-	-	
Total	Mean	2.44	2.24	2.20	2.98	2.44	<b>12.30</b>
	Std. Deviation	1.005	0.907	0.921	1.102	1.106	

**Figure 11**

- 0% VAT when buying a car
- 0 customs fees
- 0% vehicle tax
- At least 50% rebate on ferry fees
- Up to 50% rebate on parking fees in major cities
- Access to drive in bus lanes

**Figure 12**



**Figure 13**

<b>Expert ID</b>	<b>Name</b>	<b>Title</b>	<b>Company market cap</b>	<b>Industry / Sector</b>
1	Anonymous	Marketing & Growth manager	\$4.54 B	Charging infrastructure
2	Anonymous	Experience Business manager	\$4.47 B	Consulting
3	Anonymous	Technical lead	\$4.47 B	Consulting
4	Anonymous	Machine learning specialist	\$80 B	Manufacturing
5	Anonymous	Chief growth officer	\$4.54 billion	Charging infrastructure

Figure 14

Barriers	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Expensive	2		1	1	1
Chargepoints				1	
Range				1	
Sharing	2	1			2
<b>Point to accept</b>					
Profit	1		5	2	2
Flexibility			1		1
More incentives					
Social pressure					1
More chargepoints					
Car range					
<b>Run my whom</b>					
Business	1	1		1	2
State				1	1
Households					1
<b>Other forms of SEAVs?</b>					
Yes					
No	1	1	1		1

Figure 15

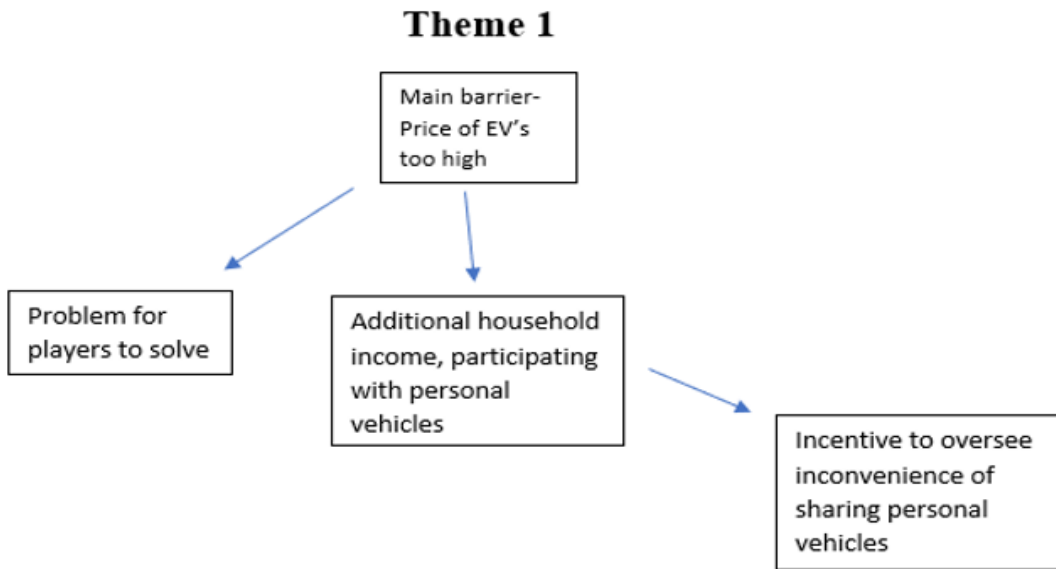


Figure 16

