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TOWARDS SUSTAINABLE ROAD TRANSPORT

Key factors on consumers' willingness to adopt electric vehicles in Sweden

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Master's thesis:	30 credits
Programme:	Master's Programme in European Studies
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Abstract

This study aims to explore and understand key factors that influence consumers' willingness to adopt electric vehicles in Sweden. As the world is facing the climate change reality, many initiatives are taking place in various sectors in different countries to tackle climate change. The transport sector in the EU is one of the sectors that have a serious impact on climate. This thesis study focuses on the transition of the automotive industry from conventional engine vehicles to battery electric vehicles and aims to understand what key factors drive people's willingness to adopt electric vehicles in Sweden. The Multilevel Perspective Framework (MLP) is chosen to understand and describe socio-technical transitions, and the key components behind them from the multi-level perspective approach. Furthermore, the Rational Choice Theory (RCT) is chosen to understand and explain the rational choice process of individuals and consumer behavior. The study implements RCT on consumer behavior and, under "utility, constraint and belief" factors are defined as sub-categories and highlighted with the support of the theory and previous literature. Additionally, this study adopts a mixed qualitative and quantitative method, and the data is collected by conducted semi-structured interviews and a questionnaire. The study offers a unique integrated theory approach of MLP and RCT to the results and provides an answer to the second research question. Finally, major factors such as cost, financial incentive, consumer knowledge, range, charging stations, environment, and minor other factors as weather and battery, reliability and uncertainty, behavioral change are found to be influencing factors on EV adoption. In conclusion, the study provides a summary of the study and draws conclusions to EU policies. The thesis study concludes by revealing the limitations of the study and offers suggestions to further studies.

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Contents

Glossary of Terms and Abbreviations

Battery Electric Vehicle (BEV or EV): It refers to any vehicle that runs via an electric motor and battery. It only uses electricity from the grid (Leandra Poindexter Cooper, 2014)

Bonus Malus: An idea of rewarding vehicles that emit small amounts of CO2 with a maximum bonus of 70,000 SEK, while burdening vehicles that emit high CO2 with higher vehicle tax

Directorate-General for Mobility and Transport: It is a Directorate-General of the European Commission that is responsible for transport in the European Union

European Commission (EC)

European Court of Auditors (ECA)

European Environment Agency (EEA)

European Green Deal: It is a set of policy initiatives by the European Commission aiming to make Europe climate neutral in 2050

European Union (EU)

EU Taxonomy: The EU taxonomy is a classification system, constituting a list of environmentally sustainable economic activities. It is enabler to enlarge sustainable investment and to implement the European Green Deal (European Commission, 2021a)

EV Driving range: An estimated distance a fully charged EV can run until the battery is out of electricity

Greenhouse Gas (GHG)

Hybrid Electric Vehicle (HEV): uses both an electric and a gasoline motor. Electricity used is made on-board, therefore there is no plug-in or electricity from the grid

Internal Combustion Engine Vehicle (ICEV): A vehicle that is powered by a regular internal combustion engine and uses fossil fuels (petrol, diesel etc.)

Multilevel Perspective Framework (MLP)

Paris Agreement: It is a legally binding international treaty on climate change adopted by 196 parties in Paris on 2015 aiming to limit global warming below 2 degrees, preferably 1.5 (United Nations, n.d.a)

Plug-in Hybrid Electric Vehicle (PHEV): similar to the HEV, but the electricity used is both made on-board and from the grid

Plug-in Vehicle (PEV): any vehicle that is charged via electricity from the grid (includes PHEVs, and BEVs)

Range Anxiety: It is a fear that a vehicle has insufficient range to reach the destination

Rational Choice Theory (RCT)

Raw Materials: The basic materials such as lithium, cobalt, nickel which a product (EV Battery) is made

Socio-technical Transitions (STT)

Supply Chain: A supply chain is the network of all the individuals, resources, activities, organizations, and technology involved in the production and sale of a product. It involves everything from the delivery of source materials from the supplier to the manufacturer to the end user

Swedish Energy Agency: It works towards transforming the Swedish Energy system into a sustainable system by collaborating with trade and industry, energy companies, municipalities and the research community on behalf of the Swedish government (Swedish Energy Agency, 2021)

Total cost of ownership: It is the purchase price of an asset (a vehicle) plus the costs of operation

1. Introduction

"There are two things keeping electric vehicles away from people. First the price of the vehicle, it is still seen as a luxurious vehicle today, but that will change within five years I can assure you, and the lack of charging infrastructure. We need to stimulate both; we need to act on both very quickly on European level and at national level"

-Frans Timmermans, Executive Vice President of the European Commission for the European Green Deal

(European Commission, 2021b)

Climate change is one of the most serious problems that the world is facing. Climate change has several serious impacts on from weather conditions to public health, water, and food security to air quality (The Climate Reality Project, 2017). The transport sector is one of the areas that affect climate badly and according to the European Commission (EC), it represents almost a quarter of Europe's greenhouse gas emissions (European Commission, 2016d). The greenhouse gas emissions (GHG) of the European Union (EU) decreased in some areas in the last years, but the transport emission was not one of the areas. On the contrary, there was a 0.9% and a 0.8% increase in 2018 and 2019 respectively in the EU (European Environment Agency, 2020). The transport sector emissions have more than doubled and increased faster than any other energy end-use sector since 1970 which has led the EU to set CO2 emission targets such as 10% renewable transport fuels by 2020 or CO2 limits for new cars as 95g of C02 by 2020 (Vassileva & Campillo, 2017). Besides, the EC launched the Green Deal in December 2019 which includes sets of policy initiatives that seek a 90% reduction in the transport sector by boosting zero-emission vehicles, building better infrastructure for alternative clean vehicles, etc. by 2050 (European Commission, 2020a).

Although there were several initiatives previously to make the European road transport sustainable such as the Green Car Initiative presented in November 2008 (European Commission, 2016b) or the European Strategy for low-emission mobility presented in 2016 by the Juncker Commission (European Commission, 2016d), the electrification of transport became vital for the EU especially with the Green Deal launch in 2019 that seeks to make Europe climate-neutral continent by 2050. After the Green Deal launch, the EU Commissioner for Transport Adina-Iona Vălean highlighted the importance of making alternatives to conventional private cars affordable and adjusting infrastructure for the goal of eliminating unnecessary emissions (European Parliament, 2019) . The EU wants nearly all vehicles zero-emission by 2050. Hence, the Sustainable and Smart Mobility Strategy presented by the EC demonstrates that highlights boosting the zero-emission vehicles as a priority for transport to become sustainable (European Commission, 2020a). The EC targets 30 million electric vehicles on the road by 2030 (Abnett, 2020), and there are several steps taken by the Commission to achieve its goals such as prospects of self-sufficiency in the lithium industry, boosting European battery production, new CO2 emission targets coming into force (European Commission, 2020c). In response to all developments, the automotive industry is also in a transition period where battery electric vehicles (BEVs or EVs) are replacing internal combustion engine vehicles (ICEVs).

However, although the EV adoption rate is increasing, from the environmental perspective, EV adoption is not coming fast to make the real change (Aakash Arora, Nathan Niese, Elizabeth Dreyer, Albert Waas, & Alex Xie, 2021). This transition from ICEVs to EVs and EV adoption represents a rapid change and faces challenges in most countries in the EU including Sweden where this research focuses on key factors that influence consumers' willingness on EV adoption in Sweden.

Climate change is a great challenge for countries and the reduction of GHG is therefore vital. The transport sector is one of the areas that affect climate poorly and it represents one-quarter of the total GHG emissions in Sweden (Energimyndigheten, 2018). Depending on the source of electricity, a transition from ICEVs to EVs has a great potential to reduce GHG emissions and to reach the climate targets. Like many other countries, Sweden also set some climate targets, initiatives, and bans which also include the transport sector. Sweden published its climate policy framework in 2017 and set climate targets to reduce GHG emissions and reach climate neutrality by 2045 (Government Offices of Sweden, 2018). The same policy framework also highlights that emissions from domestic transport will have to be reduced at least 30% compared to 2010 by 2030. The Swedish government also announced that Sweden will ban the sales of new petrol and diesel engine cars by 2030.

Sweden is a progressive and fast-forwarding country where environmental concerns are high. In the event of no sales of diesel and engine cars, it is expected that electric cars will gain more importance than they have today. In worldwide, plug-in electric vehicles accounted for only 4.2% of light vehicle sales in 2020 while they accounted for 32.2% (including plug-in hybrids and light vehicles) in Sweden (Felix Richter, 2021). Even though EV adoption is increasing in Sweden, however, according to Vassileva and Campillo (2017) the adoption rate of electric vehicles in Sweden is not enough to reach the national target. Previously, many kinds of research on consumer adoption of EVs highlighted that electric vehicles have the potential to reduce the greenhouse gas emission of the transport sector (Jian Wang & Wei Zhou, 2019). Furthermore, the Swedish Energy Agency highlights more detailed research needs on driving factors that affect the adoption of electric vehicles (Energimyndigheten, 2016).

Given the variety of stakeholders involved, ranging from the automotive sector to national and European authorities, consumers, and other sectors, it is too simplistic to talk about a single innovation that will dominate in the end. Rather, a set of innovative designs or an innovation cluster may be used to electrify road transportation (Rogers, 1995) though not all emerging from the same market. For example, if a country leads in the development of high-performance batteries, another could lead to the development of integrated mobility concepts. Therefore, a country-specific study carries huge importance for depth analysis where in the end might be a resourceful case at the European level. Market conditions within the EU show a certain degree of similarity, and a unified type of approval system, making it easier to diffuse innovation designs. Given the fact that EV adoption is in the early phase and the adoption rate is high only in a few countries, studying and learning from the Swedish case could be helpful on the European level to implement policies

and strategies to help speed up EV adoption. The adoption rate and historical automotive industry hub features of Sweden can be justified as some of the important reasons why Sweden is chosen for this thesis study.

The major benefit of driving an electric vehicle is its production of zero carbon emissions when driving (Julia Poliscanova, n.d), and due to the different characteristic features of other electric vehicle types, in this study, only battery electric vehicles are studied. Also, it is important to highlight that factor perceived as "*a fact or situation that influences the result of something*" (Cambridge Dictionary, n.d.) in this study. This thesis is structured as follows. First, the research aim and research questions are presented to give an overall idea of the motive behind the research and to identify the specific objectives that the study addresses. Later, the thematic background of electric vehicles is presented. Under this section, the European Union EV approach is viewed to provide more understanding of the EVs from the EU perspective which is followed by the current EV situation in Sweden. After, the thesis continues with the literature review to provide previous research examples. Afterward, the theoretical approach is covered under the theory section. The first chosen multi-level perspective framework is considered to give a more comprehensive understanding of the broader context of the socio-technical transition of ICEVs to EVs while the second chosen rational choice theory looks at the narrower context and describes the rational choice of consumers and their decision-making process. The study continues with the method and material section which explains the chosen data collection materials of semi-structured interviews and the questionnaire and explains the reasoning behind the choices. Next, the study continues with the presentation of the results, and after, the results are analyzed and research questions are answered in the analysis section. Finally, the summary of the study, contributions to the literature, limitations, and further research suggestions are addressed under the conclusion.

1.1. Aim and Scope

The overall research aim is to understand the key influencer factors on consumers' willingness to adopt EVs in Sweden. The consumer factor on EV adoption seems not given enough attention in Sweden based on the literature review. Although the study did not conduct EU document analysis due to its scope, this is also applicable to the EU level when looking at the published EU documents or high-profile EU Commissioners' statements. There is a research need that covers the sustainability transition of the automotive industry from ICEVs to EVs (Energimyndigheten, 2016) focusing on the perspective of consumers and key factors that have an impact on their willingness to adopt electric vehicles in Sweden.

The study identified two research gaps from the research review. First, a research gap that aims to provide key influencing factors on EV adoption in Sweden. Second, a research gap regarding the consumer factor and its role in the socio-technical transition from ICEVs to EVs. Therefore, this study aims at addressing these two research gaps. Also, the study argues that focusing on a member state will help the European cause since, first, countries have similar characteristics in the EU and innovations have a high speed of diffusion rate in similar countries, and second, the transition is a shared competence in the EU that needs national level input. Therefore, one member state, Sweden is chosen, and the thesis aims at addressing the research gaps by focusing on key factors on EV adoption in Sweden, and consumers role the socio-technical transition from ICEVs to EVs and aims to draw conclusions for EU policies.

1.2. Research Questions

Understanding the factors that affect people's willingness to adopt electric vehicles is vital for Europe's long-term climate goals. The transition of the automotive industry from ICEVs to EVs is an exciting journey to follow and due to the freshness of the topic and the latest developments mentioned, there is a research need in this field. Besides, the current EV adoption figures are not enough to reach the transport emission and climate neutrality goals. There is a research need to understand the factors that influence consumers' willingness on EV adoption. Therefore, the main research question in this study is:

- What are the key factors that influence people's willingness to adopt electric cars in Sweden?

The second research question is formulated to understand and provide an answer to consumers' role in the transition from ICEVs to EVs.

- How can the consumer factor in the socio-technical transition from ICEVs to EVs be perceived?

2. Thematic Background of Electric vehicles

2.1. European Union EV Approach

In the last couple of years, several environment relevant events and changes have happened in Sweden, Europe, and the world such as the climate change strike that took place in many countries organized, the Paris Agreement, sustainability popularization, electric car commitments from car companies, the rise of green policies and parties, Covid19, EU's Green Deal launch, and many more. The automotive industry is also taking an action and transforming itself towards more sustainable road transport options such as battery electric vehicles. This transition includes and requires many actors due to its complexity such as car companies, national and European governments, policymakers and regulations, consumers. The EU is one of the influencer actors that had been working on sustainable transport solutions even before the last couple of years' events and the Green Deal. The EC includes a Commissioner for Transport, Adina Iona Vălean, and since 2012, the EC also includes a Directorate-General for Mobility and Transport which is responsible for EU policies on mobility and transport and manages funding for technological development, innovation (European Commission, n.d.c). Transport is a shared competence between the EU and the member states and it is seen as one of the EU's most strategic common policies (EUR-Lex, n.d.). It is also seen as the cornerstone of European integration and significant for the free movement of individuals, services, and goods as well as a success story that connects people across the continent. As Europe has become more connected and mobile, so the carbon footprint from transport has grown. Transport accounts for a quarter of the EU's GHG emissions and which has been increasing as the demand grows (J. Smith, 2016). Currently, Europe is leading in EV sales in the world (Lu, 2021) as well as has the most ambitious goals such as being the first climate-neutral country that was announced with the Green Deal launch. The European Green Deal seeks a 90% reduction in transport by 2050 and the key objective for the EU is to switch to clean vehicles and alternative fuels as well as regulate the CO2 emissions performance standards. For example, the EU Commissioner for Transport Adina-Iona Vălean stated that "this deal cannot be complete without transport at its core" and committed herself to green the mobility (European Parliament, 2019). However, several authors argue that the EU needs to cut light-vehicle emissions by 90% by 2043, seven years earlier than currently planned (Aakash Arora et al., 2021). Nevertheless, the electric vehicle adoption level is not on course to deliver on this goal in the EU.

On 1 January 2020, Regulation (EU) 2019/631 entered into force which replaced and repealed the former Regulations (EC) 443/2009 (cars) and (EU) 510/2011 (vans) (European Commission, n.d.b). One of the targets of the Green Deal is to reduce GHG emissions at least 55% by 2030 and the EC is preparing a revision of the Regulation as part of the 'Fit for 55%' package for which is expected to be adopted by

the Commission on the third quarter of 2021 (European Commission, n.d.a). The EC also highlighted the importance of electric vehicles in its green finance taxonomy, mentioning that only cars which emit zero CO2 will be considered as "sustainable" investments as of 2026 (European Commission, 2019b). In the Inception Impact Assessment report of the EC, however, the cost of CO2 emissions to society is mentioned as an external cost, and consumers tend to undervalue future fuel savings and not to pay more for zero-emission vehicles (European Commission, 2021c). Other barriers of vehicle and battery cost, model availability, availability of recharging infrastructure are mentioned in the document. Besides, the document highlights that under the Green Deal, the EU will invest to build charging infrastructure as part of the Next Generation EU that allows zero-emission vehicles to travel across Europe. The charging and infrastructure availability are again seen as a priority in order to achieve mass acceptance of deployment of EVs in the EC's 'A European Strategy for Low-Emission Mobility' paper in 2016 (European Commission, 2016a). The EC estimates that Europe will need 3 million public charging points by 2030, and promises a "roll-out plan with funding opportunities and requirements" (Taylor, 2020). It seems that the EC highlights some issues, e.g., cost, infrastructure, and charging stations, as barriers to mass acceptance. According to an EC draft document, reaching the bloc's climate goals will require 'at least' 30 million electric vehicles by 2030 (Abnett, 2020) which the number of EV registrations in 2019 and 2020 was 550,000 and 750,000 respectively (Statista, 2021). Although the EC's plan to have 30 million EVs on the road by 2030 is quite ambitious, it does not reflect the current reality and consumer roles on EV adoption seem undervalued. The Green Deal calls for a 55% reduction in emissions from the EU's car sector by 2030 from a 1990 baseline of 433 million metric tons of CO2 equivalents, and more than a 90% reduction by 2050. However, based on an estimation by Aakash Arora et al. (2021), zero-emission vehicles will account for 42% of new sales in 2030, and gasoline and diesel-powered vehicles will account for 65% of the EU's total vehicle. Consequently, it is estimated that the EU passenger vehicle sector will only be able to reduce GHG emissions by 28%, far from the 55% goal. Currently, the electric vehicle adoption level is not on track to meet this goal.

The member states of the EU are the core of the EU's policies and regulations and studying and understanding member states specific features carries significant importance to be able to meet the EU's goals. In Europe, countries have similar characteristics, and studying a member state is often valuable to other countries as well. Also, according to European Environment Agency (2021), the European Green Deal and sustainability transitions do not only require technological change but also changes in consumption and social practices. Therefore, the study focuses on consumers who often practice social changes and consume from a member state level on EV adoption.

2.2. Current EV Registration Situation in Sweden

Electric vehicles do not have a negative carbon footprint, instead, the emission depends on the power source. Since over 90 percent of the electricity production in Sweden is generated from renewable or nuclear sources (Sweden.se, 2020), the greenhouse gas emissions of electric cars are low which creates a high positive impact on Sweden's climate neutrality goal. However, the EV adoption numbers are currently not high in Sweden even though the adaptation is increasing. ***Figure 1*** shows the distribution of the total amount of cars in Sweden in 2020 which were 4, 944 067 while only 3% percent of it represented electric hybrids and 1% electric vehicles (Trafik Analys, 2021). However, diesel and petrol engine cars represented 89% of the total vehicles in Sweden even though a slight decrease of 2% between 2019 and 2020. ***Figure** 2* statistics highlight the new car registrations in Sweden which shows that the new petrol and diesel car registration percentage still was high as 38% and 22% respectively in 2020. During the same period, Sweden introduced a bonus-malus system in which new environmentally friendly car registrations were offered 60000 SEK after 1 July 2018 (MiljöFordon, 2020). According to Trafik Analys (2021), the bonus-malus system affected the new electric vehicles' registrations which increased from 2% in 2018 to 9% in 2020. While electric hybrids represented 8% of new car registrations, electric vehicles and plug-in hybrids represented 9% and 22% of the total percentage respectively.

The above information provides two insights. First, electric vehicles represent a very small amount in the total number of vehicles in Sweden even though the electric vehicle registrations are increasing. Second, the financial incentive by the government is seen as a factor that increases the total number of electric vehicle registrations in Sweden (Trafik Analys, 2021). The bonus-malus amount, however, was increased by the government from 60,000 SEK to 70,000 SEK (Regeringskansliet, 2020) which this change might lead to an increase in the number of electric vehicle registrations in 2021.

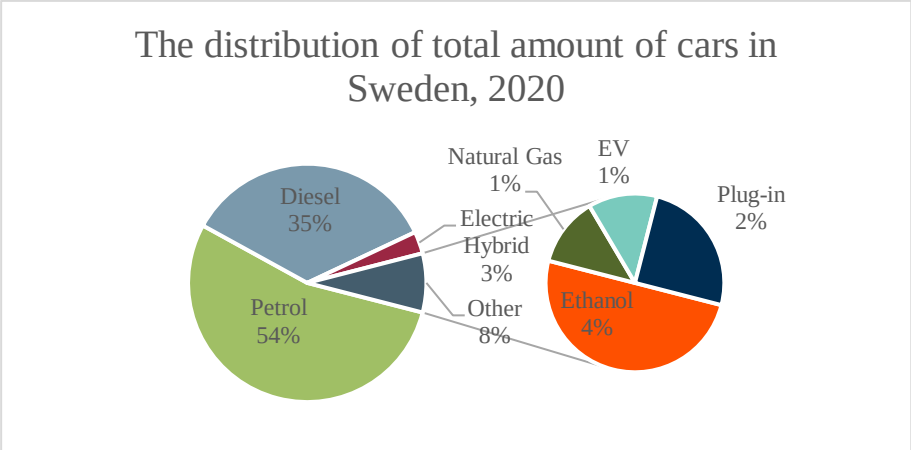

Figure 1 The distribution of the total amount of cars in Sweden, 2020 (Trafik Analys, 2021)

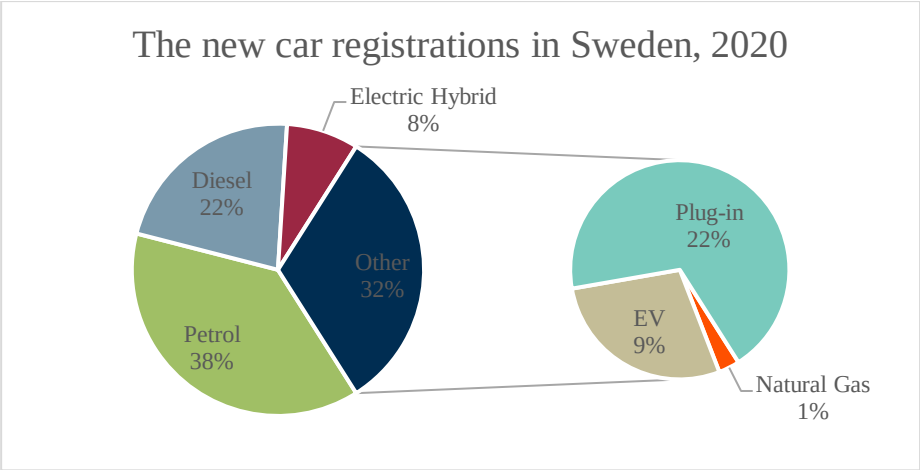

Figure 2 The new car registrations in Sweden, 2020 (Trafik Analys, 2021)

3. Literature Review

In general, most previous studies on this topic are dated (Egnér & Trosvik, 2018; Jansson, Nordlund, & Westin, 2017; Vassileva & Campillo, 2017) or focused on several countries in Europe (Haustein & Jensen, 2018; Haustein, Jensen, & Cherchi, 2021; Statharas, Moysoglou, Siskos, Zazias, & Capros, 2019). This is a topic where needs a constant update since the electrification of vehicles has recently become serious. Considering the short (e.g., 2030 emission goals) and long-term (e.g., climate neutrality by 2045) national goals set by the Swedish government, it might be possible to better understand the importance of ongoing research in this context. There is previous research focused on EV adoption from different perspectives such as local policy impacts (Egnér & Trosvik, 2018), early adopters (Vassileva & Campillo, 2017), future scenarios (Katharina Rossbach, 2015), urban, sub-urban, rural (Newman, Wells, Donovan, Nieuwenhuis, & Davies, 2014) or different country focus, namely China and the Netherlands (Jian Wang & Wei Zhou, 2019; Robbert Slot, 2017) but not on the particular topic of focusing on key factors that influence people's willingness on EV adoption in Sweden. It should be noted that the factors presented below are chosen after a careful and detailed research review. Although there are several influencing factors found and considered from previous research, e.g., perceived social influence (Jian Wang & Wei Zhou, 2019), urban density, and vehicle diversity (Ali Soltani-Sobh, Kevin Heaslip, Ryan Bosworth, Ryan Barnes, & Donghyung Yook, 2015) or family factors (Li, Long, Chen, & Geng, 2017), the below factors by the previous research are found to be the most researched and relevant factors on EV adoption in Sweden and Europe, and therefore, they are chosen and included in this thesis to narrow the influencing factors to most researched, relevant and key factors.

3.1. Charging Infrastructure

The main difference between EVs and ICEs is the fact that EVs do not run on fossil fuels but electricity. Therefore, electric vehicles are needed to be charged from time to time depending on the driving range of the car, driving behavior of a person, weather conditions, etc. The current structure in rural and urban areas is not designed for electric vehicles and therefore, there is a lack of charging stations in many locations. Another related issue is the charging need and time of electric vehicles. Previous research on EVs in Sweden and Denmark by Haustein and Jensen (2018) highlights that charging the car is found as the most important factor and barrier for EV adoption intention. At the same time, increasing the charging infrastructure is seen as the highest relevance for the current EV owners. Vassileva and Campillo (2017) also underline the charging time and lack of structure as a barrier and stress the importance of offering free charging as a monetary incentive to boost EV adoption. Furthermore, they justify Norway's success and becoming the top EV user country by their financial incentive and an effective charging infrastructure network construct. On the contrary, however, Westin et al. (2018) underline that lack of extensive charging infrastructure is not considered an obstacle in Norway where most people charge at home. But they also focus on geographical context and characteristics' importance on EV adoption in their study where people live in rural areas or drive long distances to get to work. In this manner, they highlight the importance of charging infrastructure and stress that lack of charging infrastructure could serve as a psychological barrier. The previous research clearly shows that the lack of charging infrastructure is an important factor and can be a barrier to EV adoption.

3.2. Environmental Concern

Climate change and environmental concerns are important topics of the last couple of years. As previously mentioned, the main reason for this transition from ICEVs to EVs is a will to decrease the environmental impact of vehicles. The transport sector is responsible for one-quarter of the total greenhouse gas emission in Sweden and Sweden has set a target to achieve fossil independent vehicles by 2030 (Egnér & Trosvik, 2018). It is, therefore, important to consider environmental concerns on EV adoption, especially in a country like Sweden. Sweden has been ranked several times as one of the most innovative countries in the world as well as an environmental pioneer (Vassileva & Campillo, 2017). Besides, Sweden has other characteristics that make the country very suitable for large-scale EV adoption such as a large share of renewable energy sources (Sweden.se, 2020). Although Egnér and Trosvik (2018) highlight that environmentally beneficial technologies often have slow diffusion rates,

several studies (Haustein & Jensen, 2018; Jansson et al., 2017; Jian Wang & Wei Zhou, 2019; Rezvani et al., 2015; Westin et al., 2018) underline that environmental concern is an important factor for the EV adoption. An interesting result found by Haustein and Jensen (2018) shows that people who bought an electric vehicle use their cars more often than previously. The reason for this is because the car is seen as an eco-friendly car which results in increased mileage. EVs are mainly considered eco-friendly and seen as a symbol for environmental concern according to Rezvani et al. (2015). However, a comparative study including 30 countries highlighted by Westin et al. (2018) found no proof of environmental concern. They also underline another study from Norway which shows high environmental expression in terms of EV adoption. A survey example in Vassileva and Campillo (2017)'s study underlines that environmental concern was the most attractive motive to adopt an electric vehicle for both women and men (55% and 45% respectively). As explained in their study, environmental concerns were a huge driver for the early EV adopters in Sweden as well as factors such as government support and economic concerns. In general, the main reason why the transition towards electrification happens is because of the willingness to reduce greenhouse gas emissions from road transport. Therefore, it can be argued that environmental concern is an important factor for many people to consider adopting an electric vehicle.

3.3. Purchase Cost and Financial Incentives

The cost of the car is highly important for many people to even consider purchasing a car. Today, electric cars are more expensive than traditional combustion engine cars due to their expensive rechargeable lithium-ion batteries (*Why Are Electric Cars More Expensive than Conventional Ones? | Drupal*, n.d.). Financial incentives, therefore, are seen as a key factor to be considered in EV adoption because of the high price of EVs. Even though the operational costs of EVs are relatively low and cheaper in the long term than the ICEVs, the initial purchase cost is still very important for many people (Ingeborgrud & Ryghaug, 2019). Levay and Drossinos (2017) argue that the high purchase cost of electric vehicles is a significant barrier to sales. Furthermore, even though Rezvani et al. (2015) highlight the importance of financial incentives and their positive influence on the intention of EV adoption, they also argue that there are further research needs on financial incentives' effects. Based on the previous literature review by Egnér and Trosvik (2018), nationally implemented financial incentives and locally implemented policies have a constructive impact on EV adoption. However, the effectiveness of Sweden's national financial instruments promoting EVs has been found insufficient by them. It is worth mentioning at this point that Egnér and Trosvik (2018)'s study was published in 2017 and the literature reference based on the argument of Sweden's national financial incentives weakness was published in 2015 and 2014. This

is one of the areas where the thesis aims to fill the research gap and look through the incentives impacts from the 2021 perspective. Consequently, due to the high purchase cost of EVs, governments offer financial incentives to encourage and direct people towards eco-friendly vehicle adoption.

3.4. Driving Range

Recent developments in electric vehicle batteries have significantly improved the driving range of some EVs. The current range of EVs varies from 95km to 750km which also depends on several factors such as driving style, temperature, etc. The concern that the vehicle's range is inadequate to meet its destination is commonly known as range anxiety. Haustein and Jensen (2018) argue that range anxiety is considered as a functional barrier while Vassileva and Campillo (2017) highlight the importance of increasing driving range as a non-monetary incentive to increase EV adoption. Besides, Haustein and Jensen. (2018) provides a finding that charging the car is perceived as the most important functional barrier of EV adoption intention. A study on Denmark and Sweden by Haustein et al. (2021) shows that range anxiety is perceived as a functional barrier and it is one of the most important factors along with charging infrastructure and environmental performance when looking at EV users. However, Rezvani et al. (2015) argue that range limitation and charging behavior are parts of the adaptation process and need behavioral change. Their study also underlines that range anxiety is likely to disappear if consumers consider EVs as an urban transportation method. It is, however, arguable that in some big cities people might need a long drive to get to work than in rural areas. In their study, it has been demonstrated that a limited range of EVs can be overcome by methods such as driver training and interface design. However, this kind of approach might face resistance by the customers and find this unpractical in terms of large-scale EV adoptions in countries. A study carried out in Europe discovers that 60% of drivers would not consider a driving range less than 160km even though they drive less than 160 km in a day (Vassileva & Campillo, 2017). These findings are important to consider when providing EV policies, campaigns, etc. to educate consumers and reduce the range anxiety.

3.5. Technology & Innovation

Electric cars do not only bring environmental benefits but also new technology, experience, and excitement to their users. According to Egnér & Trosvik, 2018, the adoption choice of an electric car is because they are seen as one of the most attractive technology alternatives to ICEVs. However, there is inconsistency with this argument, given the fact that biofuel cars, for instance, were also seen as an attractive technology alternative to ICEVs at some point (Fevolden & Klitkou, 2017). However, they did not become as successful as EVs are today. This can be understood by Leandra Poindexter Cooper (2014)'s study on acceptance and technological innovation. According to her, acceptance and technology innovation never happens in one dimension. The success or failure of innovation is influenced by several factors, and only one of them is technological performance. Jansson et al. (2017) also highlight that consumers choose electric cars not only for their environmental benefits but also for their innovativeness and technological boom. Vehicle technology awareness is also a significant factor to be considered to increase awareness and finally EV adoption. This view is supported by Haustein et al. (2021)'s research that proves the population in Denmark and Sweden have little knowledge about EVs even though the technology has been around for several decades. Vassileva and Campillo. (2017) focuses on Sweden's pioneer position on developing alternative fuel technology since the 1970s with the support of strong policy frameworks. This, however, changed after 2010 due to the negative social and environmental impacts of biofuels which made policymakers more cautious to adopt strong policies to support EVs. Concerning EV adoption, new technologies and innovativeness are perceived as exciting and seen as influencing factors.

4. Theory

4.1. Multi-level Perspective Framework and Socio-technical Transitions

Understanding large-scale transitions and why do they happen is significant to understand and analyze the key factors that affect consumers' willingness to adopt electric vehicles. Previously mentioned, moving from ICEVs to EVs is a transition period which requires change within various stage, place, or subject. Oxford dictionary describes the transition as "*a process or a period of changing from one state to another*" (Oxford Dictionary, n.d.). Nonetheless, the transition might have various meanings to different people depending on the situation where it is used. However, I will address transitions from the framework of the multi-level perspective to understand societal and technological changes. Transition research generally acknowledges the critical role of firms in driving transitions as well as emphasizes the multitude of actors' involvement and the role of consumers and demand. However, much potential remains to generate insights into how this interrelation functions from the consumer perspective (Steinhilber, Wells, & Thankappan, 2013a). Therefore, I will first describe the socio-technical transition and multi-level perspective approach. I will then try implementing the customer perspective and EV adoption into the MLP which I hope will provide valuable insight into the literature.

Electric vehicle batteries are the technological part of this transition but also there are technological changes that are needed such as charging infrastructure. Therefore, the technological part of the transition cannot be perceived from one technological change. It is rather on the change of an entire complex technological system that is embedded in a societal context in which consumers are part of that societal context. Technology is mentioned as 'configurations that work' and configurations as alignment between a heterogeneous range of variables by Geels (2002). **Figure 3** represents the socio-technical configuration for personal transportation which I will use to analyze consumer perspective on electric vehicle adoption. As it is shown, many elements in the sociotechnical configuration are intersectional. A change in one element is highly likely to affect another one. Looking at **Figure 3** below, it can be said that several factors such as regulations, policies, infrastructure, culture, etc., are part of the sociotechnical configurations in personal transportation. In Sweden, the environment has culturally an important place in the society where people feel obliged to act. Having an electric car might carry a symbolic meaning to people who care about climate change deeply and feel obliged to act. Furthermore, the fuel infrastructure shown below is relevant to battery charging infrastructure availability in rural and urban areas where people charge their electric vehicles. However, the cost of the car can be seen as an important factor for many people as electric vehicles are expensive and seen as premium today. This is also relevant with symbolic meaning where people are willing to pay more because of the innovation &

excitement reason and the environmental concern. But the price of the EV can be reduced by local, national, and European initiatives, regulations, and policies. The driving range of batteries is seen as a major barrier for many people known as 'range anxiety'. User practices, however, could be useful to reduce range anxiety. This transition, like many others, requires behavior change where people need to adapt to the 'new normal'. Other relevant factors on EV adoption, for instance, could be the maintenance of batteries where there might be trust issues towards batteries, e.g., explosion risk. Consequently, the socio-technical approach to transitions views transport systems as a set of elements. All of these elements shown and described are interrelated where radical new technologies have a difficult time coming through since many elements have linked each other and to the existing technology (Geels, 2002).

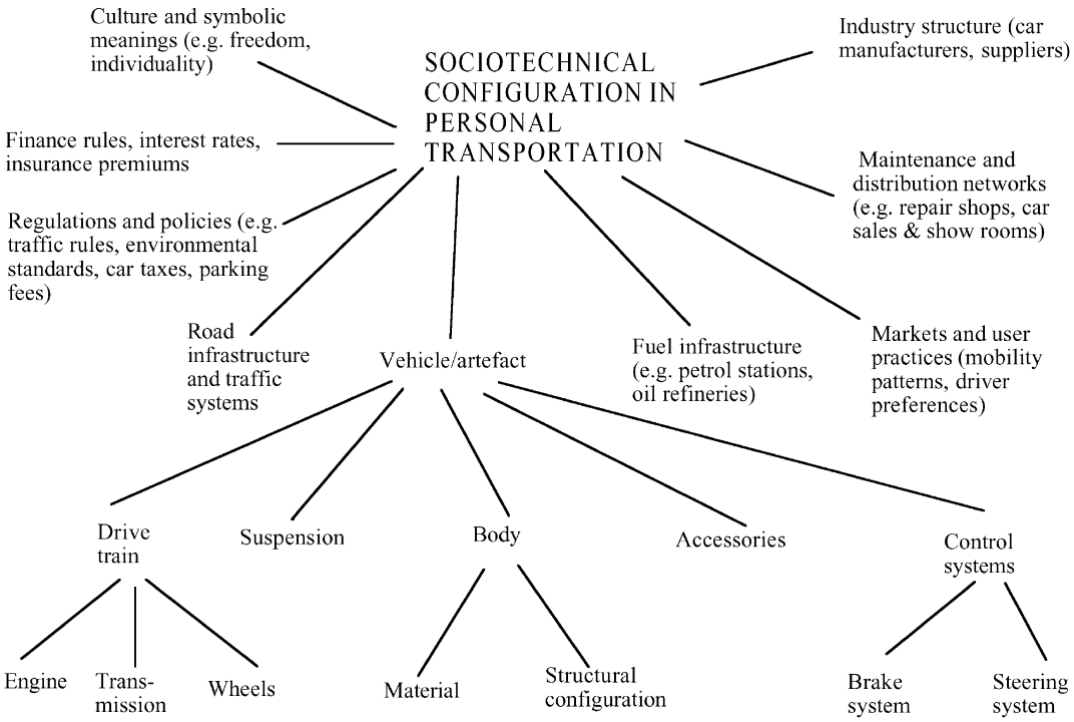

Figure 3 Sociotechnical configuration in personal transportation (Geels, 2002)

The socio-technical approaches emphasize multi-dimensional interactions among technology, policy, culture, civil society, and industry. Understanding large-scale transitions require analytical frameworks that capable of addressing interactions among various actors. The multi-level perspective (MLP) approach is the chosen framework for this study. On the one hand, established systems (ICEVs) are characterized by stability, lock-in, and path dependency, all of which lead to gradual change along predictable paths (Geels, 2012). On the other hand, radical alternatives (EVs) are being developed and brought forward. Implementing this to the EV adoption, electric vehicles are having a hard time against

established ICEVs since they are more expensive and require user behavior change and adoption, regulations change, and existing lack of charging infrastructure, etc. The MLP has emerged as a fruitful framework for analyzing socio-technical transitions towards sustainability (Geels, 2011) which offers a solution to the central analytical complexity of transitions.

4.1.1. Socio-technical Niche

According to MLP, socio-technical transformations are characterized by interactions between the incumbent “regime”, radical "niche developments," and the "socio-technical landscape" (Geels, Sovacool, Schwanen, & Sorrell, 2017). Transitions are regarded as multi-phase, multi-level processes. Niche innovations are emerging social or technical innovations that are radically different from the existed socio-technical system and regime. Niche-actors hope that radical innovation is used more eventually and even replace the existing regime. Geels (2012) highlights their importance by saying that they are the seeds for systemic change. He then provides three processes within niches shortly as the learning process, the articulation of expectations or visions, and the building of a social network. The learning process involves several actors from policy instruments to market demand, infrastructure requirements to user behavior. Implementing this to EV adoption and consumers, it can be argued that consumers are still in the discovery and learning process. Consumers adapt their expectations from a car based on various factors such as driving range. Lastly, people build networks all the time and share information, even sometimes unintentionally. Cars' cultural and symbolic meanings emerge from interactions between consumers, the media, and social networks (Geels, 2002). From this perspective, it can be stated that niches gain momentum when they are more visible, shared, and in the end accepted.

4.1.2. Socio-technical Regime

Regimes keep a socio-technical system stable by offering "*a semi-coherent collection of rules that orient and coordinate the actions of social groups that replicate the different elements of socio-technical structures"* (Wesseling, Bidmon, & Bohnsack, 2020, p.2). Technologies that benefit from well-developed systems must compete with innovations. Socio-technical frameworks are the product of the alignment of existing technologies, policies, consumer habits, infrastructures, and cultural discourses (Geels, 2012). In existing regimes, innovation is often gradual because of lock-in processes and route dependency. Change tends to occur, but it does so in reasonably predictable ways, resulting in a stable path. Consumer lifestyles, regulations, and laws are great examples of lock-in mechanisms. For many

years, consumers have built the regular practice of using internal combustion engine vehicles. This is a daily habit where people know that if they want to fuel the car up, they need to go to a petrol station. Relevant to this, road infrastructure is built up to this kind of lifestyle where people can find petrol stations on their route without worrying. However, this lifestyle needs to change with EV adoption. To begin with, many people will charge their electric vehicles at home as almost everyone does with their smartphones now. Also, due to the waiting time of charging, it is important to plan long trips. The old lifestyle would not necessarily need planning the road trip in terms of fueling the car. Furthermore, it is also the same for regulations and laws where serious changes are needed. It usually starts as local, national, or European governments start putting limitations, but limitations increase and come closer to the real change over time. An example of this from a European perspective is EU regulations that put CO2 emission reduction targets in place (European Commission, 2016c) that turned into the 2050 climate neutrality goal by time (European Commission, 2019a). As an EU member state, Sweden also follows the European regulations and sets its targets as well. The climate neutrality goal of Sweden is 2045, which is 5 years earlier than the EU's target is a good example. Furthermore, it is important to note that "regime" is an interpretive analytical term that encourages the analyst to look into the "deep framework" of practices, such as shared values, standards, standardized processes (Geels, 2012) where this study aims to research from the consumer's perspective in Sweden. Consequently, socio-technical regimes produce incremental innovations, e.g., the transition of one technological system (ICEVs) to another one (EVs) that happens in close interaction of a societal context where consumer adoption plays an important role.

4.1.3. Socio-technical Landscape

The socio-technical landscape is a broader context, which influences niche and regime dynamics as **Figure 4** presents below. As previously mentioned, the three levels are intertwined with each other where changes occur and affect each other. However, changes at the landscape level, such as a collection of deep structural patterns, social values, or worldviews, destabilize the regime and open doors for niche innovation to extend, become a part or even reposition the current regime (Wesseling et al., 2020). For example, the way Greta Thunberg traveled, e.g., arriving at a climate summit by an electric car, is a powerful way of influencing people to think twice when driving a traditional vehicle. The powerful moments in a landscape influence change in regimes and niches as well. The socio-technical landscape encompasses structures such as political ideologies, societal values, beliefs, concerns, the media landscape (Geels, 2012). The movement also has its impacts on the auto industry. Even a car company, Volkswagen, promoted its ID car brand by referring to the Paris Agreement's goal of climate and Greta

Thunberg and her movement's important demands (Volkswagen, n.d.). Although this is highly likely to be a commercial move, it is not for this study to investigate as the point is the importance of the socio-technical landscape's broader context and what kind of actions might affect niche and regime. As the examples show, this is an approach where various stakeholders are nested. Changes in the socio-technical landscape influence niche innovation and regime and go beyond the control of individual actors. At the same time, these changes namely Greta Thunberg's electric car use, the EU climate regulations, and law or an automotive manufacturer's commitment influence consumers and their behavior. It is either people who are admired due to the influencer effect or forced to change their behavior due to the law and regulations and possibly adopt an EV. Finally, all these changes at the landscape level impact and destabilize the regime and create a great opportunity for niche innovation to take its place (Wesseling et al., 2020).

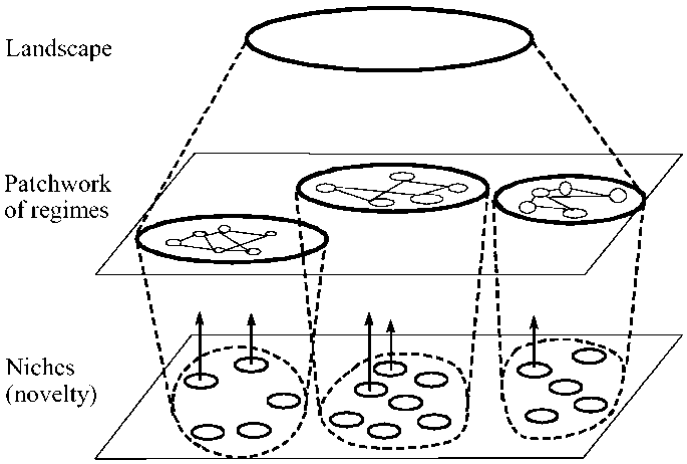

Figure 4 Presenting landscape, regimes, and niches (Geels, 2002)

Finally, the MLP has the potential to offer more understanding concerning the actual role of actors (e.g., consumers) in the transition period. In a nutshell, within the MLP, innovation emerges in niches and these niches work on radical innovations that overtake existing regimes. Besides, niches gain momentum and become certain and accepted if social networks become bigger. In another saying that is more proper to this study is more EV adoptions by consumers make social networks bigger. And in the end, niche actors hope that promised innovations replace the existing regimes. Therefore, it is important to mention that niches are crucial for transitions and the choice of multi-level perspective approach is well within the line in the transitions since the MLP represents an interpretive research style. This is also in line with uncertain processes such as socio-technical transitions where this study aims to gain more insight knowledge. Although the MLP has been criticized by some researchers due to its lack of agency (A.

Smith, Stirling, & Berkhout, 2005), operationalization (Berkhout, Smith, & Stirling, 2004) or its explanatory style (Genus & Coles, 2008), it is still thought to be a well fit for the aim of this study.

4.2. Rational Choice Theory

Why did you buy a specific brand and model of your vehicle? How did you decide to buy it? Have you ever considered you could have bought something else instead of your current vehicle? Perhaps you chose to buy an expensive vehicle due to several reasons. You could have perhaps saved 150000 SEK if you have chosen a model lower and save some money in the long term. Does that mean that your vehicle is worth 150000 SEK more? What is the value of your vehicle to you? How could you assess the value? It is hard for people to decide what options or a product to choose over another one as there are many options to consider. Besides options, various factors impact consumers' behavior when they want to choose or purchase a product. The rational choice theory (RCT) is a valuable theory that aims to provide an answer to people's decision-making process. The RCT is defined to mean the process of determining what options are available and choosing the most preferred one according to a coherent criterion (Levin & Milgrom, 2004). The theory has been discussed and developed over the years by several researchers (Smith, 1991; SMELSER, 1992; Posner, 1998). The theory is used in various fields from economics to psychology, anthropology to political science. In economics, for instance, the RCT became an unchallenged theory where it is commonly referred to as an "economic approach" (Chai, 2001). One of the main strengths of the RCT is that its traditional assumptions of actors are cautious and applicable for a broad range of environments, generating hypotheses about action in these environments. Additionally, the attractiveness of rational choice theory is found to be as no further questions are needed once the rational choice is complete (Boudon, 1998).

The rational choice theory defends that all actors have a logically consistent belief in the results of their actions (Chai, 2001). Several scholars in consumer EV adoption research have considered EV adoption behavior as rational behavior and measured consuming attitudes to EVs in different dimensions to predict consumer buying intentions for EVs (Carley, Krause, Lane, & Graham, 2013; Jensen, Cherchi, & Mabit, 2013; Lieven, Mühlmeier, Henkel, & Waller, 2011; Zhang, Yu, & Zou, 2011). The theory of rational choice usually begins with a view to the choice of one or several different decision-making units which are usually consumers. Anable, Skippon, Schuitema, and Kinnear (2016) state that RCT is the primary theoretical paradigm used in economics to understand the behavior of individuals. The adoption of electric vehicles is generally viewed as more rational and takes more time to consider since it is an infrequent act of considerable financial expenditure (Anable et al., 2016). The RCT is a suitable theory

to analyze and understand consumer behaviors on electric vehicle adoption. The basic premise of rational choice theory is that people do their best given the circumstances. This makes consumers analyze and consider some topics before adopting electric vehicles which are seen as premium today due to their price range. Furthermore, EVs are generally regarded as environmentally friendly innovations and from this point, EV adoption can be considered as pro-environmental behavior. This is underlined by Bamberg and Möser (2007) stating that pro-environmental behaviors are motivated by a combination of self-interest (as theorized by the Rational Choice Theory) and consideration of other people and the environment.

The process of determining what options are better and then choosing the preferred one over another lies at the heart of RCT (Levin & Milgrom, 2004). Rational choice is described as following "*an agent should choose the course of action that leads to what she thinks is the best consequence"* (Paternotte, 2011, p.2). Rational evaluation is quite important especially in the case of buying an electric vehicle since they are more expensive than traditional vehicles and carry an environmentally friendly logo on them. According to Dagsvik, Wennemo, Wetterwald, and Aaberge (2002), consumers make a rational evaluation and consideration of vehicle brands, their attributes to maximize the benefit of the product. Also, consumers' willingness to adopt can be affected by various elements. For example, Sato (2013) states that utility, constraints, and beliefs are highly critical elements in implementing RCT into consumer behaviors.

Electric vehicles are considered to be a promising alternative to fossil fuel vehicles but they have failed to compete with ICEVs even though their adaptation increase (Steinhilber et al., 2013). Today there are many factors to consider before the adaptation of an electric car. Vassileva and Campillo (2017) highlight different criteria such as environmental concern, cost, new technology & excitement, and financial incentives by the governmental authorities that have an impact on people's willingness to adopt electric vehicles. Understanding the factors to electric vehicle adaption is an important step to create, adjust and implement local, national, and EU level policies, marketing strategies, infrastructure, or any other relevant requirements to fight against climate change and reach national and European climate targets. Different relevant factors for this study's intention to research are presented under the following sections of constraint, utility, and belief.

4.2.1. Constraint

Consumers often face challenges when they want to adopt a product due to several reasons such as financial situation. This is especially important when it comes to electric vehicle adoption as they are

more expensive than internal combustion engine vehicles as mentioned previously. Flamm and Agrawal (2012) consider constraints that prevent people with environmental concerns from purchasing 'green' vehicles. The budget constraint is common in consumer choice (Steven L. Green, 2002). Consumers may make a rational decision to buy what they want, but it is based on their circumstances. According to Scott (2021), individuals act within specific constraints and based on the information they have about contexts in which they are acting. As often, it is not possible for consumers to achieve all the variety of things they desire, the impact of constraints on consumers carries significant importance. Rational consumers select the option that is most likely to provide the most satisfaction. The second step in the rational choice process according to Ogu (2013) is to identify the constraints that agents (consumers) face that comes after the first step which is identifying the relevant agents and making assumptions about their objectives. Therefore, constraints play an important role in consumer behavior in rational choice theory. This study considers charging infrastructure availability and purchase cost and driving range as part of constraints.

4.2.2. Utility

The theory of rational choice ensures that human behavior is based upon benefits and utility maximization (Rezvani et al., 2015). Actors select an alternative that they believe will result in a social outcome that maximizes their utility within subjectively defined constraints (Sato, 2013). They then prioritize potential social outcomes based on their utility. If an outcome of purchasing an EV over the outcome of purchasing an ICE is preferred, this means that EV's utility is greater than the ICEV. If they had complete information on the EV (e.g., enough to trigger willingness to adopt, not necessarily every technical information) and no blocker constraints on their choice, then they would choose the best outcome that offers the greatest utility, the EV. The utility is especially important in electric vehicles because the majority of consumers buy electric vehicles for daily use, which is referred to as the daily utility of electric vehicles (Rezvani et al., 2015). The use of vehicles has a daily impact on people's lives and, therefore, many need to maximize their utility by making the best choice in terms of vehicle adoption. Additionally, Rezvani et al. (2015) also underline that EV's technical features and perceptions of the utility of EV's are seen both as driving and hindering factors on electric vehicle adoption. If it is applied to electric vehicles, the most relevant one is the batteries and driving range that comes from the battery technicalities. But other EV factors such as noise, speed, performance are also important to consider. Therefore, this study underlines innovation, and technology, financial incentives are critical factors to be analyzed under utility.

4.2.3. Belief

Beliefs are affected by personal values and personal values play an important role in the rational consumer choice period. A person who cares about the environment deeply, for instance, is more likely to approach purchasing or choosing environmentally friendly transport options. This applies to a country where historically environment has been an important part of daily life, policies, etc. EV adoption behavior has been considered as environmentally friendly behavior in which adoption literature has primarily focused on values, beliefs, norms, and pro-environmental attitudes (Rezvani et al., 2015). Prior probability refers to when a fact is not known, an individual should have beliefs about it (Gilboa, Postlewaite, & Schmeidler, 2012). Besides, expected utility is considered when an individual faces a decision problem, the person should maximize expected utility with the respect to personal beliefs in line with all information the individual has. Kaidesoja (2012) perceives desires and beliefs as intentional mental events of individuals and describes the cause of action as a "*constellation of desires, beliefs, and opportunities in the light of which the action appears reasonable*" (Kaidesoja, 2012, p.7). In this study, therefore, environmental concern is chosen to be analyzed as part of belief.

There are, however, some critics that have been raised towards the RCT. In the rational choice theory, for example, 'rational' reflects an agent's most preferred feasible choice which according to Steven L. Green (2002), is a quite narrow definition. Furthermore, the RCT assumes that individual action is instrumental meaning it can be explained by the actors' will to reach certain goals but Boudon (1998) points out that action is not supposed to be always instrumental and which makes RCT non-applicable to all types of action. Even though the raised criticism towards the RCT, it is found to be a good match for this thesis' study.

5. Method and material

5.1. Collecting Data – Questionnaire

In this study, I combined quantitative and qualitative method approaches focusing on a questionnaire and in-depth semi-structured interviews for the data collection. At first, I conducted a questionnaire to get an overall perspective on the EV adoption factors that were found to be relevant in the theory and literature review. To administer the questionnaire and obtain data, I followed the five stages proposed by Shin and Shin (2011): 1) finding possible factors; 2) administering the factors; 3) exploring the reliability of the administered factors; 4) conducting a pilot questionnaire and; 5) conducting the main questionnaire. Before it was administrated, the questionnaire was tested by 10 participants selected from different gender, ages, and professional varieties. The questionnaire had both open-ended and close-ended questions. Then the questionnaire was administrated online in April 2021 by using an online survey development cloud-based software and the language was English. The first attempt to reach out to an e-mail list for participants was through Swedish Energy Agency and Swedish Transport Agency; however, it was not successful. The emails sent to Swedish Transport Agency did not receive any return. Also, Swedish Energy Agency declined to give an e-mail list but rather a person accepted to be a part of the interviews. Another option was to use Polestar's email list; however, I did not choose this option not to make the study biased and focused on one car company's consumers' perspective. Finally, the distribution of the questionnaire was made through the University of Gothenburg's European Studies Program, and the Department of Political Science, and several social media platforms including LinkedIn, Instagram, and various Facebook groups. For every channel that the questionnaire was distributed, an informational text was written to inform the potential recipient (see Appendix 3). There was no age limitation except being 18+ older. The reason for that was to represent all age groups in the study as EVs are seen as the future transport model as well as today's increasing trend.

5.1.1. Questionnaire

The introduction of the questionnaire explained what the questionnaire is about and specifically highlighted that the questionnaire targets people who live in Sweden and do not own an electric car. Participants were not paid, and the completion of the questionnaire was voluntary based and anonymous. Due to the use of different channels for the distribution, it was not possible to track how many people the questionnaire received by. The main purpose was to reach and receive as many completions as possible since there was no e-mail list received from the Agencies. In the end, the questionnaire was

responded by 119 people and the completion rate was 96% among the 119 respondents. The responses were carefully analyzed after the closure of the questionnaire and non-logical responses were eliminated which are also mentioned in the results section.The questions were asked in line with the purpose of the research and allowed me to understand consumer behavior, and how found key factors were perceived by the non-EV owners. In the end, this presented an overall view of how people in Sweden perceive electric vehicles and some of the key factors. The results of the questionnaire were used in semi-structured interviews to get in-depth knowledge on the topic. Although the questionnaire is a very useful preliminary tool and suitable for a special type of response, the reliability and validity of questionnaires are low and it lacks personal contact (Akash Choudhury, 2015). On the opposite, there is always a possibility to rephrase questions for further clarification in an interview. Questionnaires are very suitable to be used as a preliminary tool for conducting a depth study by another method. Therefore, this study relied on both in-depth interviews and the questionnaire that complete each other.

5.2. Collecting Data and Material - Semi-Structured Interviews

First, I did a research overview through different channels and documents, where I overviewed and identified relevant experts, such as I2 and I3 at a car company, Polestar (see Appendix 2). It was also proper and relatively easy to get in touch with these experts since I was an intern at the company. Accordingly, I contacted the interviewees to ask for a short meeting and then I explained briefly the thesis, the aim and asked for interviews. Besides, the last expert, I1, the interviewee was found after the phone communication with the Swedish Energy Agency for an e-mail list to send the questionnaire. However, it was not accepted by the Agency, rather, a person could do an interview. There was a phone communication with the Gothenburg Transport Office as well, but the result was negative in the end. Non-expert interviews, however, were chosen among people that I knew. There was no discussion prior to interviews about electric vehicles with the interviewees, therefore no influence, and I carefully selected the people I wanted to interview based on different features such as age, gender, education, and profession to enrich the study. Gender equality was considered, four females and four males were a part of the interviews in the end. Eight non-experts' people were contacted in the beginning, and all accepted to do an interview, however, three of them could not make it due to several reasons. Due to limitations from both sides, rescheduling could not happen. In the end, I decided to carry on with five non-experts and three expert interviews in this study. Then the interviews were held in English, both digitally and face to face, and all lasted between 30 - 90 minutes and the interview guide was followed (See Appendix 1). Covid19 restrictions and guidelines were also taken into consideration.

After the collection of the interview data, each interview was transcribed and then thematically coded. I presented quotes from interviewees under different themes discussed below. The interviewees coded as I1, I2, etc. which detailed version can be found in Appendix 2 as well as the interview guide in Appendix 1.

5.2.1. Semi-structured Interviews

After collecting the questionnaire results, to explore the socio-technical factors surrounding electric vehicle mobility more comprehensively, I relied on data and material collected through semi-structured interviews. Semi-structured interviews are flexible interviews and do not follow a strict formalized question method which allows the interviewer to ask open-ended questions. Besides, due to the complexity of the research topic, the semi-structured interview method is thought to be in line with the research question, the theories, and the aim of the study. Also, semi-structured interviews allow the researchers to explore subjective viewpoints and to gather in-depth knowledge of people's experiences on a specific topic (SAGE, 2018).

Collecting data that are completed by interviews is one of the main instruments for collecting social data (Alan Bryman, 2012). I formulated a semi-structured interview method based on the theoretical approach of MLP and RCT. According to Yin (2003), the semi-structured form of interviewing is suitable when the objective of the research is to understand complex elements and their intersection with perceptions, beliefs, and values. Following this, the rational choice theory was implemented into the interview results and analyzed. Besides, the analysis was evaluated from the transitions and MLP perspective, and then the integrative approach of MLP and RCT was presented.

Expert interviews results are used as materials to complement the non-expert interviews to give a broader and critical understanding of the topic. It was important to include expert interviews due to the topics need for expert views. However, the expert interviews are separated from the non-expert interviews and are placed under the same categories in the results section since the topic & factor discussed were the same although the difference of opinions exists. Therefore, a comparison was made to understand the differences and similarities between the non-expert and expert interviews. Furthermore, in the analysis section, first, the non-experts' results were analyzed with the complementation of expert interviews. Then a comparison was finally made to get a broad understanding of the issue from a different perspective.

5.3. Ethical Considerations

In terms of ethical considerations, confidentiality and informed consent were well defined prior to interviews. Reliability and validity are described as trustworthiness, rigor, and quality in qualitative exemplar by Nahid Golafshani (2003), which being open and transparent helps to improve reliability and validity and resolve preconceptions. Considering that, each interviewee was asked to be recorded by stating that the participants' answers will be anonymous, and their names will not be shared in the thesis study. This gave a broad room for participants to talk and express their thoughts freely, without concerns. The interviewees were also provided with information on the thesis, the author's university and study, research aim. It was also clearly mentioned that the participants were not required to answer any questions if they do not want to answer so. By doing so, consent and information requirements were provided to the participants.

According to KELLEY, CLARK, BROWN, and SITZIA (2003), two important ethical issues to consider when conducting an online questionnaire are confidentiality and informed consent. The introduction was written in the distribution of the questionnaire as well as at the beginning of the questionnaire as stated above. The text was to make sure that everything about the questionnaire and the process is transparent explaining the thesis study, the aim, the author's university, and the program and also, clearly stated that participants participate anonymously in which their answers and selections will be a part of the thesis study anonymously.

Reliability is defined as the consistency of measurement or stability of measurement in a variety of conditions in which essentially the same results should be achieved in the study (Drost, 2011). In this study, reliability was increased since both interview and questionnaire questions were prepared considering the theories and previous literature. Besides, each interview was recorded and transcribed carefully. Also, each open-ended question of the questionnaire was carefully analyzed and answers that did not make sense were not considered. Also, both the questionnaire and interviews were in the English language meaning there were no translations needed. In conclusion, the reliability of this study considered increased due to the mentioned factors.

When researchers measure behaviors, they are concerned about whether they are measuring what they set out to measure. The meaningfulness of study components is concerned with validity. Validity refers to whether a measure of concept truly measures that concept (Alan Bryman, 2012). The validity of this research was addressed by ensuring that analyzed data, both from the interviews and the questionnaire, literature review, and theories were aligned with the research questions and the aim of the thesis study.

Finally, the credibility of this study was reflected from the 'triangulation' technique described as '*using more than one method or source of data in the study' (Alan Bryman, 2012, p.392).*

6. Results

This section presents the results. First, I present some of the questionnaire results and then interpret each figure. As mentioned, questionnaire results were thought to provide a general overview to the study. Therefore, only the most relevant questions of the questionnaire are presented. The rest is attached in the appendix. The open-ended questions were coded and combined under relevant themes in the questionnaire. Furthermore, interviews were conducted to provide a depth knowledge of the topic. The results were also coded and after coding the various responses and adding new codes whenever a new topic was discussed, the results combined into more general themes. Environment, driving range, financial incentives and cost, charging, and consumer knowledge were among the themes addressed. For example, a code related to purchasing cost of EV or financial support of the government gathered under financial incentives and cost theme and this was applied to the rest of the themes as well.

6.1. Questionnaire Results

Q1: What is the first word that comes to mind when you think of electric cars?

Figure 5 indicates that almost 39% of participants correlate electric cars with the environment. This is followed by innovation and technology and Tesla by 20% and 15% respectively. Other least relevant word associations were charging, saving money, and future each represented by 5%. The other was also created to categorize word associations that did not fall under any categories, e.g., cool, good. In general, it is important to highlight that seeing the results of this question is significant since the first thought is key that gives an idea of what people correlate electric cars with.

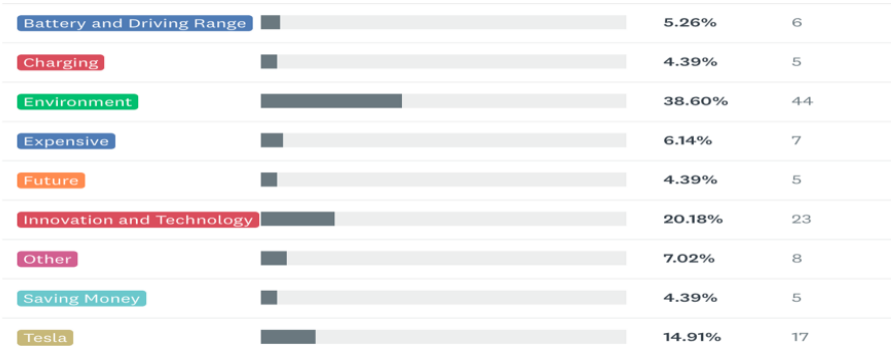

Figure 5 Correlation of EVs with words

Q2: Can you tell me why would you adopt an electric car?

Figure 6 portrays that environment is the biggest reason why participants would consider adopting an EV. It is an expected result which was also underlined in other questions. It is followed by financial benefits and technology & design. Financial benefits, especially, are quite interesting because the price was highlighted as the leading answer for the reason for not adopting an EV in Q3 shown in ***Figure 7***. However, the environment is the leading answer here out and away for the main reason for adopting an EV. Short-range drive, however, was the least important reason for the participants to adopt an electric car. Lastly, 2 out of 3 responses under other is eliminated due to non-logical responses. The last response was "I would but a hybrid, not an EV".

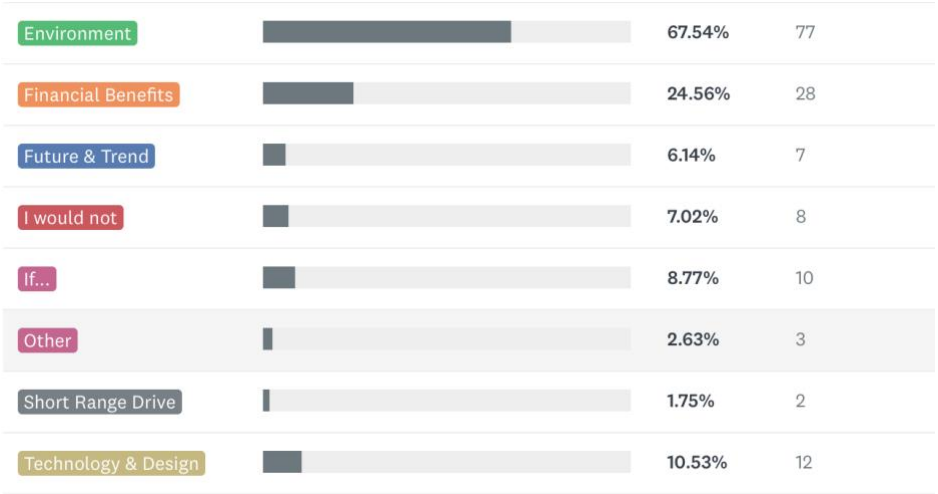

Figure 6 Why would participants adopt EV?

Q3: Can you tell me why would not you adopt an electric car?

The biggest concern of the participants towards EV adoption is mainly due to the price tag of electric vehicles which represents 47% of total responses as shown in **Figure 7.** The purchase cost of EVs is often mentioned and touched upon previously in this study. From this perspective, it should not come as a surprise as it was selected almost by half of the respondents. Lack of infrastructure and environmental concern around electric vehicles were other following concerns of the participants. Especially environmental concern should be remarked separately here as it is seen both positive and negative factor on EV adoption as it was also stated in Q4 shown in ***Table 1***. Although charging and infrastructure interact, the reason charging was coded separately from lack of infrastructure is due to the several responses of 'long charging and waiting time'. The least concern was reflected as 'not fun to drive'.

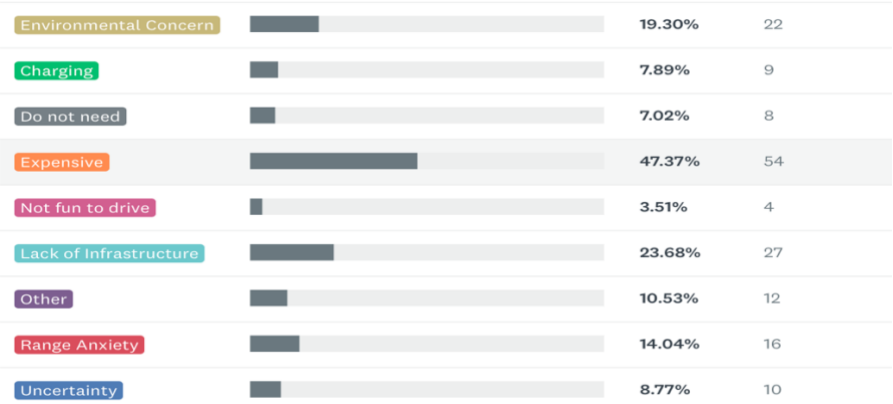

Figure 7 Negative Factors towards EV Adoption

Q4: How positive or negative is the impact of electric cars on the environment?

Table 1 depicts that most of the participants correlate EVs' impacts on the environment as positive or very positive. However, 26% of participants did not have an opinion on how EVs impact the environment which was selected as neither positive nor negative. The rest of the participants expressed their opinions as negative and very negative for the EVs' impact on the environment. This is an interesting result to see as 1 out of 4 people have no clear idea whether electric vehicles are environmentally friendly or not. But also, it is still clear that the majority consider EVs' impact on the environment as positive.

ANSWER CHOICES	RESPONSES	
Very positive (1)	17.54%	20
Positive (2)	47.37%	54
Neither positive nor negative (3)	26.32%	30
Negative (4)	7.02%	8
Very negative (5)	1.75%	2
TOTAL		114

BASIC STATISTICS				
Minimum	Maximum	Median	Mean	Standard Deviation
1.00	5.00	2.00	2.28	0.89

Table 1 EVs vs Environment

Q5: Finally, can you rank the following five topics based on their importance to you when thinking about electric cars?

The average of responses was highest in the charging stations infrastructure availability and lowest in innovation and technology which is shown in **Table 2.** The biggest factor to the participants was charging station availability where nearly 93% mentioned it as very important and important. This represents the highest mean value of 4.54 over 5. The environment was perceived as the second most important factor with a 4.27 mean value by the participants. The lowest mean value to the participants, however, was innovation and technology by 3.61/5. In general, the table reflects that all topics were received more than 50% of the total responses either as important or very important, and the lowest median value recorded as 4.00. An interesting observation is that when all the factors are given, respondents tend to choose charging stations availability and driving range over environmental concern based on their importance to them. The environment is, however, the leading answer in Q3 where participants mention the environment as the biggest reason for their EV adoption.

	NOT IMPORTANT AT ALL (1)	NOT IMPORTANT (2)	SOMEHOW IMPORTANT (3)	IMPORTANT (4)	VERY IMPORTANT (5)	TOTAL	WEIGHTED AVERAGE
Financial incentives	2.65% 3	5.31% 6	20.35% 23	40.71% 46	30.97% 35	113	3.92
Charging Stations Infrastructure Availability	1.75% 2	1.75% 2	3.51% 4	27.19% 31	65.79% 75	114	4.54
Environmental Concern	0.88% 1	4.39% 5	14.91% 17	26.32% 30	53.51% 61	114	4.27
Innovation and Technology	8.04% 9	9.82% 11	21.43% 24	34.82% 39	25.89% 29	112	3.61
Driving Range	0.88% 1	1.75% 2	9.65% 11	33.33% 38	54.39% 62	114	4.39

BASIC STATISTICS	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION
Financial incentives	1.00	5.00	4.00	3.92	0.98
Charging Stations Infrastructure Availability	1.00	5.00	5.00	4.54	0.80
Environmental Concern	1.00	5.00	5.00	4.27	0.93
Innovation and Technology	1.00	5.00	4.00	3.61	1.20
Driving Range	1.00	5.00	5.00	4.39	0.80

Table 2 EV Relevant Adoption Factors

6.2. Semi-structured Interview Results

6.2.1. Environmental Concern

6.2.1.1. Non-expert Interview results

The environment in terms of climate change, batteries, recycling, raw materials were highly stressed by the interviewees as all highlighted. When thinking about Sweden's sustainability ranking as 1st (Robeco, 2020) and environmental ranking as 8th in the world (Environmental Performance Index, 2020), this does not come as a surprise.

Realization of individual contribution and acting is a part of the climate action, without awareness, however, it is hard to expect huge changes within the society and the country. Usually, realization comes with actions but some factors and/or barriers might delay the action as it was underlined by **I5** focusing on the environment and his future electric car:

"Environment is important to me, and the current situation is worrying. Especially in the last couple of years, I tried to change my behaviors, reduce waste, and minimize my impact on the environment. This (EV purchase) is not my initial plan, but my car will be environmentally friendly one day in the future. I am not sure if electric cars are environmentally friendly right now, due to many issues of batteries, recycling, plastics they use? But I think they might be better than petrol cars in the future."

When the discussion took part whether EVs are climate-friendly vehicles or not, **I6** responded:

"I believe electric vehicles are the way to go for future transportation, but the extraction of the metals used for the batteries of these vehicles are of concern from an environmental perspective."

Moreover, participants seemed eager on EV adoption even though they express their concerns around EV batteries. For example, the negative impact of EV batteries was mentioned again by **I8**:

"Yes, I believe EVs will be used a lot in the future even if it is concerning that the battery production for e-cars has a similar carbon footprint."

The same topic was highlighted by **I8** around the exploitation of the raw materials and underlined the importance of using western labor laws so that there will be a right (environment, labor, human) guarantee for people:

"Another reason for my hesitation about EVs is the exploitation of the raw materials in the developing nations and its people for the components in the battery. Since going electric is inevitable, my hope is

that we can mine the raw materials in developed nations with western labor laws so no exploitation occurs since the electric car will mostly be bought in the west anyway."

I7 also added on this by mentioning the environment and rather unfriendliness of EVs:

"If they are affordable and more environmentally than 'traditional vehicles', I think they could be the future. I believe there is an issue with production and disposal of batteries which makes them rather unfriendly."

However, the environmental impact of EVs was not the first concern of some interviewees as **I5** stressed:

"I believe either an electric car or any other form of cars that do not harm the environment will most likely be the future, at least in developed nations like Sweden. But I do not trust electric vehicles yet, and I do not think that they are environment-friendly currently. And if I can be honest, the environment is not the first thing I think of if I want a car. Maybe in the future, yes. But not now."

When asked why **I5** answered:

"I feel bad to say this, but I do not think my car purchase is going to solve everything in terms of the environment. There are some countries and huge companies that emit tons of thousands of CO2. In a way, they should be targeted first. But I would like to experience traditional cars before they are all gone. I like to hear the engine sound."

I4, however, brings a new perspective to the topic by talking about public transport how relevant transport is in terms of the relationship between the environment and future transport mobility:

"I also think that public transport is becoming more popular day by day and it is slowly spreading out to even small cities, rural areas which had no public transportation before. If more people use public transport and all the transport options are electric or sustainable somehow in general, which what they are trying to achieve in Gothenburg, this can be great for the environment."

Another point of EV usage period and batteries is discussed by some interviewees. The environmental impact of batteries seems unknown and unclear to some participants. Here how it was perceived by **I8**:

"Use of EVs should also be long... Many people I know like to change cars every 3-4 years. This is not sustainable. And what is going to happen to the batteries? I hope they are being recycled already. I do not know. There are too many loose ends, or I did not read enough. If they cannot recycle the batteries, it is not worth buying an EV to help the environment. I need to know."

6.2.1.2. Expert Interview Results

Although negative aspects of EVs in terms of environment was stressed by the experts, in general, the environment was mentioned as an action need by the experts, and electric vehicles were associated with it as **I1** mentioned:

"*I do not know why people do not take it (environment) seriously. I know that not every part of the world is the same as Sweden, but perhaps we can do something and lead the way to the others. This is why the electrification of cars is very important. We need to start thinking about the environment seriously.*"

Likewise, **I2** also focused on this in the very early part of the interview connecting it to the automotive industry's stance:

"As you probably know, electric vehicles were invented many years ago. The reason they are coming back as a rescuer is because of the climate change. We know that EVs are not perfect right now, but they have a great potential to be. We, as a company, promote transparency and invite others (car companies) to do the same. They are advertising as EVs are completely environment friendly, but they are not. According to our surveys, the environment is the strongest reason people purchase our cars. But if they learn later that EVs are not as described as they thought, they might be disappointed, and it might backfire which is very dangerous."

I3 added value to the discussion of the environment by giving an example of customer surveys:

"The environment comes first when I think about factors. We send a survey to our customers after their cars are delivered to understand the reasons for their purchase and whether the whole period went smooth or not. Also, we regularly conduct and collect surveys about different topics. The response rate is usually quite high and one of the most important topics for consumers to buy an EV is the environment."

The same topic was also discussed by **I2** from the car company's perspective:

"As I said before, we would like to be 100% transparent of our supply chain and that is why we use blockchain to increase transparency. With blockchain technology, all sources of materials are traceable within the OECD's supply chain guidelines. We are committed to reaching climate neutrality in our cars in 9 years by 2030 and therefore I can say that yes, EVs are the future travel vehicles at least for the near term. There will be other types of vehicles such as hydrogen-fueled but for the near future, I see EVs as our biggest focus."

I1, however, focused on environment topic from the Swedish Energy Agency and talked over a consultant paper that the Agency ordered:

"Three or four years ago, we ordered a consultant study. They looked at batteries and how much emission they have and where the production & emission come from. According to the results, all EV brands knew the problem, and this was an important result of the study. You could see that it is not only the factory where they (EVs) are produced but also materials. Magnesium, copper, lithium, and so on."

I1 expressed his opinions about the production phase and use phase of EVs:

"It is very complicated. You have the problems, but not so much from the vehicles, but you have emissions still where it is produced. And what is the battery life? Is battery recycling 100% sustainable? It is complicated to compare. It might be a problem to push people to buy EVs. I think we need to ask these questions first."

6.2.1.3. Summary & Comparison

Noteworthy, the environment was a hot topic for almost every interviewee except I5. Many explained their views on the unclearness around EVs and their impacts on the environment. However, even though all existed uncertainty among EVs, batteries, materials, recycling, and environment relation as shown in **Figure 8**, it can still be seen that EV adoption is seen as a positive move towards contributing to fights against climate change. Besides providing an expert view on the topic, the main difference between expert and non-expert interviews on the environment is non-expert participants mostly highlighted uncertainty around the EVs and highlighted that EVs are not trustable yet from an environmental point of view.

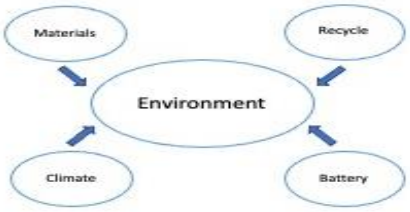

Figure 8 Environmental Concern

6.2.2. Range Anxiety

6.2.2.1 Non-Expert Interview Results

The range was a highly discussed factor of EV adoption among the interviewees. Winter, time, long trips and distance were among the discussed topics under the range theme. All interviewees expressed their concerns and thoughts around the range of vehicles. This can be a fact that Sweden is a large country, in fact, the largest country in Northern Europe and third largest in Europe (Sweden, 2015), which makes people worry about traveling even inside of the country. As it was emphasized by **I5**, range, uncertainty and time seemed an issue:

"Range of EVs is a problem for me to be honest. I cannot wait for an hour to charge my car every 300-400 km. It is time-consuming right now. And you do not even know if there will be fast chargers wherever you go. I am sure it will change in the future, but uncertainty gives me anxiety in a way. I do not even think the same with petrol, diesel cars for instance. If we come to this point that I do not even think about the range of the car, then yes, I might buy it then."

As EVs are not the first technology people have, it is very natural to compare EVs with other types of vehicles people know, own, and use. As **I6** compared EVs with other types of vehicles:

"For example, I have a diesel car right not and I am currently not planning to buy an electric car. I know that the range is still fairly low compared to diesel or petrol cars, but I expect this to change soon."

However, Sweden's surface area seems like a huge factor for some as **I4** mentioned:

"If we want to go skiing up, North, for example, we would not take the electric car for transport. There are other options, you can borrow a car from a friend, or you can rent a car perhaps. But it would be very hard to go up North with an electric car."

Traveling long distances was also mentioned by **I7** both focusing on charging and range:

"We go to Åre almost every year with a car, and it is a very long drive. In the last years, I started to see people are queuing to charge their electric cars on the way and it is a very long queue. It is a long drive, yes, but I do not want to spend my time on charge or waiting to charge my car. Even though it is bad for the environment, it is a lot easier and to fuel our car and we are on the road again in max 5 minutes."

*However, talking about range, **I4** and **I8** brought a new perspective that does not apply to the general population. **I4** stated:*

"When we had test drives for some EVs, we talked about the range because we often drive to work on our beehive (with I8). It is about 6 hours away from Gothenburg. It is kind of okay. We are retired people, so we do not need to rush for something. It does not matter for us to stop one or two times to charge."

I8 agreed with **I4** but also emphasized the need for a long-range:

"Yes, I agree for us, it is not an issue. But I think for many people this is annoying and losing time. Technology needs to support a long-range."

Next, it was common to mention different conditions and the range. For example, **I6** noted that range is usually a lot lower than what companies state:

"We do not have very cold winters in Stockholm, Malmö, and Gothenburg as Northern parts of Sweden have. But still, even in few days under minus in these big cities, the supposed range of an EV goes down from, let's say, 500km to 300km. This also depends on if you use different features of the car obviously but still a huge factor to consider."

I5 also mentioned a possible cold weather and range relationship:

"What will happen when it is too cold? Is the range the same as in normal weather conditions? I do not think so."

6.2.2.2 Expert Interview Results

However, not everyone mentioned the range as a huge problem of today. It was viewed by **I1** as yesterday's problem and highlighted suggestions:

"I think the range is about you would like to go somewhere and you want to achieve there without the fear. The range has been a problem but not much today. But it is still for very long trips. You probably drive 10 times a long drive in a year so you can rent another car for instance. I do not think it is a huge issue today."

From a car company perspective, **I3** stated that most of the people who bought the cars were people who live in urban areas and range is more than enough for many people:

"We know that range anxiety is very real for many. People are concerned about the range of EVs. Mainly, people living in urban areas are more prone to buy an EV. They usually only drive to work and from work to home which the range is more than enough. Today's EV range is more than enough for

many people to be able to handle their daily commuting. I believe knowledge awareness around the range is needed and this is what we are trying to do."

Another perspective was mentioned by **I2** from the sustainability perspective as:

"We, as a company, are aware that range is a huge topic for many. But we cannot produce a much bigger battery right now to increase range due to many factors such as sustainability, supply chain and production and the model of the vehicle, etc. There are too many factors to consider. This is the best, only for now. It will improve soon."

6.2.2.3. Summary & Comparison

The range was perceived as an important factor by most of the interviewees. Possible winter conditions and battery, charging time, long trips, and distance were the most stated sub-topics under the range theme as **Figure 9** shows below. On the other hand, expert views on the range were not the same as non-expert interviewees as they saw the range as an issue of the past, but not now. Besides, when the discussion was around daily driving, most of the interviewees mentioned that their daily driving is less than 40km. However, the importance of constant improvement of the range was clearly stated by highlighting that it will be better in the future.

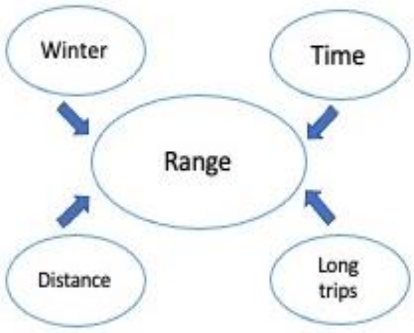

Figure 9 Range Anxiety

6.2.3. Charging Infrastructure

6.2.3.1. Non-expert Interview Results

Lack of charging infrastructure, lack of visibility, charging time, and lack of universal charging was the most discussed topics among the interviewees under this theme. It is seen as a barrier for everyone from different perspectives. The discussed topics under the range related to long-distance distance traveling in Sweden were also connected to the charging of EVs. Moreover, the lack of charging infrastructure received quite high attention from the interviewees. The general view on charging infrastructure is that it is not commonly available. This seemed especially more of a barrier for those who live in the apartment building as **I8** stated:

"We are seriously thinking to buy an electric car. We even had test drives of different models. But the problem is we do not have a charging point in the neighborhood. There is a place where you can rent to charge your car, but it does not make sense to pay for the place plus for charging."

I4 interrupted here and added:

"We are buying the car both for the environment and to save money. We will get a discount if we buy a Volkswagen and in the long term, we thought it will be cheaper. But if we pay more just to charge the car and if the charging will be a problem all the time, I do not have that energy right now."

Despite many viewed the charging infrastructure as their absence, **I7**, however, brought up a lack of visibility of charging vehicles around the city. While a simple solution might be building more charging vehicles, awareness of charging infrastructure is another topic that should be addressed:

"I'm not sure if I can describe this but let me try. When I see a petrol station, I am aware that it is a petrol station. But this is not the same for EV charging stations. I rarely realize their existence around my neighborhood or in the city. Now when you ask, I am thinking where would I go if I need one? I do not know. But I know for sure a petrol station even though I do not go to that petrol station with a car. It is strange but I think it needs visibility so that they could get inside of our mind."

Charging time, however, was mentioned by many of the interviewees. **I6**, for instance, characterized charging time as the most important fact:

"Time is very important. You do not want to waste it. Not sure exactly how long it takes to charge an EV but if I remember correctly, it is about 13, 14 hours with slow charging. And I think the fastest one is around 40-45 minutes. I mean who has this time frame to wait just to be able to use a car?"

This topic was also mentioned by **I5** by stating the importance of time management:

"I think the technology of charging should be improved as people do not have enough time in their daily lives. I would not want to wait for an hour to charge my car. I know some car brands like Tesla improved their technology inside the car so that you can watch videos, movies but still why should I spend my time like this? Charging time should be same or at least close to petrol cars".

6.2.3.2. Expert Interview Results

Another important point was the lack of universal charging infrastructure as only mentioned by experts. For instance, **I2** stated:

"This is a problem we need to challenge soon. For instance, you cannot use Tesla's charging infrastructure for your Polestar. We have different partnerships, cooperation with various companies, agencies, etc. But Tesla is different, and their charging infrastructure is very developed in Europe. This is a concern for many of our consumers. There should be one type of infrastructure that each EV brand's model can use. This is very important in the early stage of EVs but unfortunately, does not reflect the reality."

I3 continued the topic further by mentioning the customer surveys:

"As you might know, there are different charging types you can use such as AC, DC and then they are divided into other types such as Type 1, Type 2 and so on. This, obviously, confuses people. Our customer support center receives daily questions about the charging of their vehicles. There should be regulations around this."

I1, however, was more positive about the charging infrastructure even though stating that more needs to be built:

"In the last couple of years, the infrastructure has grown immensely. I do not think it is a problem today, for heavy vehicles and so on, maybe. But not for personal vehicles"

When asked about the source of charging stations, and apartment charging structure, **I1** was rather sparing:

"Imm… I am not sure about the apartments. It could be a problem, yes. In cities, however, it is still okay today but not outside of cities. Car-sharing can be a solution. Then you can have a charging station in another person's location. Also in Sweden, we are quite good at charging, it almost 100% sustainable. I think this is a problem in other countries in Europe".

I2, on the other hand, focused on the mental part of charging infrastructure issue:

"I see the battery charging as connected with range anxiety. Range anxiety is very real even though I think it should not be. People do not drive as they think they will do. This is a mental issue rather than a real one. But it does not matter, if it is there, we need to work on solutions."

I2 continued focusing on the source of the energy:

"But these solutions, they should be built around sustainability. The source of the electricity must be sustainable as well. In Sweden, however, we are pretty in good shape for this, but I can't say the same for many other countries"

6.2.3.3. Summary & Comparison

As a result, charging infrastructure is often perceived as a negative factor on the adoption, however, this might be a result of inexperienced ownership with EVs according to experts. Many interviewees stated their concerns while some were not completely on the same page as others. But in general, it was acknowledged that this is an existed issue that needs to be addressed. Experts, on the other hand, perceived this issue is not as problematic as non-expert respondents perceived. But they raised other important matters such as one fits all type of charging and regulations need around this in Europe. In conclusion, lack of charging points, charging time, absence of universal charging, and visibility were the most discussed topics undercharging as **Figure 10** shows.

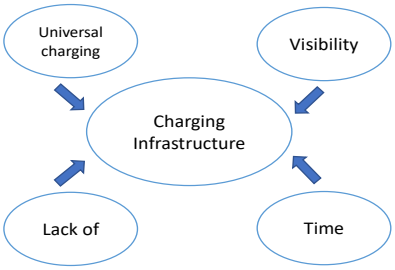

Figure 10 Charging Infrastructure

6.2.4. Financial Incentives & Cost

6.2.4.1. Non-expert Interview Results

As it was mentioned before, electric vehicles are seen as premium today due to their price range. This was discussed by most of the interviewees and is usually referred to as an important barrier. For instance, as **I4** and **I8** were already thinking to buy an EV, and they shared their experiences with test drives. The price of electric cars was a big factor as they highlighted several times. They stated that they tried a few different EVs already, but the price range was too high even with incentives as **I8** stated:

"We tried three different electric cars. Last week we tried Tesla. Insane car, so beautiful, but too expensive. We can't afford it, even with the incentives. We are considering Volkswagen iD3 because first, we get government incentives. Then we get a discount from a magazine we have been members of for years. When you combine these two, it can be affordable."

I4, however, was more critical towards the incentives:

"Yes, incentives definitely help but is it enough? Our neighbor, Norway has the highest electric car share in the world now. It is because the government is supporting and helping financially with huge incentives. Without enough support, it is hard to convince people. There are many lacking already. If they (Norway) can do it, why can't we?"

*Comparison of Sweden with Norway was also mentioned by **I5**:*

"As a student, there is no way that I can afford an electric car. I am a car enthusiast you know. I look at cars and prices all the time. EVs are way more expensive. I started to see more EVs on the road in Sweden which is good. But there is also Norway as an example. I read it on news. They managed to sell more than half of total cars as EVs. I think it was in December. I do not see any big reason except financial support. Cars are expensive, if you reduce their price, more people will buy. This is simple."

After a conversation around public transport and not needing a car, when asked "when would you consider if you ever", **I7** stated:

"If the price goes down. I looked at Tesla's price, just for curiosity. You need a fortune to be able to buy one. But it is a very good-looking car and environmentally friendly. I would like to have one day, not necessarily Tesla, but only if the price goes down significantly."

6.2.4.2. Expert Interview Results

Even though the topic was discussed by experts as well, the cost of an EV was not viewed as a barrier by **I3** stated due to the company's stance as a brand:

"We are a premium brand, so our target is a specific part of the society. Therefore, I cannot say that the purchase cost is an issue for our customers."

This was maintained by **I2** focusing on the importance of support & financial incentives from the government:

"By 2030 we expect to have half emissions on transport than we have today and one conditionality for this is the maintainability of the support from the government. You can get 70000 SEK back from the government when you purchase an EV, and this is an important driving force on EV adoption."

I1, however, emphasized the importance of cost as the biggest problem in Sweden:

"I think the cost is the biggest problem for people in Sweden today. The EV market is growing but it is open to discussion if it is enough? I have quite many friends who have EVs today. But the cost is a problem for many people even with incentives."

Another price tag discussion and comparison of Sweden not only with Norway but other European countries highlighted by **I1:**

"It is costly to purchase electric cars, but not in Norway for instance. We have also a high incentive in Sweden. In Norway, it is higher, but it is quite good in Sweden when you compare it with other European countries. Also, if you compare with other European countries, Sweden is second or third in sales and I think it is because of incentives".

6.2.4.3. Summary & Comparison

In the end, price, support from the government, cost, Norway comparison was most discussed topics under financial incentives and cost theme as **Figure 11** shows below. Incentives by the Swedish authorities were viewed as good but not enough. This is perhaps also a fact that Sweden's neighbor, Norway, is leading the way on EV adoption. It is reasonable for participants to look at the closest example and compare the country they live in. Interestingly, this section was not a heated discussion as environment, for instance. Most of the non-expert interviewees' stance was clear on incentives: a must need and currently but not enough as well especially compared with the neighboring country, Norway.

On the other hand, expert views on this are EV incentives drive the sales up and the government support on this is good when comparing other countries in Europe rather than Norway.

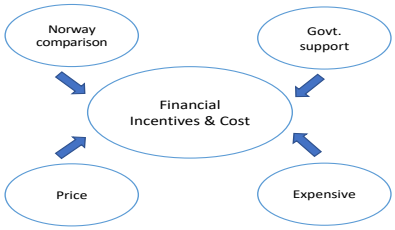

Figure 11 Financial Incentives and Cost

6.2.5. Consumer Knowledge

6.2.5.1. Non-expert Interview Results

As electric cars have started to become popular more recently, many people might not have enough knowledge about vehicles, batteries, charging, or any other relevant feature. In this theme, consumer knowledge was emphasized by 6 out of 8 interviewees and centered around the lack of knowledge, awareness, and experience, and visibility. Even though the below quote was part of the discussion under the charging infrastructure theme, it is still very relevant what **I7** mentioned when talking about charging infrastructure and their lack of visibility:

"*It is strange, but I think it (charging infrastructure) needs visibility so that they could get inside our mind."*

When discussing the government policies and why EVs are not so popular yet, **I4** stated:

"The biggest issue we have is a mental barrier in Sweden"

I8 continued:

"I agree. Back in the days, when I was teaching, the first thing I would do is to make children like the topic. Once they are engaged, it is easy. The government needs to promote somehow. Incentives and so on, yes, good but not enough. Educating people is always the key"

Moreover**, I6** focused on the environmental aspect and lack of knowledge around the impacts of EVs:

"They (car companies) promote the EVs as they are perfect for the environment. Once you dig deep, you see that they are not, and many people do not even know about all these impacts."

I6 continued:

"There is a need for better understanding around electric vehicles, not their technicalities, but simple features like how (quick) charging functions, where to find charging points, the environmental impact of the car, how does the range work – it is not same in each condition, but people tend to consider the first range knowledge they see/get from a car company -, how much the total car of ownership will be and how much an individual can save up in the long term, etc. These things need a little push."

Moreover, **I4** shared opinions on other countries and the problems in those countries due to the supply chain of batteries. The discussion around the poor conditions in some countries, transparency need, environment, and EVs:

"I feel like all the discussion today is around the climate change and environment, that is why we need to buy electric cars. But then we rarely read in the newspaper about the child laborers in Congo, low salaries, poor health conditions of those people. The environment is for sure one of the biggest reasons for us, perhaps the biggest, to buy an electric car. But the other part is worrying. When we talk with our neighbors and friends, they do not know these issues. They are surprised. More transparency and education, that is how it should be. I do not know how exactly, but it should be"

I8 continued and agreed on I4 by stating:

"Absolutely, I agree. We should not break something in other countries while trying to fix it in West"

6.2.5.2. Expert Interview Results

I3, however, approached this topic from the customer's angle. Talking about the current customer portfolio of the company, **I3** stated:

"Based on our customer data, I can say that most of our customers are represented by +55 years old white males. This can be due to many factors. But as you see, something is missing here."

***I2** viewed the discussion from daily driving and lack of knowledge around EVs:*

"People drive more or less 50 km in a day today in Europe, not only in Sweden. Any electric car from 2010 onwards can provide daily life transportation needs. Yet, lack of knowledge around EVs creates terms as range anxiety. Many people do not even know that they can charge at home for instance. This is a mental barrier and an education problem."

I1, however, highlighted the issue from lack of research on consumer knowledge around EVs.

"The electric vehicles on the street are increasing. But there is a clear lack of knowledge around these vehicles, charging, etc. Lots of incorrect or lacking knowledge around them. I think what we need is educating people for EVs and we need more research".

6.2.5.3. Summary & Comparison

The discussion of consumer knowledge was around awareness, lack of knowledge, experience, visibility as shown in **Figure 12.** Both expert and non-expert interviewees highlighted the lack of consumer knowledge and underlined the need for education, awareness, and visibility around electric vehicles. The main difference between expert and non-expert results is that non-expert participants see this issue from consumers' perspectives which is why they were motivated to talk broadly and explain their thoughts. However, non-expert participants knew the problem and they briefly mentioned that this exists and is an issue. As the EV market and adoption are quite new in countries, early education might be the key for people to consider EV adoption seriously.

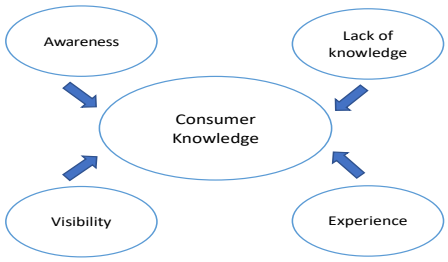

Figure 12 Consumer Knowledge

6.2.6. Other Factors

6.2.6.1. Non-expert Interview Results

There are some other factors such as electric overload, winter weather, reliability and dependency, batteries, time management was mentioned by interviewees which were not shared by the majority. Due to their importance, they will be shared under this section briefly.

Winter weather and battery reliability were highlighted by **I7**:

"I am worried about batteries in minus degrees we have in winter. Are they safe? Since we often hear battery explosions from batteries, this worries me a lot."

As most EVs seem premium today, people pay the premium price. Outside of the EV environment, when a car is expensive, it is usually acknowledged as a sport, noisy car. This was viewed by **I5** also touching upon EVs reliability:

"One thing I might miss compared to a fossil-fuel-powered car is the sound and feel driving off. The electric car is not that exciting to drive apart from good acceleration. I like to hear the sound of the engine and have a manual gearbox, also because I am not sure about their reliability."

Dependency, reliability, and uncertainty around EVs were also mentioned by **I6**:

"The technology is not fully there. It is over over-reliant on software and has forced obsolescence built into them. There is a dependency."

Even though battery concerns were a part of the discussion under the environment theme, another perspective was raised about batteries by **I7**:

"What is the battery life especially in cold countries like Sweden? How long will it last? How can it be replaced? Also, ethical aspects of where the materials in the battery come from? I am not sure whether the answers are already there. Maybe I need more research."

Lastly, time management and planning were also emphasized as a concern by **I5**:

"Needing to plan and incorporate charging on long travels. It is also more time-consuming than stopping to fill up with petrol."

6.2.6.2. Expert Interview Results

Only one expert mentioned another factor that is important to consider when it comes to electric vehicles and charging. Electric overload when charging the electric cars overnight was stressed from an expert point of view by **I1**:

"Perhaps this is not today's problem but when many more people have electric cars, they will charge them at night in their home. This will create overloading on the electricity system which might cause distribution issues. This should be thought in advance before we have large numbers."

6.2.6.3. Summary & Comparison

All different factors shown in **Figure 13** were highlighted by some of the interviewees even though they did not hold the majority as it happened in other themes. It is noteworthy to mention that mostly non-expert interviewees expressed their concerns around 'other' factors rather than expert interviewees. Only one expert interviewee, I1, expressed his thoughts on electric overload. Finally, due to other factors' importance for this study, I decided to include them which are also analyzed under the analysis section.

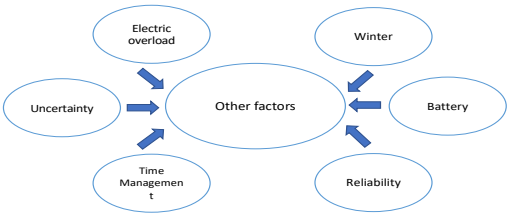

Figure 13 Other Factors

7. Analysis

In this section, the analysis combines the results, theories, and previous research. I, first, present the analysis of the results which answer the main research question. Then, I present the integrated theory implementation intertwined with the results that provides an answer to the second research question. By doing so, the thesis provides an answer to the aim of this study, the key factors on consumers' willingness to adopt EVs as well as the question of how consumer factor can be perceived in the transition from ICEVs to EVs.

7.1. Key Factors on EV Adoption

The first research question is: "What are the key factors that influence people's willingness to adopt EVs in Sweden". The research question allows understanding the surrounding important influencing factors around EVs which the results are used to answer the research question. Some of the factors discussed here go back to the literature but placing them in a country context validates and makes it possible to understand the consumer adoption behavior around the topic of EV adoption from a member state level as well as to measure their importance and validity.

Financial Incentives & Cost

To begin with, the results highlight that financial incentives and purchase cost carry huge importance on EV adoption, and it was highly emphasized by most of the interviewees as well as the respondents of the questionnaire. For instance, in the question (Q3) of why you would not adopt an EV, the coded answer 'expensive' was the most mentioned answer by almost half of the respondents in the questionnaire. Since most of the electric car prices are higher than petrol or diesel vehicles, not every individual can afford an EV. Many participants of this study mentioned the cost of the vehicles and hence, the importance of financial incentives. While some of the participants, for example, I7, mentioned that if the price goes down then they would consider an EV, others such as I6 and I4 underlined that Norway's EV adoption rate is too high and the reason behind was financial incentives. Also, current financial incentives are not seen enough for large EV adoption which was also argued by Norway and Sweden comparison. Besides Aasness & Odeck (2015) found out in their study that multiple financial incentives caused the enormous increase in EV adoption in Norway. Increasing financial incentives and making them visible to people is likely to increase EVs on the road. For example, during the interviews, at some moments I needed to mention the incentives from the government of Sweden stating that incentives from the government exist. This also underlines another side which is the visibility and awareness of these incentives. In conclusion, financial incentives are

found to be not currently enough, and visible as well as found to be an important key factor on EV adoption alongside with the purchase cost.

Environment

As the main reason for this transition from ICEVs to EVs is happening due to climate change and the environmental impact of fossil fuel vehicles, it did not come as a surprise the environment was an important factor to consider. However, the environment is reflected both from positive and negative attitudes towards electric vehicles according to both interview and questionnaire results as well as neither positive nor negative only in the questionnaire. From the negative perspective, many participants raised their concerns about electric vehicles and their negative impacts due to mainly battery production and raw materials. It is, however, important to mention that although negative environmental concerns were raised towards electric vehicles both in the questionnaire and interviews, the environment is still seen as one of the most important factors that influence people positively towards EV adoption. For example, analysis of several studies by Rezvani et al. (2015) show that environment was one of the most important influencing factors on EV adoption. However, the environmental concern comes after driving range and charging infrastructure according to the questionnaire results which is quite interesting to analyze. It appears that participants tend to secure their 'comfort zones', e.g., vehicles' range and charging, before the environmental concern. Besides, this might be the result of uncertainty around the environmental impacts of electric vehicles on consumers. In the questionnaire, the results of Q4 clearly show that over 26% of respondents have neither a positive nor negative idea of how electric vehicles impact the environment. Furthermore, the discussed topics of interviews under the environment were batteries, recycling, raw materials, and climate. Although a will to adopt EVs was often highlighted, it was also followed by a 'but' or 'if' as I8 stated, "EVs will be used a lot in the future even if it is concerning due to…". In conclusion, environmental concern was found to be both positive and negative influencing factors towards the EV adoption as well as uncertainty around the impact of EVs on the environment was found.

Charging Infrastructure & Range Anxiety

This study found out that charging infrastructure and range anxiety are key influencing factors on EV adoption. Universal charging, visibility, lack of charging, and charging time were highly underlined by the interviewees and charging infrastructure availability was the most important to the respondents of the questionnaire as it was shown in ***Table 2***. The lack of charging infrastructure was also taken second place after the expensiveness of the vehicles in the Q3 of 'why you would not you adopt an EV' in the questionnaire. Besides, the range anxiety is very much related to the charging infrastructure. These two factors were the most important factors selected by the participants in the same question in

the questionnaire. Also, almost 40% of the respondents chose lack of infrastructure and range as negative factors towards EV adoption as presented in ***Figure 7***. Long-distance trips, winter, distance, and charging time have an impact on range. Furthermore, even though the long-distance trips happen only a few times a year, not being able to complete all the travels stays as a worrying situation for the participants. When combining range anxiety with lack of charging infrastructure, these two factors have the most influence on the participants. In terms of range, a study conducted in Sweden by Haustein and Jensen (2018) also shows that range anxiety alongside charging infrastructure is perceived as a functional barrier. In conclusion, lack of charging infrastructure and range anxiety are found to be the most important two key factors on EV adoption.

Consumer Knowledge

Consumer knowledge and awareness is found to be a key influencing factor. For instance, the whole lacking numbers on EV adoption is connected to consumer knowledge and described as a "mental barrier" by I4. The lack of consumer knowledge and education around EVs are also connected to other found key factors. Lack of education around EVs was brought up by I6, for instance, and raised questions such as how to find charging stations, how does the range work, environmental impact of the car. Range and charging are highlighted by I2 stating that people drive less than 50km a day in their daily lives, however, still worry about the range of the vehicles and many people do not know that they can charge at home and referred these due to lack of knowledge education. This is a very significant finding that affects other key factors as well. For instance, according to Long, Axsen, and Kormos (2019), consumers continue to be confused about electric vehicles, and EV adoption stays limited although policy support and technological progress is increasing. They emphasize consumer awareness as a barrier and present a survey from two different years, 2013 and 2017, which the only difference was a higher proportion of people have heard of key electric vehicle models in 2017. In conclusion, while technology and innovation are not found to be a factor, consumer knowledge is found a key influencing factor on EV adoption.

Other Factors

There are more factors found according to the results although they do not represent most of the participants' results. However, due to their importance, they are included and analyzed in this study. Uncertainty around EVs seems to be an important other factor. As it was raised by I7, there are

questions to be answered that lead to uncertainty around EVs. Also, as electric vehicles are quite new on the market, it might come as normal to people not to trust the vehicles yet. This was perceived as the reliability of vehicles due to the new technology. Weather conditions and battery safety were part of the conversations. Also, technological change of vehicles from engines to battery-charged EVs will require a new behavior in people's lives. For instance, this was reflected by I5 comparing focusing on time management and planning in advance to go on long trips. This is a valid concern and reality today when considering the lack of charging infrastructure and charging time need, EV owners need to plan trips in advance. Lastly, electric overload was highlighted by an expert, I1, considering people will charge EVs at night in their homes. However, this does not reflect today's conditions but the future considering the current EV registrations and market share as also was highlighted by the interviewee, hence, not included as a factor. In conclusion, these factors are included in this study as sub influencing factors.

In a summary, the results found in this study are reliable and comply with previous research. Surprisingly, even Sweden, one of the most sustainable and environmentally friendly countries in the world, faces several challenges in terms of EV adoption. In this study, several factors are found to be important for EV adoption in Sweden. Environmental concern, cost, financial incentives, charging, range, consumer knowledge are the factors that were found to be the most important factors according to the results. There are also, however, sub-factors found and discussed under other factors such as the battery, weather conditions, uncertainty, reliability, and behavioral change. Some factors that were already mentioned in the theories and literature review were found to be relevant to the participants of the study such as environment, charging, battery, range, cost, and financial incentives. However, innovation and technology were found to be not important factors in the interview results and least important in the questionnaire, therefore not included. On the other hand, consumer knowledge is found to be a key influencing factor that was highlighted by most of the interviewees.

7.2. Integrated MLP and RCT Approach

The second research question of the study is: "How can the consumer factor in socio-technical transitions such as from ICEVs to EVs be perceived?" and answered in this section. This study perceives the change in the automotive industry from ICEVs to EVs as a socio-technical transition. I argue that a socio-technical transition needs to be completed in order to achieve a complete large-scale EV adoption and consumer perception plays an important role in it. In this thesis, the broader context of EV adoption was perceived by the socio-technical transition from ICEVs to EVs and addressed within the MLP framework. However, this socio-technical transition comes with social challenges which consumers play a significant part in it. The narrower context of EV adoption, therefore, was perceived from a rational decision-making process of consumers and addressed with the RCT. Within this change, there are some contexts of rational choices that affect consumer's decision-making. These factors which influence consumers' rational choices have important roles in the MLP. Rational choices of consumers take place in the context of a change in the larger technological system.

In existing regimes in MLP, the process of lock-in and route dependence often leads to an innovation gradually. Change is often accomplished but in reasonable ways, which leads to a stable path. Consumer lifestyle is a great example of lock-in mechanisms. There are three processes within niches shortly as the learning process, the articulation of expectations or visions, and the building of a social network (Geels, 2012). Besides, niches gain momentum and become definite and accepted if social networks become bigger. The key point here is making sure that niches gain momentum and accepted. This is where consumers' adoption behavior study carries importance to investigate where RCT implementation through influencing factors on EV adoption can help niches to grow and get accepted.

Rational choice theory is utilized to explain pro-environmental behavior with the categories of self-interest motivations which the RCT views beliefs as motives for pro-environmental behavior (Rezvani et al., 2015). Adopting an electric vehicle is a pro-environmental behavior where self-interest motivations, knowledge, and motives lead individuals to EV adoption. The theory of rational choice ensures that human behavior is based upon benefits and utility maximization (Rezvani et al., 2015) and in the end, individuals rely on rational calculations to make rational choices expecting the maximized outcome.

Radical low-carbon niche innovations are included in the MLP that provides an understanding of low carbon transitions (Geels et al., 2017). In MLP under regimes, innovation perceived as a gradual process, and change tends to occur in a stable path. Socio-technical frameworks require infrastructure alignment as stressed under the regimes by MLP (Geels, 2002) which, for instance, lack of

infrastructure importance was also found to be a constraint by RCT. Also, changes at the landscape level such as a collection of deep structural patterns and social values, e.g., environmental concern, destabilize the regime and open doors for niche innovation to extend, become a part or even reposition the current regime. The development of a sustainable charging infrastructure was found to be the key enablers for the low carbon transitions by Bolton and Foxon (2015). Also, according to some contemporary RCT theorists, lowering the price provides a possible explanation for sales increase where Judge Posner highlights "*Buyers do not choose randomly. Rationality is the only reasonable explanation for their reactions to changes in relative prices*." (Jacoby, 2013, p. 88). According to Wittek (2013)'s description of full rationality, individuals are fully informed on all alternatives to decisions, probabilities of results, and consequences, and the perception and processing of this information do not have any cognitive limitations. The study predicts that understanding the influencing factors could provide a path to full rationality. Having the knowledge, e.g., consumer knowledge, around products help consumers' decision and might direct consumers to the special product. At RCT's core, individuals choose their best option within the scope they are in. Awareness and knowledge increase result to maximization of the utility. In STT, one process within the niches is the learning process as stressed by Geels (2012), which increased knowledge and awareness help niches to gain momentum speed up the transition to be completed.

Under MLP's regimes, for instance, consumer lifestyle plays an important role where EV adoption is significantly relevant to changing the lifestyle. Besides, as mentioned in the landscape, huge important events or individual decisions influence the socio-technical transition where consumers' rational choices are affected either directly or indirectly. Therefore, to be able to make the transition successful, societal perspectives should be taken into consideration. One way of doing this is finding the influencing factors on consumers and use to maximize rational choices which are the influencing factors in the socio-technical transitions as two theory integration highlights. Integration of multi-level perspective and rational choice theory is given this study a unique, integrated approach to perceive consumer factor within the STT. Gradual changes and innovation acceptance is dependent on consumers' acceptance level of the innovation where maximizing the rational choice plays a key role within the STT. In the end, finding the key factors that influence people's willingness to adopt EVs helps to understand the rational choice of consumers that reflects the societal part in the MLP and offers a path to complete the transition from ICEVs to EVs.

Firstly, I argue that the socio-technical transition needs to be completed in order to achieve a complete large-scale EV adoption and consumer perception plays an important role in it. Secondly, rational choices of consumers are affected by the influencing factors, i.e., the results of the study, and they take place in the context of a change in the broader MLP system. Lastly, the found influencing factors are not simply factors that influence consumer willingness on EV adoption in the narrow context, but they also play a bigger role in the broader context and influence the socio-technical transition from different perspectives.

After all, it can be argued that gradual change and innovation acceptance, therefore, the large-scale EV adoption and the transition from ICEVs to EVs cannot be completed without considering and involving consumer factor. The consumer factor represents the societal perspective within the STT, and consumer factor plays a key role with their rational choices with the influencing factors from different perspectives as illustrated. In conclusion, consumer factor should be perceived as an influencing and fundamental factor that represents the societal perspective in the socio-technical transition from ICEVs to EVs.

8. Conclusion

8.1. Conclusion

This master's thesis aim was to study the key factors that influence consumers' willingness to adopt electric vehicles in Sweden which was answered through the first research question. Also, the question of 'How can the consumer factor in socio-technical transitions such as from ICEVs to EVs be perceived?' was answered through the second research question. As presented in the results and analyzed in the analysis sections, the main conclusions of the study are stated below:

1.Financial incentives, purchase cost, driving range, and charging infrastructure are found to be key major influencing factors.

2.Innovation and technology that are found to be influencing factors during the research review are not found to be influencing key factors in this study.

3.Consumer knowledge is found to be one of the key influencing factors that have an impact on other found factors towards EV adoption.

4. Under other factors, minor factors such as the battery, weather conditions, uncertainty, reliability, and behavioral change are found to be influencing factors.

5. It is argued that the transition from ICEVs to EVs cannot be completed without considering and involving consumer factor. Therefore, the consumer factor should be perceived as an influencing and fundamental factor that represents the societal perspective in the socio-technical transition from ICEVs to EVs.

As this study highlighted, neither at the national nor European level, the EV adoption is not enough to research the emission and climate targets. Also, the consumer factor on EV adoption seems underestimated. The study, first, focused on consumers' willingness to adopt EVs and provided the key influencing factors to increase EV adoption. Then, the study highlighted the role that consumers play within the transition. Considering the results of this study, although there might be national or local level differences, I suggest that most of the findings of this study are applicable to the European level. The first reason for this is electric vehicles on the road have recently started to grow and become popular, and challenges around EVs are similar. The second reason is that many member states in the EU have similar characteristics that make the innovation diffusion easier. And the last reason is that the transport is a shared competence between member states and the EU. Therefore, tackling the transport-related issues at the EU level will be more effective as well as applicable at the national level. However, as

previous research and the result of this study proves, there are important factors that should be focused on. This study did not carry EU document analysis due to its scope and limitations however mentioned EU documents or statements from Commissioners show that the consumer factor is neglected. Instead, the EU seems focusing on charging infrastructure and cost. The EU is already investing in EV charging stations and the goal is 1 million electric and hydrogen vehicle charging stations to be installed by 2025 (Virta, 2021). However, the European Court of Auditors (ECA) looked at how the EC supports member states in expanding EV charging infrastructure and found out that deployment of charging infrastructure is not quick enough to meet the targets and despite successes (European Court of Auditors, 2021). Furthermore, the same report by the European Court of Auditors (2021) also found out that there is a lack of an integrated EU electric mobility roadmap that helps member states to implement. In an environment where even charging infrastructure aims do not match with reality and the EU does not offer enough help to member states, consumer factors' importance becomes even more important on EV adoption. The charging infrastructure and the cost are often mentioned by the EU but results of this study show that these are only two of the found influencing factors. Education and consumer knowledge is the most important key factor in this study where focusing on education and improving awareness and knowledge can solve other influencing factors such as the range anxiety, cost and environmental concerns. For instance, according to LeasePlan (2020)'s Car Cost Index 2020, EVs are now more affordable than ever across Europe, and drivers in Sweden and Denmark have the lowest total cost of ownership. However, people tend to focus on the purchase cost rather than the total cost of ownership. Also, range anxiety seems unnecessary concern as people drive less than 40km daily and only need to charge the vehicle one time a week. It is shown that range is sufficient for over 90% of trips in Nordic countries according to Liu, Wu, Christinsen, Rautitatien, and Xue (2015). Therefore, considering the found factors of this study, providing and implementing EU-wide policies and education strategies could be very valuable and affect other factors positively towards EV adoption.

As mentioned in the thematic background of this study, Europe is leading in EV sales in the world but at the same time, Europe has the most ambitious climate goals. According to Vandermoere (2019), sustainability transitions such as transport system shifts take from 25 to 50 years to occur in a given system, however, the EU does not have this time to achieve the transport and climate goals that are set. Hence, if consumers are not put into the focus and their concerns, and influencing factors on EV adoption are not focused, it is not possible to complete the transition as the study underlined, hence, not possible to reach the emission goals or the Green Deal goals. In conclusion, this study aimed to provide the key factors on EV adoption as well as consumers' role in the socio-technical transition from ICEVs to EVs. A possible recommendation from this study is to approach EV policies from the consumers' perspective and influencing factors on consumers' willingness towards EVs from the EU level. Finally,

contributions from and limitations of this study are presented below as well as recommendations for further research.

8.2. Contributions & Limitations & Further Research

This thesis study brings unique contributions to literature. First, I perceived the EV adoption both from broader and narrower contexts and offer a two-theory integrated approach to answer the second research question, namely the rational choice and the multi-level perspective framework. Moreover, Sweden seems to rarely study the market of electric vehicles, especially from the influencing factors perspective on EV adoption. I provided factors besides the ones in the literature such as consumer knowledge, uncertainty, reliability, weather conditions, and behavioral change that were not found under the theory section. Besides, I drew conclusions for EU policies based on the results that could be very valuable to increase EV adoption in the EU. By analyzing which key factors influence people's willingness to adopt electric vehicles, it can be argued that findings towards EV adoption could speed up the EV adoption in Sweden, and the EU. The study also provided both qualitative and quantitative methods for data collection and involved both expert and non-expert perspectives which enriched the thesis' content.

This thesis study comes with limitations due to its scope and time frame such as only one Northern European country focus, one type of vehicle research as the electric vehicle, or not including some found factors. Some factors such as fuel prices are not included in the study thoroughly even though some research (Beresteanu & Li, 2011; Diamond, 2009) found them as an important factor. However, the inclusion of fuel price might need to include electricity price as well which makes it a topic to study itself. Furthermore, the importance of socio-demographical attributes and geographic conditions on EV adoption in Sweden dimension is highlighted by Westin et al. (2018). However, the geographical dimension was not focused on this study as well. There are, for instance, interesting factors that are not included in this research but could be a part of further research. As an example, Vassileva and Campillo (2017) found out that early adopters of EVs in Sweden are mostly male, well-educated, and medium-high income as this was also referred by I3 (see consumer knowledge). The study acknowledges that the participants to the questionnaire and interviews varied among different age groups and not all might not represent people who can afford electric vehicles or buy new cars. According to Parker (2020), millennials choose age 21 as the ideal time to buy or lease car first car, while Christopher Butleer (2019) highlights that EVs have started to become in the price range of Gen Z and millennials or as I3 mentioned that mostly 55+ males purchase EVs from the company perspective. The first two examples reflect the US consumers; however, a similar study is not found in Sweden or the EU. Besides, the author acknowledges that although involving all age groups provided a broad perspective and represented all

groups, on the other hand, it also might result in less representativeness on the age groups that buy new cars, usually older than 35 or 40. These age groups are seen as financially secure who can also afford to buy today's luxurious electric vehicles, therefore, including younger ages might not present today's conditions although different age group on EV purchase studies exist. However, considering the constant EV price decrease, and constant government incentives increase and the long-term emission and climate goals, the study aimed to represent all age groups older than 18+ as EVs are a growing trend and seen as the future transport models rather than today's acknowledging the possible impact of not limiting the age groups. Therefore, the study suggests that future studies could only focus on different age groups on EV adoption. Lastly, it should be noted that the integration of two theories namely RCT and MLP that answered the second research question has not been practiced before so far as the author's knowledge. Therefore, this approach might come with limitations and should be considered from this perspective. Moving forward, this thesis study calls for further research, policy development, and decision-making to acknowledge the dynamics and connection between the factors and barriers that electric vehicle adoption is facing. Therefore, the future study could focus on other countries in Europe to diversify, compare and enrich the study. Another suggestion would be to involve different vehicle types such as hybrid or hydrogen as this study only focused on battery electric vehicles. Finally using a different selection of methods and theories in the future study could offer a different perspective that enhances the study.

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Appendix

Appendix 1 Semi-structured Interview Guide

The design of the interviews was organized through the findings of the research review and considering theories. The findings from theories and research review made it possible to gather data and analyze the research questions. In the beginning of each interview, the procedure of informing the interviewees regarding the author, the author's program and university, and the aim of the thesis is followed. Also, each interviewee was asked for consent to record and publish the interviewee's answers anonymously. The questions were adjusted based on the participants' workplace and background. For example, the questions were slightly re-arranged with the expert interviews to get the institution or the company's perspective as well as the experts' thoughts both individually and professionally. The guide was followed in general, however, a spontaneous question was asked sometimes depending on the topic and the discussion when it was possible to get a better understanding of the topic. In general, the aim was to get an in-depth understanding of the factors on EV adoption that influence the interviewees. Interviewees were not cut in and allowed to talk as much as they want. This led, sometimes, interviewees to talk about topics before I ask the questions. In general, this allowed us to have broad and deep discussions around the topics. Also, each time interview did not have the specific knowledge, relevant information was provided to the interviewee and then the question was asked again. As an example, if the interviewee did not know about the range of EVs today, general information was provided and then asked the following question of 'do you consider EVs range enough today for you to consider an electric vehicle?". Experts explicitly stated that the answers represent their own opinions, not the institution, company itself.

1. Background

The interviews started with the background information of the interviewee. In the beginning of each interview, the interview guide was followed. The information about the thesis, the author, the study program was provided. And it was clearly defined that the interviewees' names will not be shared, and it will be anonymous. This was to make sure that participants feel comfortable and speak freely without concerns. Then the background questions were followed under the below headers.

Name

Age

Location

EV experience

Car ownership

2. What are the key factors/barriers that affect your attitudes towards EV adoption?

The interviews were held in line with the thesis study's literature review and theories. Depending on the discussion, the below questions were slightly changed, another question was asked to get a better grasp of the topic. However, in general, the found influencing factors were part of the interviews and followed through.

How important the environment and environmental initiatives to you? And how do you associate the environment with electric vehicles?

Do you consider the cost of the electric vehicle as an important factor?

- Do you think electric cars are affordable today?

Do you think financial incentives & government policies are important on EV adoption?

- Are you aware of the Sweden's government incentives?
- Do you think the government's incentive is efficient enough?

Do you find charging & charging infrastructure an influencer factor on EV adoption?

- Do you think charging infrastructure is available enough for you to consider an EV today?
- Do you think charging infrastructure visible to you?

How do you consider the driving range of electric vehicles on EV adoption?

- Do you have knowledge on driving range of electric vehicles?
- Do you consider EVs range enough for you to consider an electric vehicle?

3. Are there any other factors/topics you would like to share?

This question's aim was to prevent the study to only focus on the above factors and lose sight of other possible factors to the interviewee. Therefore, the aim was to discover other factors & topics that the study did not consider yet might be an important factor to the interviewee. This question led the thesis study to discover the 'other factors' that were presented in the results section.

Appendix 2 Semi-structured Interview Participants

I1: Swedish Energy Agency (Programme Manager) – 43 years old - M

I2: Polestar (Sustainability Dept.) – 42 years old - F

I3: Polestar (Customer Experience) – 35 years old - F

I4: Retired Nurse – 65 years old - F

I5: Student (Engineer) – 24 years old - M

I6: Engineer – 30 years old - M

I7: Academician, Ph.D. – 28 years old - F

I8: Retired Teacher – 67 years old – M

Appendix 3 Questionnaire Text

Key Factors on Electric Car Adoption in Sweden

Are you interested in electric cars and do not have one currently? Do you live in Sweden and want to help to contribute to a more sustainable future road transport by completing a 5-minute questionnaire?

This questionnaire forms part of a Master's Thesis project for Gothenburg University. For this, the questionnaire looks to understand the perception of the non-EV owners on electric vehicle adoption in Sweden. The car is one of the main forms of transport and is slowly beginning to transition from fossil fuels to renewable energy sources, e.g., electricity. This transition comes with challenges and therefore, understanding key factors that influence people's willingness to adopt electric cars is key to speed up to reach the climate goals. You can participate anonymously by clicking the link below and answer 14 questions.

https://www.surveymonkey.com/r/EVadoption

My name is Gökay Cinar and I study European Studies at the University of Gothenburg. If you have more questions, please reach out to;

gokaycinar23@gmail.com

Many thanks for your time.

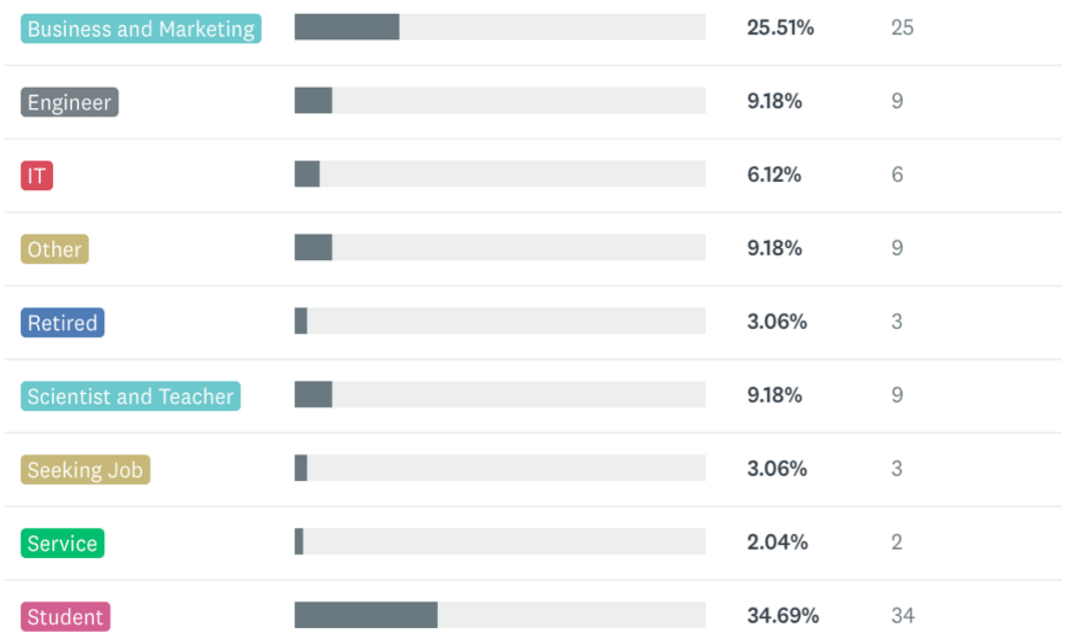
Appendix 4 Questionnaire Results

Age, Gender Distribution

	18-24 (1)	25-34 (2)	35-44 (3)	45-54 (4)	55-64 (5)	65+ (6)	TOTAL	WEIGHTED AVERAGE
Male	18.33% 11	48.33% 29	18.33% 11	8.33% 5	5.00% 3	1.67% 1	60	2.38
Female	13.56% 8	54.24% 32	20.34% 12	6.78% 4	1.69% 1	3.39% 2	59	2.39
Prefer not to say	0.00% 0	100.00% 1	0.00% 0	0.00% 0	0.00% 0	0.00% 0	1	2.00

BASIC STATISTICS					
	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION
Male	1.00	6.00	2.00	2.38	1.13
Female	1.00	6.00	2.00	2.39	1.07
Prefer not to say	2.00	2.00	2.00	2.00	0.00

Profession of Participants



Location Distribution

ANSWER CHOICES	RESPONSES	
Gothenburg (1)	38.66%	46
Stockholm (2)	13.45%	16
Malmö (3)	34.45%	41
Other (4)	10.92%	13
Other (please specify) (5)	2.52%	3
TOTAL		119

BASIC STATISTICS				
Minimum	Maximum	Median	Mean	Standard Deviation
1.00	5.00	2.00	2.25	1.15

Car ownership

ANSWER CHOICES	RESPONSES	
None of the above	0.00%	0
Bensin	27.97%	33
Diesel	13.56%	16
Hybrid	4.24%	5
Plug-in Hybrid	2.54%	3
No	48.31%	57
Other	3.39%	4
TOTAL		118

Cars' frequency of use

ANSWER CHOICES	RESPONSES	
1-2 times a week	16.95%	20
3-4 times a week	20.34%	24
Everyday	22.03%	26
Do not use a car	40.68%	48
TOTAL		118

Electric Vehicle Drive Experience

ANSWER CHOICES	RESPONSES	
Yes	42.37%	50
No	38.14%	45
Not yet	19.49%	23
Total Respondents: 118		

Willingness to adopt an EV (1=unlikely, 5=very likely)

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
Willingness to adopt an EV	7.02% 8	3.51% 4	22.81% 26	26.32% 30	40.35% 46	114	3.89

BASIC STATISTICS				
Minimum 1.00	Maximum 5.00	Median 4.00	Mean 3.89	Standard Deviation 1.18