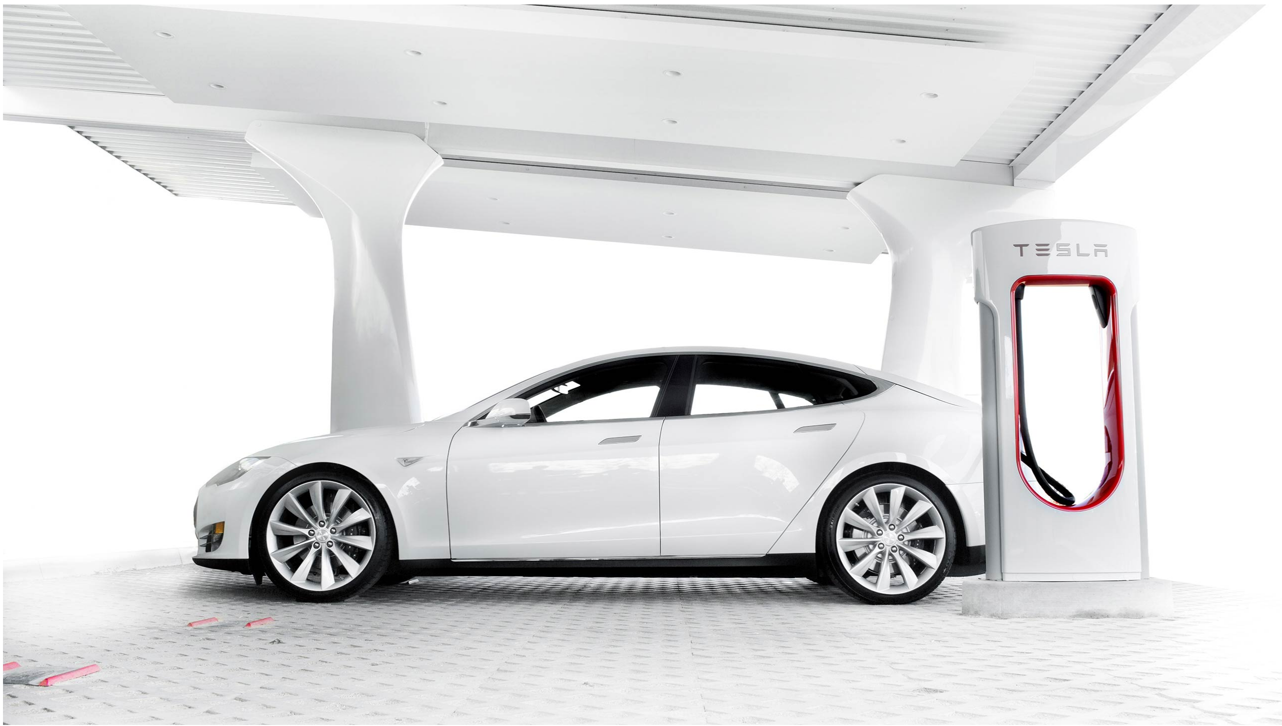
Master Thesis

THE BATTERY ELECTRIC VEHICLE-EXPERIENCE:

Understanding BEV perceptions: from early adopters towards mass acceptance



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Preface

This report is the result of a master thesis project in fulfilment of the Master of Science in System Engineering, Policy Analysis & Management at the Faculty of Technology, Policy & Management of Delft University of Technology.

The subject area is the adoption of battery electric vehicles and which perceptions exists among experienced users. The study focusses specifically on Tesla users which has a high adoption rate within the geographical boundaries of this study; The Netherlands. This case study gave me a unique opportunity to study perceptions of experienced battery electric vehicle users and creating new insights in the spectrum of the adoption of electric mobility.

For readers interested in the theoretical side of this project, I refer to Chapter 2 in which the conceptual framework is elaborated. For readers who are more interested in the results of this case study, I refer to Chapter 5 in which the results are interpreted. I hope that all readers find the study useful in a way, and I welcome all discussions and comments about the result as presented.

I would like to thank everyone that contributed to my research. Family and friends for their patience and support; the members of my graduation committee for their valuable feedback, and especially my supervisor Jan Anne Annema for his positivity which kept me motivated throughout the process.

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Abstract

Electric mobility is considered as the next step towards sustainable mobility. Within the Netherlands, as one of the leading countries if it comes to electric mobility, the market share of battery electric vehicles is still limited to 0,2 percent. Many studies are executed on consumer behaviour regarding electric vehicles. But no studies are found based on users with actual experience with battery electric vehicles. A theoretical framework was developed to create better understanding on how actual user experience relates with perception, attitude and adoption behaviour. The Q-experiment shows four shared perspectives among experienced battery electric vehicle users, which are all positive. Differences were found comparing these perceptions with perceptions from unexperienced consumers found in literature. Interestingly, the result suggests positivity among experienced users is not only caused by usual vehicle characteristics as drivetrain. But also, by brand image, self-identity and innovations on user interface. Suggesting that experience influences perception on BEV usage, it is interesting to understand how to bring experience towards non-experienced users.

Key words: battery electric vehicles, perceptions, adoption, mobility, the Netherlands

Executive summary

The worldwide stock of electric vehicles (EVs) is increasing exponentially since 2013. However, the market share is still relatively limited, especially if it comes to battery electric vehicles (BEVs), which have no internal combustion engine in contrast with other types of EVs. The BEV is considered as the long-term replacement of cars with an internal combustion engine. The interest of my research lies in the adoption of BEVs, discussing perceptions of experienced users in relation with the adoption process of the general public. Findings in this subject area contribute to understanding BEV-user perceptions and thus to understanding the BEV adoption process. The main research questions used in this study is: Which perception on BEV-usage exist among BEV-users, and how can this knowledge contribute towards further BEV adoption?

Based on the literature study, a plausible theoretical framework is constructed describing the relation between the perceptions studied on BEV-usage and the change of these perceptions based on experience. The framework as presented in Figure 1, shows an extended version of the Technology Acceptance Model. Based on studies found in literature, a causal relation is found between BEV experience and the perception on BEVs. This doesn't only apply on individual level, the blue dot line in Figure 1 shows that interaction and communication between an experienced user and non-experienced user can influence the perception of a non-experienced user. For more details on the theoretical framework, I refer to chapter 2.

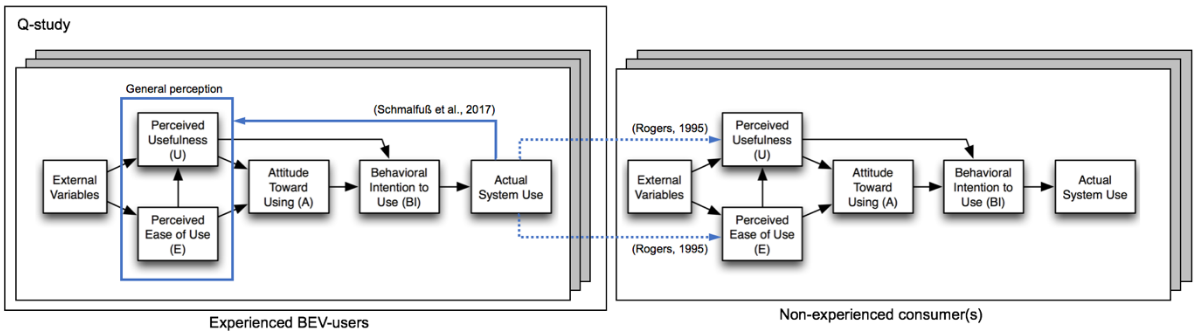


Figure 1: Theoretical framework combining TAM with literature study

The empirical data collection existed of two interviews with high experience and expertise on BEV usage and Q surveys with 40 Tesla users which were conducted at Tesla super charger stations in Amsterdam and Zwolle during June and July 2017. This region was selected because of the relatively high number of BEV users within the Netherlands. As charging time at super charger stations takes around 40 minutes, it was ideal to conduct interviews while respondents are charging their vehicle. Q method is designed to measure perceptions subjectively which are statically interpretable.

Different perceptions among the group of experienced users are found, expressed through the preferences for different statements in the survey. Four groups were identified based on these preferences; the environmentalist, the financial driver, the realist and the BEV positivist. Notably, perceptions found were all overly positive if it comes to BEV usage. For a more detailed description on these perception groups, I refer to Chapter 5.

Additionally, the result suggests that the differences in perceptions of the four groups is mainly based on importance of statements rather than contrary opinions. On the statements that are determining in the composition of the perceptions, disagreement cannot be found on statement level. Furthermore, respondents made reference to additional aspects of BEV usage as the free charging infrastructure which Tesla offers, the frequent over the air updates of the car systems, self-driving possibilities and innovative user interfaces. The way to include these offering in their perception on BEV usage, users probably consider these offerings as an integral part of BEV usage.

The main findings of this study are the four shared perceptions found among this specific group of users considered as innovators and early adopters. Combining these perceptions with knowledge from literature, differences were uncovered where main barriers as range anxiety, charging difficulties and mileage problems were not considered as barriers among actual users. Other studies found in literature suggest that BEV experience influence the perception on BEVs, thus, attitude and behavior if it comes to BEV adoption. Interestingly, as perceptions found in this study are very positive in general, it endorses the suggestion of causalities between experience and perception. Furthermore, perceptions of non-experienced users might also be influenced by perceptions of experienced users by communication and interaction.

However, certain considerations should be taken into account interpreting the results as presented. Within the Netherlands, the market share of 0,2% indicates that the group of respondents predominantly exist of innovators and early adopters. Results might be different if this study is reproduced with a broader target group. Due the low adoption rate, I started the research with a limited group of potential respondents to approach. Limiting the respondents group even further, to Tesla users only, I was able to interview respondents at high traffic charging locations. This practical consideration should be noted, even though Tesla holds the biggest market share in the Dutch BEV market, and also offers the most mature BEVs.

To conclude, suggesting that BEV experience and BEV perception are related, bringing BEV experience to non-experienced users can directly contribute to turn negative perceptions focused on barriers into more positive perceptions. Secondly, communication and interaction between non-experienced users and experienced users can also influence the perception of non-experienced users positively. The charging infrastructure, especially the Tesla superchargers can be a perfect way to use the continuous flow of experienced users, who seem to have great excitement and willingness to share their knowledge, for communication and interaction with non-experienced users.

Additionally, this study can be used as a first step in understanding BEV user perceptions, and the role of these perception in the adoption process of electric mobility. The lessons from this study are also relevant for other markets with potential for electric mobility, the challenge is to use these findings in a broader understanding on user perceptions and the position of perceptions in the BEV adoption process. Further research includes researching other groups in the adoption process and compare results with perceptions of innovators and early adopters. But also, to study inconsistencies in perceptions before and after BEV experience on individual level. At last, it remains interesting to research which other factors have significant influence on user perceptions, attitude and behavior throughout the adoption process.

1. Introduction

The worldwide stock of electric vehicles (EVs) reached 1.3 million in 2015, a near-doubling on 2014 levels. However, the market share of EVs is still relatively low. For example, the United States (USA) was the top selling country for EVs in 2015 and the EV sales only grossed around 0.66% of total new car sales in the same year. Despite this relatively low market share, EVs are a viable near-term transportation technology capable of providing sustainable mobility – according to scholars (Egbue & Long, 2012). Besides, the International Energy Agency estimates the stock of EVs to increase to over more than 30 million by 2025 and to exceed 150 million in 2040, reducing 2040 worldwide oil demand by around 1.3 million barrels per day (International Energy Agency (IEA), 2016).

Currently, the total share of BEVs within the EV market is limited, however it is widely considered as the long-term replacement of internal combustion engine vehicles (ICEVs). However, existing research shows that a large proportion of consumers have a ''wait and see'' attitude if it comes to BEVs, with the range per charge being one of the top concerns (She, Qing Sun, Ma, & Xie, 2017). Considering the current selection of available BEVs, significant differences in electric driving range between models exist. Several car manufacturers offer BEVs with driving ranges between 100 and 150 km, where Tesla with its models S ensures a range of approximately 450 km (EV Obsession, 2015). This might also add to the 55-60% market share that Tesla has with its model's S and X on the Dutch BEV market (Nederland elektrisch, 2017).

In both popular and scientific literature, EVs are used as a container including several technologies and varieties. Starting with a hybrid electric vehicle (HEV), combining an internal combustion engine along with an electric motor to achieve a higher fuel economy than similar-sized ICE (internal combustion engine) vehicles. The Plug-in Hybrid Electric Vehicle (PHEV) is comparable to an HEV but has a smaller internal combustion engine than the HEV and has a larger battery. In addition, the PHEV battery is rechargeable and can be restored to full charge by connecting a plug to an external electric source. The battery electric vehicle (BEV) is powered solely by a rechargeable electric battery and has batteries that are larger than the PHEV. BEVs represent a 'carbon free' mode of transportation if electricity for charging is generated from renewable energy sources (Egbue & Long, 2012). For now, we conclude that EVs – compared to vehicles with an internal combustion engine (ICEV) – are regarded by scholars and some policy-makers as a viable solution to reduce greenhouse gas emissions, air pollution and dependence on fossil fuels. Considering the variety of EVs, the BEV seems to offer the best solution to problems such as greenhouse gas emissions, air pollution and dependence on fossil fuels. As scholars put it: 'from a straightforward environmental perspective, full-electric vehicles [BEVs] are the most desirable as they are most energy-efficient and do not emit any local air pollutants' (Bakker, Maat, & van Wee, 2014).

BEVs might offer the best theoretical solution, the actual adoption rate of BEVs worldwide remains the lowest of all EVs (Sierzchula, Bakker, Maat, & Van Wee, 2014). Despite battery costs continue to fall, supportive policies – which are far from universal for the moment – are still critical to encourage more consumers to choose (B)EVs over conventional vehicles (International Energy Agency (IEA), 2016). Such policies are presumably most effective when they are aimed at stimulating influential factors for BEV adoption.

1.1. Understanding battery electric vehicle usage perceptions

One influential factor for BEV adoption is consumer acceptance. Several recent studies on BEV adoption focusses on a *potential* consumer acceptance and other *potential* influential factors for BEV adoption (see (Egbue & Long, 2012), (Hoen & Koetse, 2014) and (Ziefle, Beul-leusmann, Kasugai, & Schwalm, 2014)). These studies have led to recommendations for supportive policies. However, few studies have been conducted explicitly on actual BEV usage or the validity of these recommendations, let alone the actual perceived user acceptance and perspectives. This leads us to consider how well studied the *actual* user acceptance of and perspectives on BEVs are. A study into the perceptions of BEV users on BEV usage has not yet been performed – as far as I can tell (see chapter 2)

This suggests the need for greater understanding of adoption of BEVs. Thus, I aim to contribute to BEV user perception studies with this thesis, and therein contribute to the understanding of BEV adoption on a broader level.

As an estimated range of 450 km per charge can be considered as an acceptable range to replace a conventional ICE vehicle, within this study the focus will be on Tesla-users. This choice also simplified the search for respondents, as many Tesla-users are regularly using Tesla's 'supercharging' infrastructures where they must wait 20-40 minutes charging their vehicles. Which gave the opportunity to do the research on actual Tesla users. This specific scope also brings its limitations, these will be discussed in chapter 7 of this research.

1.2. Application in the Netherlands

Here, I propose to use the Netherlands as a case study, as there is a relatively large group of early adopters of BEVs. Besides, the Dutch government has aimed the past year to acquire the position as international test bed for EVs and smart charging infrastructures. Several financial and other incentives have been offered to early adopters of both full BEVs and plug-in hybrid EVs (Bakker et al., 2014). The coming years these incentives are slowly reversed, where understanding on EV-user's motivation for purchasing and actual perception on BEV usage after purchasing is lacking to predict the effect of new policy or to tailor policy.

In 2010, the Dutch government formulated three main objectives for 2011-2015 to encourage the adoption of EVs (Mil van, Schelven van, & Kuiperi, 2016).

1. 20.000 EVs at the end of 2015, including sufficient charging infrastructure to increase the number of electric miles.
2. Increase the earning potential of the EV-industry.
3. Encourage innovation within the EV-industry.

By the end of 2015, already 90.275 EVs were registered which is very successful based on the quantified objective. With 17.000 charging points and 400 fast charging points, the Netherlands is internationally leading when it comes to charging infrastructure. The earning potential of the EV-industry grew towards €820 million, and different innovations took place regarding the interoperability of the charging infrastructure, possibilities on fast charging and pilots on smart grids (Mil van et al., 2016). These key figures indicate that policy measures were successful despite some goals still lacking behind. Considering that only 10% of the EVs registered at the end of 2015 is a BEV (Rijksdienst voor Ondernemend Nederland, 2016). And 86% of the PHEVs are driving less electric miles than expected, according to (Stelt et al., 2008) the average share of electric miles of PHEVs is around 26% and is still decreasing. It can be said that the number of electric miles is way behind compared to the number of EVs sold.

Financial incentives have a substantial influence in the adoption of EV's within the Netherlands. Considering Table 1, we can see that the EV market share in terms of new cars sold is varying over the years. Within the years 2013 and 2015 the financial advantages of purchasing and using the car (five years fixed circulation subsidy), were very attractive compared to the year after. This also resulted in a substantial increase of EV's registered in the last months of 2013 and 2015 (Mil van et al., 2016). The number of BEV's sold over the period 2013-2016 shows limited increase, in which it is important to understand that the Tesla Model S represents between 60-85% of the BEV market in those four years (Rijksdienst voor Ondernemend Nederland (RVO), 2016).

Table 1: EV market share new cars sold within The Netherlands

Year	**EV market share new cars sold within the Netherlands**	**Amount EV's sold within the Netherlands (Rijksdienst voor Ondernemend Nederland (RVO), 2016)**	**Amount BEV's sold within the Netherlands (Rijksdienst voor Ondernemend Nederland (RVO), 2016)**
2013	5.55% (Shahan, 2014)	22.590	2.251
2014	3.87% (Cobb, 2015)	15.678	2.664
2015	9.74% (Cobb, 2016)	43.971	2.543
2016	6.4% (Cobb, 2017)	24.645	3.737

1.3. Research objective & deliverables

Currently, academic efforts studying perceptions on BEV's of experienced users is scarce. Secondly, several studies have been executed focusing on consumer expectations and perceptions, without differentiating between PHEV's and BEV's. However, with the existing differences in mileage, carbon emissions and dependency on charging infrastructure, differences in perceptions among might exist. These two knowledge gaps are elaborated in more detail in chapter 2. The focus of this case study will be on perceptions of experienced BEV-users, more specifically it will aim on BEV-users with vehicles with characteristics that are comparable to PHEVs and vehicles with an ICE

The public is not considered to be a homogenous whole, but diverse perspectives on BEV's should be acknowledged. The main objective of this case study is to understand the potential difference between perceptions of the (unexperienced) public on BEV's, and perceptions of experienced BEV users on BEVs. This could contribute to improved understanding on BEV usage and consumer preferences, and, thus, to policy making processes which aim to stimulate EV adoption.

The primary deliverable is an overview on which perceptions exists among BEV-users, understanding underlying incentives of their BEV purchase. Comparing those perceptions with perceptions of the public, can identify differences or similarities between perceptions of non-experienced users and users. General understanding about these differences and similarities can be relevant for further decision-making processes regarding EV-adoption and analyses of implemented policies.

1.4. Research questions

The gap between perception without BEV experience and perception of actual BEV users is important to understand in the EV context. For closing the well-known attitude-behaviour gap (Stern, 2000), this study can provide further understanding of consumer BEV adoption.

Which perceptions on BEV-usage exist among BEV-users, and how can this knowledge contribute towards further BEV adoption?

The deliverable, in the form of recommendations, is based on the current state of affairs. The main research question is systematically addressed through five sub-questions.

Sub-questions:

1) Which perceptions towards electric driving currently exists?
2) Which factors might influence BEV user perception?
3) How do actual BEV users perceive BEV usage?
4) What lessons can be learnt from user perceptions for further adoption of BEVs?

1.5. Reading guide

This study exists of four main components, in this first chapter the subject is introduced in which the context is elaborated. Also, the research objective, deliverables and questions are formulated. For readers who are interested in the conceptual model and theoretical framework I refer to chapter two. In this chapter the relation between perception, adoption and experience is explained. Furthermore, this chapter gives a closer look into existing literature on the subject of electric mobility, which serves as a starting point towards identifying knowledge gaps. Chapter three focusses on the empirical research methods, explaining the essence of Q-methodology and the composition of the main variables in the research.

For readers who are interested in the results of this study I refer to the results which are presented from chapter four onwards. In chapter four the analysis is elaborated, without further interpretation. The analysis tool PQ Method is explained, in which certain outcomes are presented and discussed throughout the chapter. In chapter five the results are interpreted; the four factors are translated into four shared perception groups which are elaborated in detail. Furthermore, this chapter focusses on other interesting observations and returns to the literature review for placing the results in the context of the conceptual model. Finally, in chapter six the conclusion and recommendation are presented as in chapter seven the quality and limitations of this research are discussed.

2. Literature study and conceptual model

The chapter is fully based on literature study and starts with the findings regarding BEV adoption. The literature review begins with an exploration of EV adoption research in general, BEV adoption worldwide as of this moment is still limited and thus studies in the same field are also scarce. Also, current barriers to adopt BEV are studied, to understand which perceptions, experienced and unexperienced, currently exist. Next, I derive the theoretical framework from a conceptual model and a theory in the field of technology adoption research. Afterwards, I report on the integration of BEV adoption literature findings into the theoretical framework. Required changes to the model are consequently discussed. The findings from the literature review make up the theoretical perspective of the thesis. All articles for this literature review were found through online databases Scopus, Google Scholar and Science Direct. For the search, I used the following keywords, a subset of the following keywords, combinations, similar wording and synonyms: battery electric vehicles; perceptions; adoption; mobility; the Netherlands.

2.1. (B)EV adoption research

As of this moment, research on BEV adoption is scarce whereas EV adoptions research is more common. Much research on EV adoption uses the term electric vehicles (EVs) as a container for different drivetrain technologies: hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs) (Egbue & Long, 2012). Although this seems the most commonly used categorisation, the drivetrain is not the only characteristic that is used to categorise EVs. For example, some scholars prefer to categorize EVs into conventional hybrid electric vehicles and plug-in vehicles, making charging the defining characteristic. In such case, plug-in vehicles consist of plug-in hybrid electric vehicles and plug-in battery electric vehicles (Schuitema, Anable, Skippon, & Kinnear, 2013). To complicate matters, there are studies that use the term EVs to refer to plug-in vehicles, thus excluding vehicles with a hybrid drivetrain that cannot be charged externally (Larson, Viáfara, Parsons, & Elias, 2014). However, when considering recent technological developments and market adoption figures of electric vehicles in general, it becomes clear that in recent years the focus of manufactures and policy makers has changed from HEVs and PHEVs to BEVs. The general research agenda has also progressed in a similar fashion. Thus, this literature study is grounded in studies published in the 2010’s, preferably from 2015 and onwards.

In recent years, several studies have examined factors that are expected to be influential for EV adoption rates. Despite the benefits of EVs compared to traditional ICE vehicles, several obstacles need to be overcome before EVs will be widely adopted. A major barrier is that consumers tend to resist new technologies that are considered alien or unproven. This resistance is not only apparent for BEVs but seems to apply for all alternative fuel vehicles (AFVs). Considering the willingness to accept (WTA) in relation to improved functional attributes such as driving range, recharge/refuelling time, additional detour time and the number of available models of all AFVs, research shows that the WTA does not appear completely. According to the scholars, this indicates that there are often large intrinsic negative preferences for AFVs compared to the conventional technology (Hoen & Koetse, 2014). Therefore, failure by EV manufacturers and policy makers to identify and overcome consumer issues may result in continued low acceptance of EVs long after the technical problems

are solved (Egbue & Long, 2012). It can be concluded that functional attributes are important but are not sufficient to paint the complete picture.
There are multiple dimensions to consumer adoption preferences and EV characteristics. According to some, the intention to adopt BEVs is linked to consumers' innovativeness, which is defined as their tendency to buy new products in a particular product category soon after they appear in the market and relatively earlier than most other consumers. Three main motivational dimensions of consumer innovativeness have been distinguished: instrumental, hedonic, and symbolic (Schuitema et al., 2013).

Consumer motives to adopt EVs relate to the characteristics of the EV:

i) instrumental or functional (which is related to the **technical aspects**, built from the possession of new technologies i.e. BEV characteristics such as performance, driving range or charging duration),
ii) symbolic attributes which are related to a **sense of self** or **social identity** that is reflected by, or built from the possession of new technologies (characteristics that reflect driver's identity, show that s/he is conscious, and/or 'green') and
iii) the role of emotions in terms of hedonic attributes of BEVs that describe the **emotional experience** of the drivers such as their joy or pleasure. These attributes were found to be relevant to BEV purchase and/or usage intention (Schmalfuß, Mühl, & Krems, 2017).

It was found that the intention to adopt PHEVs and BEVs is stronger if people have a positive perception of their instrumental, hedonic, and symbolic attributes (Schuitema et al., 2013). Interestingly, this study also indicates that perceptions of instrumental attributes and intention to adopt BEVs are mediated by perceptions of hedonic and symbolic attributes. Instrumental attributes are mostly important because of their influence on perceptions on symbolic or hedonic attributes. These researches also find that people have more negative perceptions of the instrumental, hedonic, and symbolic attributes of BEVs and a lower intention to choose them compared to PHEVs. Basically, people link the limited instrumental attributes of BEVs to less joy and pleasure in owning and driving a BEV and a negative social identity. As a result, they are less likely to adopt a BEV than a PHEV (Schuitema et al., 2013).

When exploring consumer EV adoption behaviour further, five dimensions can be distinguished: i) attitudinal factors, ii) pro-environmental behaviour, iii) innovation adoption behaviour, iv) symbolic behaviour and v) emotional behaviour (Rezvani, Jansson, & Bodin, 2015).

Consumer intentions and adoption behaviour of EVs are for the biggest part based on studies researching non-BEV users rather than actual BEV owners and users. How respondents perceive these perspectives once they have owned and/or used an EV – let alone a BEV – is still largely unclear.

It can be concluded that a potential future uptake of BEVs will depend heavily on how consumers perceive BEV usage. One recent literature review concludes on the matter: "one reason for the modest adoption figures is that the mass acceptance of EVs to a large extent is reliant on consumers' perception of EVs (Rezvani et al., 2015). As BEVs are a subset of EVs, I assume this dependency on consumers' perception also applies to BEVs. Establishing and understanding this relationship between consumers' perception and BEV acceptance is the focus for the remainder of the literature review.

2.2. Barriers in BEV adoption

Studying the subject of (B)EV adoption, it is interesting to see that consumers experience certain barriers when it comes to adoption of electric mobility, especially if concerns BEVs. The research of Rezvani (2015) includes a literature review on advances in consumer electric vehicle adoption. The review refers to several studies with different samples and research methods, the most relevant results are summarized in Table 2.

Table 2: Literature overview adoption of electric vehicles

Authors (year)	EV type	Technical Factors	Contextual factors	Cost factors	Individual and social factors
Caperello & Kurani, (2012)	PHEV	Confusion on how battery works, perceiving EV as car of the future	Finding an appropriate public charging station	Purchase cost, but saving on fuel	Acquiring recharging habit, changing driving habit.
Carley, Krause, Lane, & Graham, (2013)	PHEV, BEV	Recharging time, range	Visible charging stations in public	Purchase cost	Environmental beliefs, fossil fuel dependency, Education.
Graham-Rowe et al., (2012)	PHEV, BEV	Impact environment battery materials, performance, safety	Charging infrastructure	Purchase cost, saving on fuel	Less guilt feeling good for the environment
Peters & Dütschke (2014)	EV	Carbon emissions, energy efficiency	Policy measures to decrease the purchase costs	Purchase costs, fuel cost	Compatibility with own values, experience and needs
Jensen, Cherchi, & Mabit, (2013)	BEV	Carbon emissions, driving range, top speed	Charging stations on the roads and public places	Purchase costs, fuel cost	Hands-on experience with EV
Zhang, Yu, & Zou, (2011)	EV	Safety, performance	Low fuel price, non-supportive tax policies China	Purchase and maintenance cost	Number of driving license holders in family, opinion of peers
Pelsmacker, (2012)	EV	Range, performance		Purchase price	Emotions, subjective social norms, social status

The research methods used for the presented studies varied from rational choice theory, theory of planned behaviour and quantitative online surveys. Notably, none of

the studies included consumers which can be considered ''experienced'', the (B)EV experience varied from no experience at all to an organized trial of 4-6 weeks.
Furthermore, looking into the advantages and barriers which consumers perceive towards (B)EV adoption, similarities arise between the different studies. Advantages as carbon emissions, energy efficiency, environmental benefits are mentioned in multiple studies. Looking into the barriers, recharging time, mileage, charging infrastructure and purchase costs return in almost all studies in Table 2. This is not surprising as these factors are the main differences between the traditional ICE vehicle and the new technology of an EV.

2.3. Choice for the conceptual model

For the purpose of this study, I assume purchase, ownership and usage to be all indicators for acceptance. Several scholars stress the importance of subjectivity when interpreting the slow BEV acceptance. In general is can be found that psychological barriers to use a new product are based on existing norms and perceptions associated with the product (Hoeffler, 2003). This general construct was applied in studies that relate consumers' perception of vehicle attributes to their intention to adopt EVs (Schuitema et al., 2013).

A Norwegian study points out that "technology adoption is typically described by attributes of the technology or attributes of the adopter. (…) They often emphasize the adopter's perception of new technologies, related to performance expectancy (usefulness), effort expectancy (ease of use), social influence and facilitating conditions" (Bjerkan, Nørbech, & Nordtømme, 2016). This school of thought is based on the popular and widely applied technology acceptance model (TAM) (Davis, Bagozzi, & W., 1989).

As core basis for the conceptual model for this study the TAM was chosen. It has been thoroughly examined and established, initially proposed in the field of information systems but later also applied in studies into (B)EV acceptance. Subjectivity sits at its core, defined by perceived usefulness and perceived ease of use. Moreover, thanks to its conceptual clarity it was already successfully applied in the same field. Therefore, it serves as a plausible starting point for the further development of our conceptual model. Finally, when returning to our main research question, it is centred around our key concepts (perceptions and acceptance).

2.4. The conceptual model

The TAM was used to explain and predict user acceptance of information technology at work (Venkatesh & Davis, 2000). The model suggests that behavioural intention (BI) is the best predictor of actual system use – in other words: behavioural acceptance. In general it can be concluded that different types of intentional measures such as consumer readiness and willingness to adopt an innovation, are the main predictors of adoption behaviour and, are in many studies considered as a the proxy variable for adoption behaviour and thus behavioural acceptance (Rezvani et al., 2015).

Both perceived usefulness (U) and perceived ease of use (E) are assumed to have a positive relationship with attitude toward using (A). "TAM theorizes that the effects of external variables (e.g., system characteristics, development process, training) on intention to use are mediated by perceived usefulness and perceived ease of use"

(Venkatesh & Davis, 2000). This rationale is visualised in the diagram below (see Figure 2).

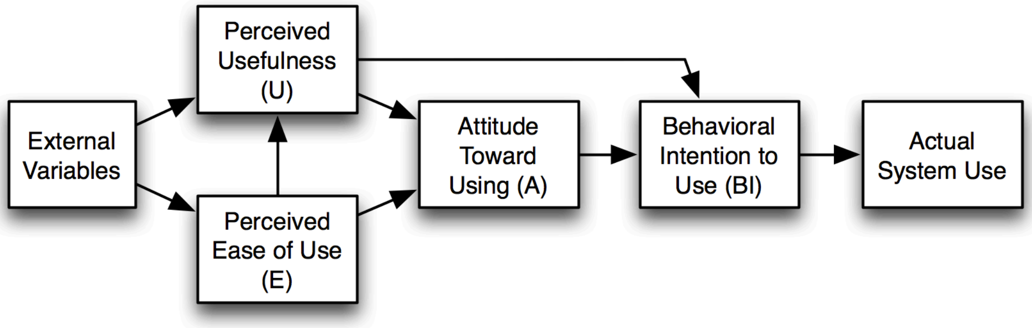


Figure 2 Technology Acceptance Model by Davis, Bagozzi & Warshaw (1989)

Differences between BEVs and traditional ICEs are not limited to the drivetrain only. When studying consumer (B)EV adoption, it becomes apparent that consumers' intentions and adoption behaviour towards (B)EVs depend on attitudinal factors such as ownership and operation costs, perceptions of supportive policy, attitudes towards EVs' technical features and perceptions of utility of EVs, knowledge and behavioural control, social norms and all kinds of behaviour (Rezvani et al., 2015). In short, it can be concluded that changing from an ICE to BEV involves a lot more than merely purchasing and using the vehicle.

2.5. Theory on user experience

The TAM hinges on users' hands-on experience with or at least clear understanding of a product and the consequential purchase or usage intention (Sentosa, 2012). However, hands-on experience with BEVs is scarce and studies in the same field even more so. Therefore, the explanatory power of the TAM in relation to BEV adoption might be limited. Since perceived usefulness (U) is such a fundamental driver of usage intentions (BI), it is important to understand the determinants of this construct and how their influence changes over time with increasing experience using the system (Venkatesh & Davis, 2000). So, to understand BI better, it is relevant to view BEV usage more holistically than through the TAM solely.

Experience is our first extension to the TAM. It was previously suggested (Axsen & Kurani, 2013), and later also established, that experience with BEVs generally changes the perceptions of the user on BEV usage. This was repeatedly found by authors of user studies with BEVs (Schmalfuß et al., 2017). Another study quantified the purchase intention by stating: 'A consumer group with experience or exposure to EVs is somewhat different. Nearly 25% of these people are willing to pay a premium of up to $10,000' (Larson et al., 2014). Recent studies indicate a difference between people who have experienced an EV and people who did not. One study in particular shows several experience-based differences in evaluations of BEV attributes, attitude and purchase intention, with most BEV attributes being evaluated more positively when people had BEV experience (Schmalfuß et al., 2017). In fact, range stress – a commonly mentioned attitudinal factor – was found to be related to range satisfaction and BEV acceptance (Franke, Rauh, Günther, & Trantow, 2016). All of this suggests a significant difference in perception between consumers with and without EV experience in perspectives on EV ownership and usage. To my knowledge, there are no studies that explicitly investigate changes in consumers’ reports of EV advantages and barriers during the process of gaining EV experience. This finding is backed up by a recent literature review (Bühler, Cocron, Neumann, Franke, & Krems, 2014).

Consumers gain experience through actual system use. The fundamental theory ‘Diffusion of Innovations’ seeks to explain how, why, and at what rate new technology spread (Rogers, 1995) and thus how user experience spreads. According to the theory, diffusion is defined as follows: the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system.

1. The innovation in this case is the battery electric vehicle, as it can be represented as an idea, practice, or object that is perceived as new by an individual or other unit of adoption.
2. One of the most distinctive problems with communication, according to Rogers (1995), is that the participants are usually quite *heterophilous*. This is the degree to which pairs of individuals who interact are different in certain attributes, such as beliefs, education, social status, and the like. For instance, the experienced BEV user is more technically competent than his clients. In general, such difference frequently leads to ineffective communication.
3. Time is relevant on multiple dimensions: the innovation-decision process, innovativeness of individuals and the rate of adoption.
    a. The innovation-decision process is the process through which an individual goes through. from first knowledge of an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.
    b. Innovativeness of individuals is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system. Rather than describing an individual as "less innovative than the average member of a social system," it is handier and more efficient to refer to the individual as being in the "late majority" or some other adopter category. The first group of consumers to use a system or adopt technology are so called *innovators.* Rogers (1995) identifies five ideal adopter categories: *innovators*, *early adopters*, *early majority*, *late majority* and *laggards*. Currently, there are no countries where the market share is above 13.5%. This means that according to Rogers’ theory, current BEV users are so called *innovators* (see Figure 3).

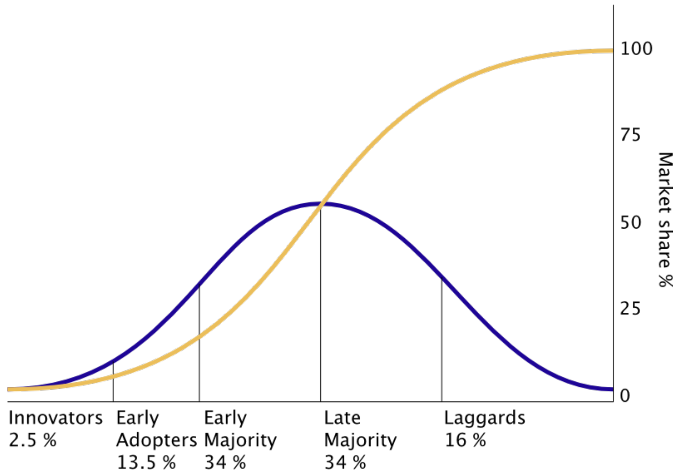


Figure 3: Successful and failure adoption curve with categories

The rate of adoption is usually measured by the length of time required for a certain percentage of the members of a system to ad adopt an innovation. Therefore, we see that rate of adoption is measured using an innovation or a system, rather than an individual, as the unit of analysis. Innovations that are perceived by individuals as possessing greater relative advantage, compatibility, and the like, have a more rapid rate of adoption

A social system is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. the social structure of the system affects the innovation's diffusion in several ways. The social system constitutes a boundary within which an innovation diffuses.

The majority of people is still unfamiliar with BEVs and possesses limited knowledge concerning performance, technology and specific aspects such as charging. Currently, due to a small market share, BEV users are considered to be *innovators* or *early adopters* at the most. Several scholars provide a clear picture of the potential for EV adoption, but their research is based on people who typically had no prior experience with EVs. Potential consumers tend to inaccurately predict their interest in products with which they have no experience (Hoeffler, 2003). Simply put, it seems that BEV usage and adoption is highly dependent on subjectivity, which might also change due to experience with BEV usage. However, research into the subjectivity of experienced users is scarce.

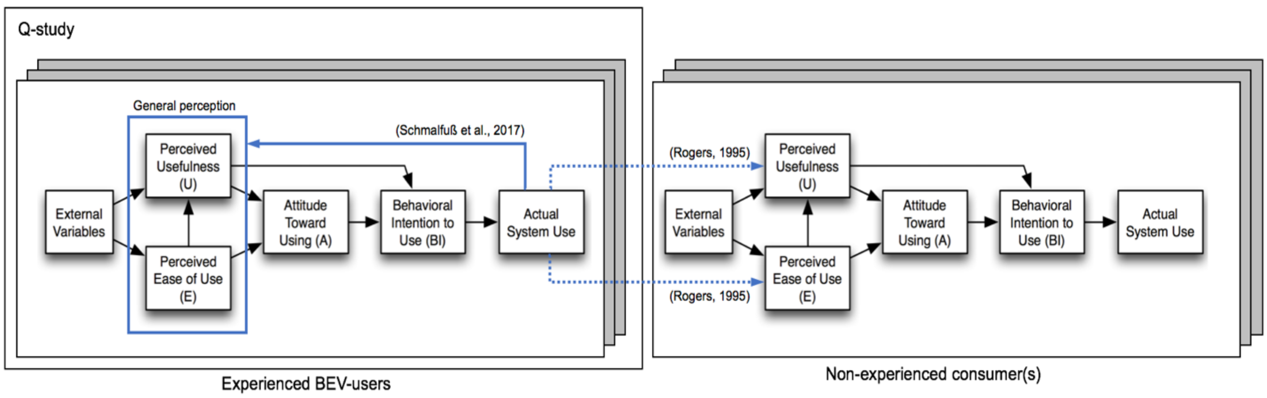
2.6. Theoretical framework

Adoption is an individual process detailing the series of stages one undergoes from first hearing about a product to finally adopting it. Diffusion signifies a group phenomenon, which suggests how an innovation spreads. The TAM is useful for explaining individual steps whereas the Diffusion of Innovations emphasises a more holistic approach to exploring innovation adoption.

As found in this literature review, studies have been executed into adoption of electric personal mobility, especially on consumer preferences with stated choice experiments regarding further EV adoption. In paragraph 2.5, I elaborated on these studies into willingness of adoption where direct BEV experience is mostly limited. Scholars note a lack of published research on the effect of experience on the perception of an instrumental attribute such as range as a barrier in electric vehicle use (Franke, Cocron, & Bühler, 2012). A more recent study draws a similar conclusion with relation to experience: "Many studies take the form of surveys, with participants who have had no direct experience of EVs on which to base their responses. In this way, they are psychologically distant from EVs, and this limits the validity of inferences about adoption drawn from their responses" (Rezvani et al., 2015).

The figure below summarizes the theoretical framework which has the TAM at its core and is expanded with additional theory on innovation diffusion and specific applied research in the field of BEV adoption. The TAM helps to explain technology acceptance on an individual level. Schmalfuß et al. (2017) found a positive feedback loop from actual system use to the general perception on BEVs, which was added to the model (uninterrupted blue arrow). However, user experience and associated perceptions on BEV usage are still to be explored. This subjectivity of multiple individuals was studied using the Q-methodology. The main focus of this methodology is to reveal subjectivity and group participants with shared perspectives. Refer to the following chapter for details on this methodology.

Rogers' (1995) approach to innovation is more holistic and focusses on groups instead of individuals and on communication channels. Experienced users could be influential to non-experienced consumers. This is depicted in the diagram below (dotted blue arrow).



2.7. Further research

Empirical evidence suggests that the potential adoption of BEVs will depend on their instrumental attributes: purchase price, running costs, reliability, performance, driving range, and recharging time are all factors that are likely to influence the adoption of BEVs. However, few studies to date have investigated whether the likelihood of adoption of EVs are influenced by perceptions of **hedonic** and **symbolic** attributes (Schuitema et al., 2013), let alone investigated these perceptions of actual system users – the experienced BEV users.

Thus, the literature study reveals a gap in the state-of-the-art research: a holistic explorative study approach would be novel to the field. Secondly, studying subjectivity of BEV users is novel as well.

Perceptions on BEVs of experienced BEV users have not been studied before. Considering the novelty of the technology, this may have to do with limited access to a set of experienced BEV-users. Fortunately, currently it is possible to find experienced BEV users. The knowledge gap covers both rational and subjective research of experienced users, as in this research I will focus on the subjective perceptions of consumers with a minimum of six months BEV experience. This to ensure that consumers are familiar with the usage and have enough practical experience with their BEV.

3. Empirical research methods

In this chapter I describe the research methods and how these are applied: Q methodology application, literature study and interviews for concourse development, and Q sort interpretation.

The aim of the empirical data gathering was to collect and consequently group perspectives on BEV usage by experienced BEV users. These perspectives are uncovered by applying the Q methodology. Simply put, this methodology requires participants to sort statements according their personal preferences: A *Q sort*. The set of statements or *Q sample selection*, which is used for the Q sort is pre-determined and selected from a total set of statements, the so-called *concourse*. This concourse is largely based on literature study and is complemented by statements derived from semi-structured interviews with experts. Additional interviews with the participants in the Q sort were also used for interpretation of the sorts.

Data collection was conducted in the Netherlands during June and July 2017 at the supercharger station and Tesla service centre in Amsterdam, and at the supercharger station in Zwolle. Both locations are considered as the busiest super charger locations within The Netherlands.

3.1. Q methodology as primary research methodology

Q methodology was chosen as primary research methodology for this study. First and foremost because the methodology is perfectly aligned with the aim of this study: to reveal subjectivity and group participants with shared perspectives (Brown, 1993). Since the aim of this particular study is to surface perspectives that experienced BEV users might have on BEV usage and to group them accordingly, Q methodology is very useful. Q methodology is designed to study correlations between a small number of participants working with a larger number of variables, whereas traditional factor analysis (R-factor) is designed to find correlations between a few variables when working with many participants. Basically, the method employs a by-person factor analysis to identify groups of participants who make sense of (and who hence Q 'sort') a pool of items in comparable ways (Watts & Stenner, 2005). Secondly, implicit or hidden perspectives might not surface in typical surveys whereas Q methodology was developed to exactly do so. This characteristic is particularly useful since the sample selection consists of enthusiastic first adopters. Initial unstructured talks about the BEV usage resulted in merely positive responses. Q methodology allows for studying different implicit perspectives which drive the positive responses. Refer to chapter 4 for more elaboration on the analysis and interpretation.

3.2. Methodology design

For this study, the Q methodology was broken down into six general steps: I. concourse development, II. Q sample selection, III. P set selection, IV. Q sort procedure, V. analysis and interpretation (Exel & Graaf, 2005).

I. Firstly, the Q set or *concourse* is the collection of 'heterogeneous items' of which the participants will sort a specific selection (Watts & Stenner, 2005). The concourse consists of the total set of real world statements, all concerning BEV usage. This total set refers to 'the collection of all the possible statements the respondents can make about the subject at hand' (Exel & Graaf, 2005). The developed concourse consists of 100 statements. Practically, it is impossible to actually develop a concourse that consists of *all* possible statements about BEV usage – or any topic for that matter. However, the gathered 100 statements represent a variety of existing opinions and arguments, things people, politicians, representative organisations, professionals, scientists have to say about the topic; this is the raw material for a Q sort (Exel & Graaf, 2005). Several different sources were consulted: literature, newspapers and internet. Additionally, two interviews were conducted to validate the statements derived from literature and to add additional statements. Refer to Appendix A: Expert interview question sheet with answers for the summaries of these interviews.

II. Secondly, the *Q sample selection* was developed using categories developed by Rezvani (2015): technical factors, contextual factors, cost factors and individual and social factors were used to ensure a representative sample. Hence, the objective for this step was to narrow down the concourse to a representative sample of statements that covers an expected variety of viewpoints. The size of the Q sample is based on the trade-off between representativeness of the statements and the expected time required for the Q sorting. Since the survey participants are selected randomly at a fast charging station, a reasonable duration for the survey is 15 minutes. The *final Q sample* consisted of 24 statements (see section 3.5). Furthermore, having too many statements may be tiring and difficult for a respondent to manage.

III. Thirdly, the *P set* refers to the sample of participants in the Q survey. One notable difference between Q methodology and other social science research methodologies, such as surveys, is that it typically requires many fewer participants. The sample should cover a range of perspectives, since the experienced BEV users are expected to hold differing perspectives in this case. Additionally, practical constraints of time and accessibility limited the choice of P set. Thus, the objective is not to obtain a representative sample of the experienced BEV users, but to demonstrate that a variety of perspectives exist within this group. The objective of Q methodology is not to describe the population, but to uncover perspectives. Thus, a large P set generates additional, non-significant data points where a small P set suffices in identifying the distinct perspectives.

    As this study was executed in the Netherlands, respondents were selected on being a resident of the Netherlands. The final P-set consisted of 40 Tesla users randomly selected at 'supercharger' stations. User experience is desired among participants; therefore, all respondents were the main driver of the vehicle, and had been using it for at least six months.

    Note that Q methodology is an exploratory technique and it cannot prove hypotheses (Watts & Stenner, 2005). Thus, expectations of different perspectives within the group are not formulated.

IV. Fourthly, the procedure for sorting consists of the pre-sort introduction, questions for sorting exercises, and the post-sort questions. During the interview at each section a short instruction was included. When respondents had questions, I personally explained to them which steps to follow. In Appendix F: Interview procedure Q-sort the procedure is elaborated.

V. Fifthly and finally: the analysis and interpretation. Analysis should not be separated from the sorting procedure. It is the effective combination of the two aspects – the Q sort and the Q factor analysis that makes subjectivity the principle research focus for a Q methodology study (Watts & Stenner, 2005).

3.3. Literature study for concourse development

The consulted sources (literature, newspapers and internet) are certainly non-exhaustive. BEV industry and usage is still in its infancy since Europe has just entered the initial adoption phase of electric mobility (McKinsey, 2014). New studies and official product announcements by Original equipment manufacturers (OEMs) are released even while this research is underway. Search terms include: electric driving, perceptions, consumer attitude, upside, downside, cost, acceptance and combinations of the aforementioned. The terms are based on the following categories: technical factors, contextual factors, cost factors and individual and social factors (Rezvani et al., 2015). Although these factors result in a simplified and thus limited developed concourse, it is necessary to make some practical choices since the number of relevant sources continues to expand and the research is limited in time.

3.4. Additional expert interviews

The aim of the interviews was to uncover views, experiences, beliefs and motivations of individuals regarding BEVs, which might be complementary to the literature study. Therefore, interviews are appropriate when detailed insights are required from an interviewee (Silverman, 2000). Ultimately, these two interviews have resulted in additional statements to complement the concourse.

Firstly, interviewees should have expertise in the field of BEV usage or stimulation. Their capacity may vary. Experience with actual usage was not a requirement since the aim is to capture al existing statements – from users as well as non-experienced users. Nonetheless, since the experts were selected based on their expertise on BEV usage, they both do have (some) experience with BEV usage.

The interviewees approached were an owner of a car sales organization (having the biggest stock of BEVs in Europe), and an experienced BEV user which have experience with multiple BEVs for more than 2 years.

The interviews were aimed to be used for concourse development. Thus, interviews are semi-structured, and were structured around a 'lose' topic list, allowing for the interviewees to add additional statements. Moreover, it was not necessary to conduct similar interviews to allow for comparison because the aim of the interviews is to find additional statements to include in the concourse development.

3.5. Composing the Q-set

Based on the literature and additional expert interviews (for expert interview summaries see Appendix A: Expert interview question sheet with answers), 36 statements were sorted over the four categories according to Rezvani (2015); technical, contextual, costs, and individual and social. Hereby the direction of the statement (positive or negative) is also used in the sorting which created eight different categories in which the statements are allocated (see Table 3)

Table 3: Eight categories used for Q-sample selection

	Technical	Contextual	Cost	Individual and Social
Positive	1	3	5	7
Negative	2	4	6	8

To narrow down towards 24 statements, it was also important to create a representative sample. A variety of viewpoints needed to be included which created the following steps in order to create the final Q-set:

1. For all categories with three or less statements, all statements in that category were selected.
2. For the remaining five categories, for each category statements with slight overlap were selected from which only one is included in the final Q-set. Overlap could also exist between positive and negative within a category.
3. The last step in the selection procedure regarded the positive statements in the category individual and social. Hereby 4 out of 9 statements were selected, in which my own opinion in relevance contributed to the final selection.

In Appendix B: Statement selection, the statement selection is substantiated and elaborated in detail. In Table 4 the final Q-set is orderly explicated, which will be randomly ordered in the survey.

Table 4: Final Q-set divided over four categories

	Selection perceptions Q-sort
	Technical -positive
1	Faster acceleration/more horse power (Lelij, 2013)
2	Relaxed driving because of no engine sound (Nu elektrisch, 2015)
3	Full electric cars only have 10% of moving parts compared to conventional cars, that makes it more reliable (Duivenvoorden, 2017)
	Technical - negative
4	Mileage is limited(ANWB, 2015)
5	Charging takes too long(Lelij, 2013)(ANWB, 2015)
6	I'm afraid that the car will stop during a trip (Lelij, 2013)
7	Relatively new technology, specific parts and dependency on supplier (Duivenvoorden, 2017)

	Contextual - positive
8	Less dependency on fossil fuels (Lelij, 2013)
9	Available parking spot specific for electric vehicles (Lelij, 2013)
10	I can complete my daily trips without a public charging infrastructure (Bunce, Harris, & Burgess, 2014)
	Contextual - negative
11	Charging infrastructure is not sufficient enough (Lelij, 2013)
12	Charging point can be occupied when you need it (ANWB, 2015)
13	More planning is required for traveling by car (de Jager, 2017)
	Cost - positive
14	Saving money on petrol (Lelij, 2013)
15	Government subsidies when purchasing an EV (Lelij, 2013)
16	Low tax on usage (bijtelling[1] + road tax benefits) (Lelij, 2013)(ANWB, 2015)
17	The cost on maintenance is low compared to maintenance of conventional cars (de Jager, 2017)
	Cost - negative
18	Expensive to purchase a BEV/Tesla (Lelij, 2013) (ANWB, 2015)(Duivenvoorden, 2017)
19	I have no clear overview on costs of usage (Lelij, 2013)
	Individual and social - positive
20	Driving an electric vehicle is cool (Lelij, 2013)
21	Contribute towards less CO_2 emissions (Lelij, 2013)
22	I would be willing to pay more for a vehicle that I knew was less harmful to the environment (Bunce et al., 2014)
23	Driving a Tesla is an unique driving experience (de Jager, 2017)
	Individual and social - negative
24	People in my surrounding are a bit jealous because it is an expensive car (Duivenvoorden, 2017)

[1] 'bijtelling'' is a Dutch word referring to adding a certain percentage of the vehicle value to your income. This amount will be taxed as using a company car is considered as a part of the salary.

3.6. Survey execution

Instead of the traditional sorting procedure in which a participant sorts a deck of cards on a map, the Q sort data was collected using a free online survey application called Q-Software which facilitates a virtual drag and drop procedure instead. The application was also used to collect and register answers to open questions. Moreover, the user interface also assisted to instruct and direct participants about the nature of your experiment (University of York, n.d.). (See Appendix F: Interview procedure Q-sort for a procedure explanation with a Q-sort example). During the surveys, respondents were able to ask me questions about the procedure. Some of them asked for help with filling in the Q-sort, others did it by themselves. After the survey ended, I always tried to start a conversation with the respondent about electric mobility and how they experience it. Subsequently, the Q sort data was analysed using PQMethod, a free statically software application specifically written to perform Q analysis.

3.7. Interviewees selection

Firstly, the interviewees who participated to the Q-sort should own a BEV and be the main user of the vehicle as well. Also, a minimum of six months of ownership/experience was required which ensures the responses in the Q-sort were based on actual experience rather than influenced by theories and other perspectives. Interviewees were randomly approached at supercharger stations of Tesla, and if they fitted the two requirements they were invited to participate to the Q-sort, around 75% of the invited users were willing to participate to the survey. The main reason for rejection was that users were busy with work or didn’t had enough time as they would leave the charging station soon again. In my observation, in none of the cases rejection was a result of dissatisfaction towards BEVs. In Appendix F: Interview procedure Q-sort the interview procedure is elaborated in steps.

4. Analysis

The analysis part of the study is the first step in translating the 40 individual Q sorts into an interpretable set of shared perspectives on BEV usage. These shared perspectives are based on factors which are extracted from the individual Q sorts through factor analysis performed using the application PQMethod.

4.1. Descriptive analysis

In this paragraph, descriptive data is presented which gives better understanding on the background of respondents. This data is collected from the survey forms (see Appendix G: Response sheet Q-sort interview) which were filled in by respondents aside from the Q-sort.

In Figure 4 the age deviation of respondents is presented. The youngest respondent was 26 years old, the oldest 68. Surprisingly, 13 respondents are below 40 years old, which was a little bit unexpected considering the high purchasing price of this type of BEV.

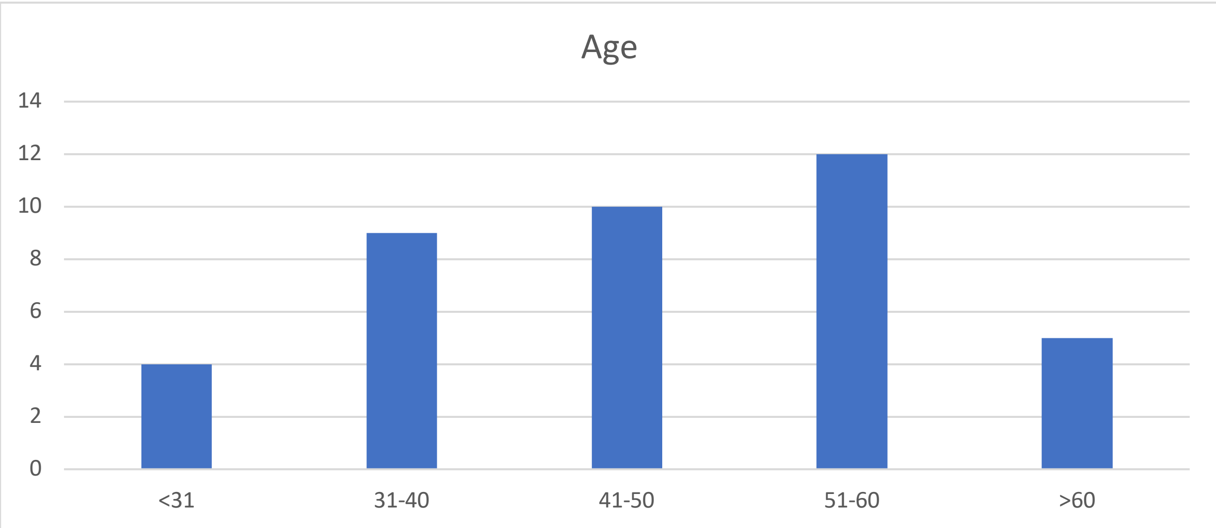


Figure 4: Respondents age graph

Furthermore, it is interesting to see the relatively high number of 35 out of 40 which is man within the P-set. Based on the observed traffic around the supercharger stations, this seems representative.

Table 5: Gender balance in P-set

Gender	Number
Man	35
Woman	5

Also, the education level is asked, which is presented in Figure 5. As expected the group ''Graduate degree or higher'' is represented strongest within the P-set. Surprising the group with a high school graduates is also represented with 12 respondents. Giving a closer look in the dataset, this group of high school graduates is represented by IT consultants, entrepreneurs and respondents with undefined job descriptions.

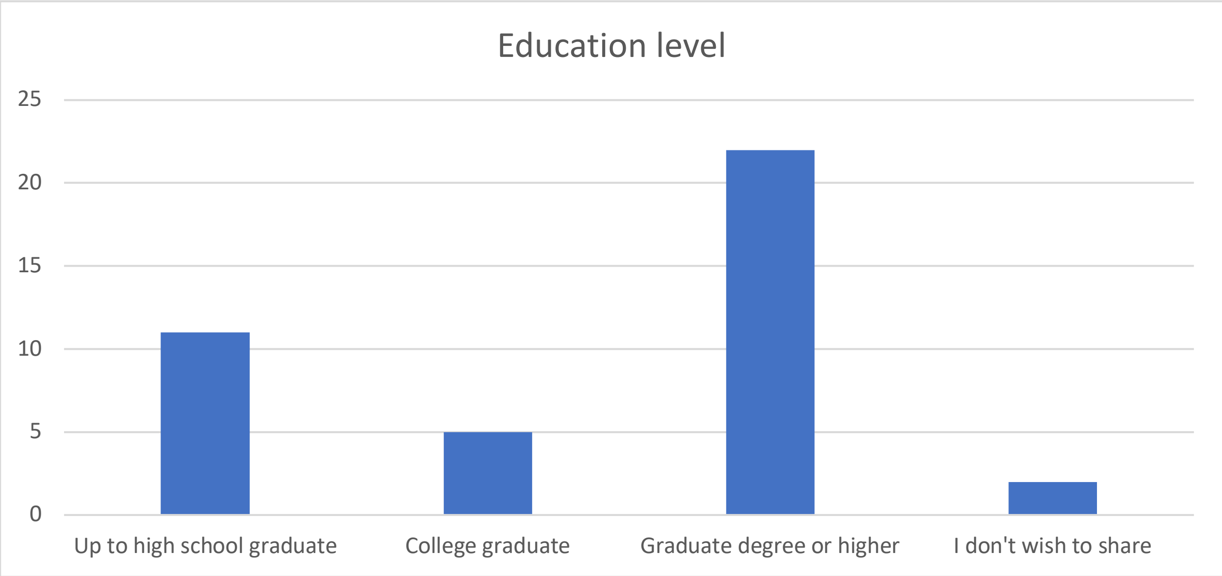


Figure 5: Education level

Looking into the job description see Figure 6, the first observation is the high number of entrepreneurs. Considering the financial incentive and the purchase price of the BEV, it is not surprising to see that the entrepreneurs and respondents with managing and director positions represents 75% of the P-set. This might suggest that most respondents are using a company car, however this has not been surveyed.

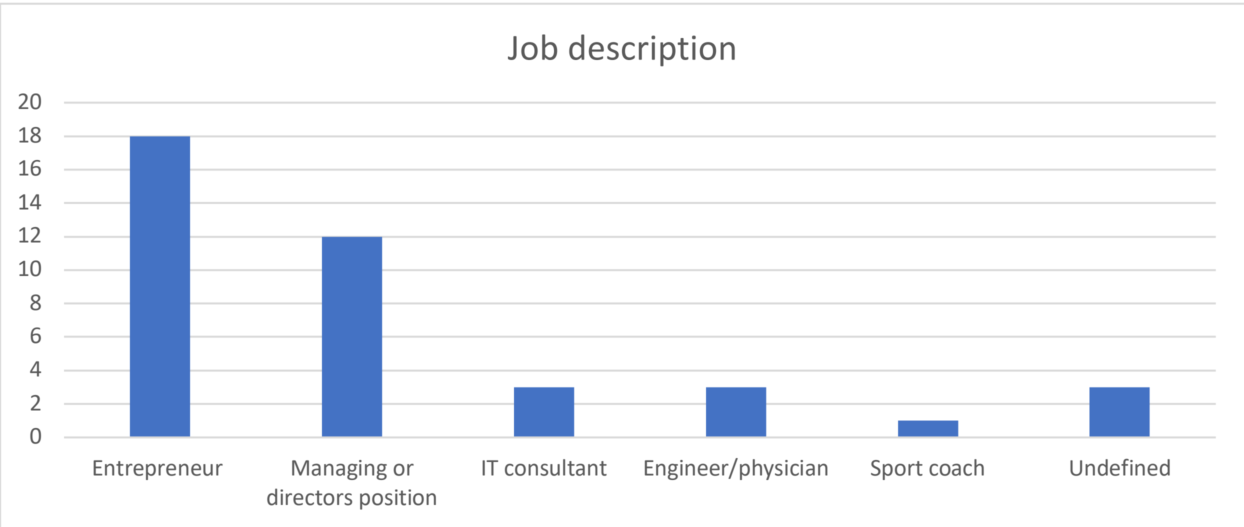


Figure 6: Job description of respondents

The last descriptive statistic is about the experience of respondents and the score per group selected on experience. Looking into Figure 7, the difference of experience is equally divided with a little bit less respondents in the group with 3 years of BEV experience. For the different groups the average score is also included, hereby the score slightly increases from 8,7 in ‘’1 year or less’’ towards 9,2 in ‘’3 years’’. In the group of ‘’4 years or more’’ the average score is 9,0.

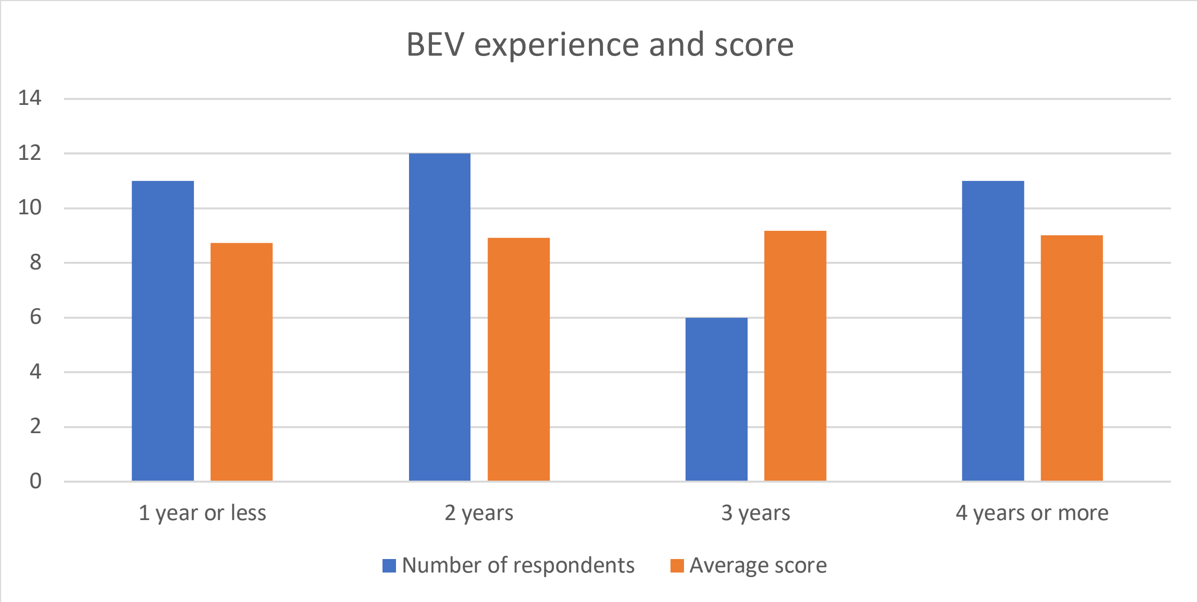


Figure 7: Years of BEV experience with average score

4.2. Factor analysis

Factor analysis tells us how many different shared perspectives (factors) may be identified based on the set of Q sorts. Factor analysis typically starts with examining the correlation matrix between the different Q sorts, as that reported in Appendix D: Data. It shows which Q sorts were highly correlated with one another and therefore may be considered to have a resemblance. Q sorts belonging to the same shared perspective are expected to be highly correlated with one another, but uncorrelated with Q sorts of other perspectives. In short: Q sorts (participants) with similar views on the topic will share the same factor (Exel & Graaf, 2005). In conclusion, the number of identified factors is therefore purely empirical and wholly dependent on how the Q sorters (participants) actually performed (Brown, 1993).

Identification and subsequent selection of factors starts with considering the eigenvalues. The absolute value of the eigenvalues is a proxy for the explanatory power of a factor. The eigenvalue of a factor measures the relative contribution of a factor that explains the total variance in the correlation matrix (Appendix D: Data). When a factor has a value greater than one, it indicates that the factor explains more variance than a single statement within the Q-sort. Thus, a standard requirement is to select only those factors with an eigenvalue in excess of 1.00 (Watts & Stenner, 2005). Performing a Principal Component factor Analysis (PCA) results into 10 factors with an eigenvalue greater than one. Table 6 shows 10 factors with an eigenvalue greater than 1.00. Ergo, each of those 10 groups represent a group of respondents who share a certain perception on BEV-usage.

Table 6 Eigenvalues principal component factor analysis

Factor	Eigenvalues
1	14.4411
2	3.7397
3	3.1451
4	3.0267
5	2.3107
6	1.8969
7	1.6364
8	1.5707
9	1.2043
10	1.0679
11	0.9734

However, it is well known, for example, that several factors with eigenvalues in excess of 1.00 might be extracted even from random data, as random patterns will always arise and be detected (Watts & Stenner, 2005). Therefore, a second standard requirement was considered. An interpretable factor must ordinarily have multiple respondents that load significantly onto the same factor. This is not a mathematical consideration, but a practical. These Q-sorts are called 'factor exemplars' as they exemplify the shared pattern that is the characteristic for that factor. Researchers do not agree on an exact number. Considering the relative high number of factors with an eigenvalue in excess of 1.00 and the high number of respondents, I chose to look for at least three respondents that load significantly onto the same factor (Exel & Graaf, 2005). This results into selection of four interpretable factors ('perspectives') (see Appendix D: Data).

4.3. Factor rotation

To create a better fit of the respondents on the different factors, it was decided to execute a Varimax procedure to find a rotated solution which maximizes the amount of variance explained by the extracted factors. This Varimax procedure automatically seeks this mathematically superior solution (Watts & Stenner, 2005). Nonetheless, some authors are critical of modern factor rotation techniques, such as Varimax which was applied for this study. It is perceived to reveal only the most mathematically and not necessarily the most theoretically informative solution (Watts & Stenner, 2005). Interesting fact is that within the unrotated results the first factor already explained 36% of the variance. The high variance indicated that within the group of respondents there is high consensus. However, it is more interesting to see which differences exists by finding multiple factor loads on each of the factors. According to (Exel & Graaf, 2005), at least three significant loads are necessary for each of the factors to have interpretable results. Iteration on the number of factors is executed, starting with a Q-varimax rotation with seven factors. Iteration down to a Q-varimax rotation with four factors was necessary to get the desired result of at least three significant loads on all factors.

4.4. Analysing results

Factor analysis tells us how many different factors there are (Brown, 1993). In this case, the factors indicate different perceptions on driving a BEV, with those persons sharing a common conception defining the same factor.

Executing the Q-varimax rotation with four factors, the software produced the variables as presented in Table 7. For each Q-sort the load for each of the four factors is determined after rotation. Using the automated pre-flagging function, the numbers are marked with a X that are significantly loading on one of the four factors over the other factors.

Table 7 Factor loadings of Q-sorts on Q-varimax rotation on 4 factors

Q-sort	Factor 1	Factor 2	Factor 3	Factor 4
1	-0.2026	0.4818	0.4173	-0.1894
2	-0.1457	0.5074	**0.5745X**	0.1691
3	**0.6091X**	0.2334	0.0965	0.4918
4	0.3001	**0.7452X**	0.0676	0.3270
5	-0.0236	**0.7614X**	0.0531	0.0432
6	0.3794	**0.5890X**	0.1178	0.4072
7	0.2090	**0.7562X**	0.1479	0.3952
8	0.5261	**0.5890X**	0.0640	-0.2118
9	-0.2605	0.1468	**0.4903X**	-0.0582
10	0.3110	**0.6795X**	0.2483	0.1625
11	0.2436	**0.8730X**	-0.0710	0.0881
12	0.2721	0.1932	**0.7032X**	0.2107
13	**0.5314X**	0.2327	0.2066	-0.0311
14	0.3011	-0.0163	**0.6567X**	0.4063
15	0.1755	0.3455	**0.5426X**	0.1366
16	0.3733	0.1367	**0.8128X**	0.0168
17	0.3306	0.4590	0.2715	0.4773
18	0.0590	**0.6884X**	0.0878	0.3089
19	0.0593	0.3495	**0.5790X**	0.2919
20	0.3246	**0.6669X**	0.1644	-0.0377
21	-0.0197	**0.4929X**	0.0980	0.2770
22	0.3633	0.3386	0.1646	0.5012
23	0.4299	0.1693	0.2968	**0.6359X**
24	0.4327	0.5006	0.2721	0.3774
25	**0.6182X**	0.3582	0.1121	0.1514
26	0.2541	0.3647	0.0699	**0.6859X**
27	0.4606	0.2088	0.2486	**0.6041X**
28	-0.1529	-0.0320	0.1121	**0.6876X**
29	0.1921	**0.5158X**	0.2276	0.3414
30	0.1168	-0.2006	**0.7566X**	0.1145
31	**0.8246X**	0.0104	0.1109	0.1556

32	-0.0324	**0.6396X**	0.0889	-0.1245
33	**0.8423X**	0.0738	0.1671	-0.2491
34	0.4499	0.0367	**0.5415X**	0.1992
35	0.3768	0.3744	-0.0833	**0.6293X**
36	0.0572	-0.0235	0.3095	**0.5649X**
37	-0.0690	0.0705	0.1081	**0.8168X**
38	0.1921	0.5423	-0.1166	0.5535
39	**0.6147X**	0.0517	-0.0658	0.3941
40	**0.7993X**	0.1129	0.0595	0.2628
Sign. loading	7	12	9	7
exp. var.	15%	19%	12%	15%

High correlation between the factors makes it possible to have a significant load on multiple factors. In that case the q-sort is not flagged as it doesn't belong specifically on one of the factors. Given the results of the automatic pre-flagging 35 out of the 40 Q-sorts have a significant load on one of the four factors, with at least 7 respondents with a significant load in each of the factors.

The four factors, interpreted as shared perceptions, have different loads on each of the 24 statements. Table 8 contains only the significant loads that exists on the statements for each of the factors, these fifteen statements have a defining role on the four factors. The other nine statements don't have significant influence with the factors, in Table 8 these statements are left out to create a clear overview on the significant loads per factor on the determining statements.

Table 8: Significant loads per factor on statements

Statement	Factor 1	Factor 2	Factor 3	Factor 4
1 Pay more for environment	1.750			
3 Miss the engine sound		-1.510	-2.023	-2.026
4 More planning required			1.685	
7 Driving a BEV is cool				1.583
8 BEV stop during trip	-1.236	-1.669	-1.700	-1.786
9 Less dependency on fossil fuels	1.207			
10 Acceleration/power		1.297	1.950	2.046
13 Charging infrastructure not sufficient				-1.578
14 Contributes to less CO_2	1.604			
15 Government subsidies		1.877		
16 Difficult to find charging point		-1.417		
18 Mileage is limited	-1.688			
19 Tax advantages on usage		1.263		
21 No overview on costs of BEV	-1.436	-1.532	-1.258	
24 Saving money compared to petrol				1.199

Interestingly, there are no disagreements among the four factors within a single statement. This means that differences between the four factors are mainly based on importance of statements rather than contrary opinions towards statements. This will be further elaborated in paragraph 5.2 Disagreement vs consensus.

The perception groups derived from these four factors are correspondingly labelled in four perception groups: (P1) Environmentalists, (P2) Financial drivers, (P3) Realists, (P4) BEV positivists. This will be further substantiated in the next chapter.

5. Interpretation

5.1. User perspectives

Analysing the results gave some insight in how the final dataset is structured and how the factors are relating to each other. In this paragraph, the four factors are interpreted in perception groups based on the high and low loads of these factors on the 24 statements from the Q-sort.

5.1.1. Factor 1: 'The environmentalist'

Seven respondents loaded on the first of the four factors. In Table 9 the high loads are all related to environment and fossil fuels, which makes it easy to identify this group as *the environmentalists.* Taking a closer look into the individual respondents within this group, it is noticeable that only two respondent makes a remark about environment: *''We all have to work together to reduce CO_2 emissions''* and *''I support the transition to sustainable energy''.* Other remarks mainly concern positive statements about the concept of electric driving in general.

High loads within this group are all related to environment and fossil fuels, as there is high agreement on their incentive for BEV-adoption. Besides the environmental incentive, respondents who load on this factor seems to be very positive based on their average overall score of 9.14, which is the highest among the four factors.

The positive attitude of the respondents recurs in the three ''low load'' statements see Table 8, where they significantly disagree solely on negative statements about BEVs.

Table 9: Factor 1 high and low loads on statements

Z-score	Statement
1.750	I would be willing to pay more for a vehicle that I know is less harmful to the environment
1.604	I am driving a BEV because it contributes towards less CO_2 emissions
1.207	I prefer electric driving above driving a conventional car because I feel less dependent on fossil fuels
-1.236	I'm afraid that my BEV will stop during a trip
-1.436	I do not have a clear overview on the user costs of my BEV
-1.688	The mileage of my BEV is limited

5.1.2. Factor 2: 'The financial driver'

From the 35 respondents that loaded on one of the four factors, twelve of them have a significant load on this perception group. Two of the three statements with a high load are governmental financial incentives which makes it easy to identify this factor as ''the financial driver''. Among factors this is the group that is represented strongest, explaining 19% of the variance from the total dataset.

Characteristic for this group is their strong opinion on the financial statements. They seem highly aware about the financial incentives that comes with electric driving, but also seem to have a clear overview on the costs of driving their electric vehicle.

During the sorting exercise respondents were confident about the financial benefits, saying: ‘’I never drove a car this cheap in usage’’ and ‘’I thank the government every time I step into my car’’. This observation confirms the presumption that the main incentive for this perception group are the financial benefits. Additionally, respondents seem to have a very positive attitude towards their vehicle, based on the overall score of 9,08. It is possible that the awareness on financial benefits makes them more positive about their BEV experience than others, but this is a personal consideration and has not been researched.

Table 10: Factor 2 high and low loads on statements

Z-score	Statement
1.877	Government subsidies gave me an incentive to buy an BEV
1.297	A BEV has faster acceleration/more horse power
1.263	Electric driving is inexpensive because of tax advantages on usage (road tax, bijtelling)
-1.417	It can be difficult to find an available charging point sometimes when you need to charge
-1.510	I miss the engine sound when I drive in a BEV (Battery Electric Vehicle)
-1.532	I do not have a clear overview on the user costs of my BEV
-1.669	I'm afraid that my BEV will stop during a trip

From a theoretical perspective, these findings are logical, literature states that financial incentives are one of the main drivers for users to purchase an electric vehicle which corresponds with my personal expectations.

5.1.3. Factor 3: ‘The realist’

In contrast with the first two factors who were easy to identify, within this group it was more difficult to have a good understanding. Looking into Table 11 was not enough to get a good understanding, a closer look into the nine Q-sorts creates a better understanding about this group of respondents. They seem more critical on which aspects improvements on their vehicle can be made, but also honestly positive about other aspects. Giving an overall score to their BEV experience of 8.56 they still seem relatively positive, although it is the lowest score among the four groups.

Table 11: Factor 3 high and low loads on statements

Z-score	Statement
1.950	A BEV has faster acceleration/more horse power
1.685	More planning is required for traveling with my BEV
-1.258	I do not have a clear overview on the user costs of my BEV
-1.700	I'm afraid that my BEV will stop during a trip
-2.023	I miss the engine sound when I drive in a BEV (Battery Electric Vehicle)

The realists can be seen as the perception group with the most critical opinion on their BEV experience, which its existence is according to my expectation. What I didn't expect is that this group is still relatively positive, they seem to understand the disadvantages of driving a BEV as well they understand the advantages. This observation suggests that a significant factor for respondents with a strong negative perception on their BEV usage doesn't exists.

5.1.4. Factor 4: 'The BEV positivist'

The last factor that is found within the existing dataset has seven respondents that have a significant load explaining 15% of the total variance. This group is named BEV positivists because they seem solely positive about their BEV experience. A distinguishing factor is the statement ''Driving a BEV is cool'', where most of the respondents of other factors don't seem to be interested in this statement, within this group it has a significant role. Another interesting observation is that six out of seven respondents mentioned the engine sound in the post Q-sort questions to endorse the advantage of no engine sound at all. The overall score given by this group to their BEV experience is 9.00.

Table 12: Factor 4 high and low loads on statements

Z-score	Statement
2.046	A BEV has faster acceleration/more horse power
1.583	Driving a BEV is cool
1.199	I'm saving money driving on electricity compared to buying petrol
-1.578	Current charging infrastructure is not sufficient enough
-1.786	I'm afraid that my BEV will stop during a trip
-2.026	I miss the engine sound when I drive in a BEV (Battery Electric Vehicle)

It is surprising how positive the four shared perceptions are towards their BEV use experience. There are some aspects who are experienced as a disadvantage compared to conventional vehicles. This mainly exist of charging infrastructure and planning which is required. But these disadvantages are minor compared to all the advantages which are experienced. This makes the general perception predominantly positive. In Table 13: Overview on four perception groupsa compact overview is given on the four perception groups.

Table 13: Overview on four perception groups

Group	Number of respondents	Explained variance	Overall score (1-10)
The environmentalist	7	15%	9.14
The financial driver	12	19%	9.08
The realist	9	12%	8.56
The BEV positivist	7	15%	9.00

5.2. Disagreement vs consensus

As four perception groups are identified it is interesting to focus on consensus and disagreement among the shared perspectives. Understanding from the unrotated result with eight factors (see: Appendix E: Factor loadings without rotation), one factor with 27 respondents exists. In which this factor only represents 36% of the variance suggesting that there is high consensus within the total dataset. The Q-varimax rotation with four factors gives a more differentiated result where disagreements are more found in nuances and consensus is strongly represented. In Table 14 the statements are included which at least have one significant Z-score among the four perception groups. In this way, we can see how the four shared perspectives agree or disagree on individual statements. If it comes to these ''determining'' statements, the shared perspectives agree on several of them. Looking into statement 3, 8 10 and 21, at least three of the shared perspectives have a significant load in which agreement exists. However, also disagreement exists (see Appendix H: Disagreement vs consensus), but in these cases only one of the shared perspectives have a significant Z-score thus a defining role within the perspective. These observations suggest that the differences in perceptions of the four groups is mainly based on importance of statements rather than contrary opinions. Besides, if agreement among multiple perspectives exists, it regards solely positive perceptions towards BEV usage.

Table 14: Disagreement and consensus on statements with significant loads

Statement	1	2	3	4
1 Pay more for environment	Strongly Agree			
3 Miss the engine sound		Slightly disagree	Strongly disagree	Strongly disagree
4 More planning required			Agree	
7 Driving a BEV is cool				Agree
8 BEV stop during trip	Slightly disagree	Strongly disagree	Disagree	Disagree
9 Less dependency on fossil fuels	Slightly agree			
10 Acceleration/power		Agree	Strongly Agree	Strongly Agree
13 Charging infrastructure not sufficient			Slightly agree	
14 Contributes to less CO_2				Slightly disagree
15 Government subsidies	Agree			
16 Difficult to find available charging point		Strongly Agree		
18 Mileage is limited	Strongly disagree			
19 Tax advantages on usage		Slightly agree		
21 No overview on costs of BEV	Disagree	Disagree	Slightly disagree	
24 Saving money compared to petrol				Slightly agree

Strongly Agree	
Agree	
Slightly agree	
Slightly disagree	
Disagree	
Strongly disagree	

5.3. Other observations

For this study, the topic of interest is the battery electric vehicle and perspectives on usage of the BEV by experienced users. The interviews show that respondents generally view BEV usage as something more than just using a vehicle with a battery electric drivetrain. Rather, respondents made reference to the free charging infrastructure Tesla offers, the frequent over the air updates of the car systems which oftentimes include new features, self-driving systems and the innovative user interface of the central interior control panel. These offerings were all regarded as to be very positive. Respondents considered these offerings as an integral part of BEV usage, specifically Tesla usage. In the post-interview talks with respondents it was mentioned: *''you will only understand this concept once you have used a Tesla'',* and *''with the Tesla model 3 coming, everybody should drive a Tesla''.* Respondents show excitement, there is a real ''cool'' factor when it comes to this type of BEV.

Also, in the response sheet, some of the respondents mentioned the autonomous driving which is possible in some of the Tesla models. However, this feature is not included in every model of Tesla and was also not included in the Q-sort. As it was not measured which of the respondents has access to this feature, it is difficult to interpret the remarks about the ''autopilot'' from respondents. The remarks made were positive, which is not very surprising as users can drive themselves if they don't feel comfortable with the ''autopilot'' function.

These observations confirm that driving a Tesla is more than a car with just an electric drivetrain. This was also one of the main reasons that led this project towards a Q-methodology experiment. The outcome gives a broader insight on respondent's emotion, the attitude, the choice to a ''way of life''. Understanding that feeling of BEV users can be valuable in understanding the BEV adoption process. Perceptions are composed of more than a difference in drivetrain technology, and these other aspects might have a high significant influence on user perceptions.

5.4. Returning to literature review

My research objective was to discuss the perception of experienced BEV-users on BEV-usage, and which factors can be of influence towards further adoption. Studying the perceptions of experienced users, might uncover differences between perceptions of non-experienced users and experienced users. In paragraph 2.2 the main barriers in relevant literature studies are presented, existing of range anxiety, recharging time, charging infrastructure and purchase costs. These barriers of mainly non-experienced users are of significant influence on how they perceive BEVs, thus, their adoption behaviour.

Interestingly, within the results of this study, only one of these main barriers (sufficient charging infrastructure) returns as a determining variable in one of the four shared perceptions. Here, ''The realists'' slightly agree on an insufficient charging infrastructure (statement 13), in which they also slightly agree to statement 4 (more planning required), which in my opinion is related to the fact that the infrastructure is not sufficient. The other barriers which exists in the perception of non-experienced users, seem not to be considered as ''bad'' in the perception of experienced users.

Returning to the *Technology acceptance model,* the *perceived usefulness* and *perceived ease of use* is influenced by the mentioned barriers. But experienced users

don’t consider these main barriers as important as expected during *actual system use*. Besides the insufficiency of the charging infrastructure for *‘’the realists’’,* none of the other barriers seem to have a significant impact in the composition of the four shared perspectives. Concluding that no negative association exists towards these barriers, there seem to be a difference in perceptions between users and non-experienced users. This suggests a change of perception when BEV-adoption takes place, which endorse the study of (Schmalfuß et al., 2017), suggesting that *actual system use* as in experience , also influences *perceived usefulness* and *perceived ease of use*.
Currently the total market share of BEVs consists of 0.2% (Rijksdienst voor Ondernemend Nederland (RVO), 2016), in which according to Rogers (1995), users can be considered as *innovators* (See Figure 3). The prerequisites of *innovators* include control of substantial financial resources to absorb the possible loss owing to an unprofitable innovation, and the ability to understand and apply complex technical knowledge (Rogers,1995). Besides *the innovator* must be able to cope with a high degree of uncertainty at the moment of adoption. These characteristics were not included in the scope of this study. However, giving a closer look to the job description of respondents, respondents mainly exists of entrepreneurs and company directors. Furthermore, in my personal observation during post interview conversations, most respondents have a substantial understanding on technical aspects of battery technology and life time, challenges and limitations of charging possibilities, and environmental challenges of production. Concluding, it is likely that the P-set used for this study exists predominantly of innovators.

The longitudinal study of (Bühler et al., 2014) with early adopters showed that there is no change over usage time if it comes to main concerns such as range and charging. Taken into account that this study was published in 2014, and the technological improvements of BEVs as in range and charging infrastructure, it is interesting to see that these concerns seem to be of less importance to respondents in this study. Early adopters might have a more positive perception on range and charging possibilities than the critical mass, and still expectations might be met as I don’t see or feel dissatisfaction in the results and post interview conversations.

To conclude, the clear results of positive perceptions towards BEV differ from a diversity of perceptions found in literature. Hereby the characteristics of innovators and early adopters, from which the P-set mainly exists, might partially explain the highly positive perceptions found in this study. Furthermore, as the study of (Schmalfuß et al., 2017) suggests, an increase of experience with BEVs positively influence the perception. However, I do observe from the post interview conversations that there is something that relates to more than just ‘’rational’’ perceptions on usefulness and ease of use. Respondents made me feel they were part of a community, in which they share the same interest with other users. Their excitement and positivity, in defence of the technology they adopted was surprising. I also recognized characteristics as described by (Rogers, 1995), where cosmopolite social relationships and communication patterns exists between innovators. In this specific situation, it can easily develop as innovators are physically together for 30-40 minutes while charging, where one subject is discussed: The Tesla experience.

5.5. Researchers perceptive

In addition to the interpretation of the existing data set with clear perceptions and high explained variance, it's interesting to ask myself the question how selective respondents are within the group of Tesla users. Obviously in the previous chapter, the differences between perception are found in nuance differences in which the general perception is overly positive. With some of the respondents a short discussion on the topic took place after the survey was taken, respondents often refer to other Tesla users who has similar positive experience with their vehicle. The way some of the respondents talk about BEV-adoption and their experiences with their BEV, made me feel that they were more in the role of ambassadors than ''just'' users. Referring back to the main research questions looking for shared perceptions towards BEV-usage, I think the current set of respondents is a fair representation of existing shared perceptions.

As I can consider myself as an experienced BEV-user, it is also interesting to reflect on my own bias within this research. During the surveys, I didn't share my own experience, which kept me in the role of researcher instead of ''part of the *Tesla family''*. Out of curiosity I have filled in the survey myself, as an experiment executing the Q-varimax rotation with four factors including myself as well. According to my expectation this resulted in a significant load for the perception group ''financial drivers''. It's difficult to assess the influence of my bias within this research, but within the qualitative interpretation, framing of statements and the overall perception on BEV experience, my positivity can be of influence on the final results. At all times during the process I tried to think from the perception of the researcher, using my experience as an added value for this research, but without taking into account my own biased perception throughout the process of composing this research. I do share the positivity towards the concept electric driving and more specific Tesla. But I also recognize the observation as explained in the previous paragraph (see 5.4: Other observations), in which all added features are of high influence on my positive perception and satisfaction.

6. Conclusions

During this study, I have discovered different user perspectives on BEVs. It is interesting to learn about this case in which limited research is available, and which is also in line with my own interest towards electric mobility. But, what can we learn from this study, and how can this contribute towards further BEV adoption in the future?

The literature study served as a starting point for this study, shows different perceptions which exists towards (B)EV adoption and usage. Considering recent technological developments and market adoptions in the field of electric vehicles in general, it becomes clear that in recent years market focus has shifted from HEVs and PHEVs to BEVs. The general agenda of this research also progressed in a similar fashion.

This research’s key message lies in the four shared perceptions derived from forty Q-surveys. Interestingly, the four perceptions found are all overly positive and there is high consensus among respondents. Disagreement was only found in statements which were not considered important by respondents. Surprisingly, main barriers which were found in literature as range anxiety, charging time and charging infrastructure, seem to be perceived positively among the four groups. The only negative aspect was found in the perception group “the realists’’, which had a slight negative perception of the sufficiency of the charging infrastructure.

The main findings of this study lies in the combination of results found in this study, with the studies of Bühler, Cocron, Neumann, Franke, & Krems, (2014), Schmalfuß, Mühl, & Krems, (2017) and Rogers (1995), which indicate causal relations between BEV experience and perceptions. The suggestion of the first two studies mentioned is based on individual level, where the study of Rogers (1995) explains influence caused by interaction between individuals (see Figure 8).

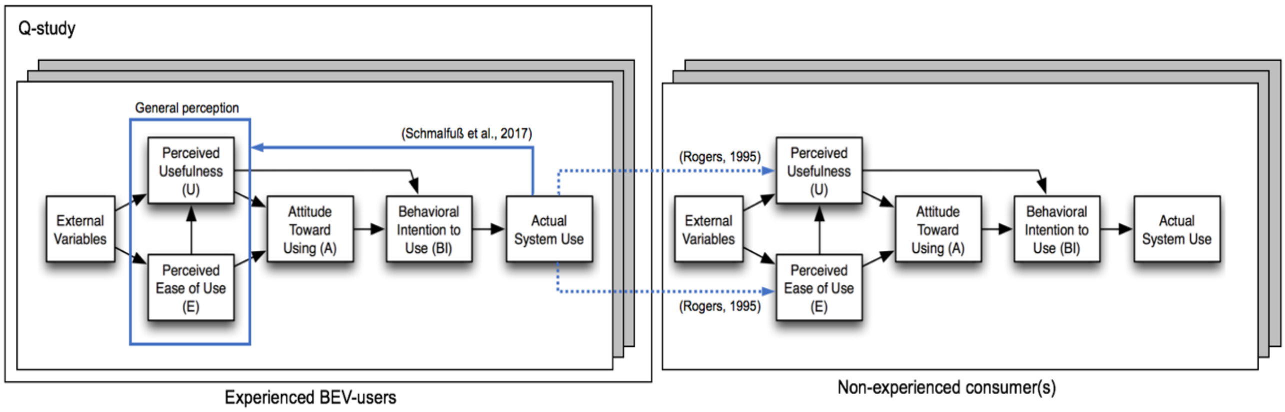


Figure 8: Theoretical framework

It is a plausible suggestion that perception is influenced positively by experience. From the main barriers as range anxiety, insufficient charging infrastructure, purchase costs and recharging time, only charging infrastructure is considered as a determining variable for the perception group ‘’the realist’’. In this study, other barriers besides charging infrastructure, are not considered as a priority in the composition of the perceptions at all. This suggests that experience influences the perception on BEVs. This is also in line with the post conversations with respondents, which took place after the survey. Positive remarks were given, and negative aspects were mostly dismissed as side effect which they got used to after adoption. I can also relate to the study of Rogers, (1995) in which the perception of experienced users can influence the perception of non-experienced users. This happens through communication, where respondents share knowledge on their BEV usage with excitement and positivity.

However, other considerations should also be taken into account. I observed that perceptions found in this study are related to more than a different drivetrain technology, difference in fuelling, mileage limitations and other obvious differences between BEVs and conventional vehicles. This observation corresponds with the Diffusion of Innovations theory by Rogers (1995). Respondents often make reference to the free charging infrastructure that Tesla as a brand offers, the frequent over the air updates which include new features, self-driving systems and innovative user interface. These offerings were all regarded as very positive and are possibly considered as an integral part of BEV-usage. Obviously, these offerings are brand specific, and if other manufacturers enter the market with BEVs, it doesn't automatically mean that similar offerings are integrated.

The contribution of this study towards further BEV adoption within the Netherlands lies mainly in the recommendations for further research. Several studies have been conducted on BEV adoption, but none are executed with data from experienced BEV-users. By measuring perceptions of experienced users, differences between experienced and unexperienced users can be uncovered. This study can serve as a starting point in researching the adoption process and understanding how perceptions of consumers without experience can be influenced to trigger BEV adoption. In chapter 8. Recommendations for further research are proposed.

A final observation includes the profile of respondents, which in my opinion match the profile of innovators and early adopters described by Rogers, (1995). As in general innovators and early adopters have a more positive attitude towards a new adopted technology, different perception might arise when a similar study is executed with for example ''the early majority''. In chapter 7, a discussion is further elaborated on the quality of the research findings, ability to answer the main research question and a personal reflection.

7. Discussion

This chapter covers a discussion on the most important limitations that might have impacted the quality of the findings and the ability to effectively answer the main research question. Furthermore, I explain the nature of these research-specific limitations and the choices that were made. In conclusion, I suggest some approaches to overcome these limitations in future research.

7.1. Quality of the research findings

7.1.1. New insights

As with all research, in this research I obtained new insights on the research methodology during the execution of the research. While conducting the interviews and collecting data, it became clear that a small number of selected statements in the Q-set were formulated rather factually than subjectively. This has led to sorting difficulties because sorting facts on a scale from *strongly agree* to *strongly disagree* is difficult. One can agree or disagree with opinions (subjective statements). Hence, a participant is expected to more or less ‘agree’ with factual statements. In conclusion, the quality of the emerged perspectives based on multi-interpretable Q sorts, might be limited by the inclusion of some factual statements selected for the P set. Therefore, the factual statements may have limited the quality of the research findings. Realizing this halfway, I decided not to change the survey design and redo the interviews and data collection. Instead, I tried to mitigate this potential limitation by elaborating on the objective statements myself during the Q sorts. Based on the post sort questions, some of respondents indeed proved to have a strong opinion on these specific factual statements. These opinions helped me to better understand the subjectivity relating to these factual statements.

7.1.2. Sample selection

The Q sample which is used in this study was selected by employing predefined perspectives derived from the work of Rezvani (2015). These specific perspectives have previously been utilized to understand the intentions and adoption behaviour towards (B)EVs for consumers and cover technical factors, contextual factors, cost factors and individual and social factors. Employing predefined perspectives to execute Q sample selection ensures that at least these perspectives are represented in the sample and are not overlooked. Therefore, it ensures a certain degree of representativeness when reducing the rich concourse to a relative small number of 24 statements. This structured selection thus may have contributed to the quality of the research findings. However, the relatively small number of statements remains a trade-off between representativeness and practical considerations. The richness of the study results and subsequent interpretation are thus bound by the ‘chosen’, predefined[2] Q sample selection – as are all studies which employ the Q method.

[2] The number of identified factors is purely empirical and wholy dependent on how the Q sorters (participants) actually performed (Brown, 1993). Ergo: the remainder of the study is focussed on discovering whether one or more perspectives on BEV usage would *emerge* from the data and reflection on these perspectives in relation to previous studies. This part of the study is objective by nature.

7.1.3. Analysis

Automated methods, like PCA, offer a potentially infinite number of rotated solutions. It leaves the researcher free to consider any data set from a variety of perspectives, before selecting the rotated solution which they consider to be the most appropriate and theoretically informative (Brown, 1993). A table containing a number of initial factors was created by PQMethod, which automatically extracts a maximum of eight factors by means of Principal Component factor Analysis (PCA). PQMethod is limited to eight factors in the PCA. This technical limitation may have impacted the quality of the research findings. However, eight or more factors are difficult to interpret, and this study resulted in only four perspectives. It seems that this limitation may only be theoretical.

7.2. Ability to answer the main research question

For the purpose of this study, I set out to identify perspectives on BEV usage by experienced users and comparing these to previously studied perspectives of the public on the same topic. Due to the relatively low adoption rate of BEVs by the public, I started the research with a limited group of potential respondents to approach for an interview. Luckily, I was able to collect enough data by choosing to limit the respondents group even further, to Tesla users only. The geographical location for data collection – a Tesla Supercharger station – consists of high traffic stations with many potential respondents visiting. However, this practical consideration has potentially limited the ability to answer the main research question. Hence, by solely interviewing users of one specific car brand the study results may only be considered to be valid for this group, not for all experienced BEV users in general. Currently, Tesla holds the biggest market share in the Dutch BEV market and also offers the most mature BEVs in terms of overall technology, radius and practical usability. This means that – compared to other brands – the Tesla respondents in this study might tend to hold a more positive perspective on BEV usage than BEV users of other brands. If the same research would be executed with experienced BEV users with all types of BEVs, I would expect some additional – less positive – perspectives.

It should be noted when it comes to BEV adoption, today's BEV users can still be considered early adopters. Currently 8.2 million vehicles are registered in the Netherlands (CBS, 2017), considering only 16.709 are BEVs (Rijksdienst voor Ondernemend Nederland (RVO), 2016), it comes down to around 0.2% of the total amount of vehicles. The Q methodology helped to uncover 'temporally frozen images of a connected series of subject positions' (Watts & Stenner, 2005). Unfolding or developing narratives are therefore not subject to this study. As BEVs become more common by the day, the study results are bound by the moment of data collection.

7.3. Personal reflection

Throughout this report different insights on BEV perceptions and user experiences are elaborated. Learning about a subject that is dynamic, as available information and technical developments are changing almost weekly is challenging and interesting at the same time. Executing the literature review was relatively difficult, many studies don't distinguish EVs, PHEVs and BEVs, where the differences in my opinion are essential. The lack of studies in the field of BEVs, made it harder to compose a clear literature review. However, this made it more interesting to find the knowledge gaps as a basis for this study.

I had great fun with the Q statistical analysis, which was new for me. My personal preference for quantitative analysis made me questioned my work through the process in how useful the outcome will be. The results and interpretation gave me more guidance to find the value of the work as a first step in understanding BEV-user perceptions and the relation between experience and perception.

I really enjoyed the data collection, it was very interesting to have conversations with respondents, and talk about their perception to BEV-usage, but also on how they see the future if it comes to electric mobility. It was ideal to be able to conduct the surveys at super charger stations, giving the right context to the study. The enthusiasm of some of the respondents was contagious, and endorse the positive perceptions found in the analysis.

I learned many things during this thesis process, also beyond the subject itself. Firstly, I see the importance of setting my own priorities, and the dedication of keeping those priorities in mind. It made me work focused on a project, in which this focus has to be maintained to show progress. Finalizing the last steps in this thesis experiences gives me a great satisfactory feeling, in which I’m grateful for all guidance and support from my direct surrounding.

8. Recommendations

The recommendations for further adoption of BEVs based on this study are not radical. However, if BEV adoption is desired, the theoretical framework in combination with the findings of the Q-surveys can contribute by means of practical recommendations. Furthermore, considering the limitations of this study, recommendations for further research can contribute to a better understanding on consumer perceptions on BEV usage.

The theoretical framework based on literature findings shows a causal relation between actual system use and the perception on usefulness and ease of use. Considering that the main barriers for non-experienced users concerning BEV usage are not recognized in the perceptions found in the Q-experiment, it might be that perceptions do change because of experience. In this case, giving the possibility for non-experienced users to experience BEV-usage can have a positive influence on consumer attitude and behavior. As the definition of experienced user in this study is determined on six months of experience, it can be challenging to give non-experienced users enough experience to consider them ''experienced''. I think a minimum amount of time should include BEV usage on a daily basis, this should at least be a matter of weeks to ensure non-experienced users get used to the new technology.

Besides possible change of perception on an individual basis. The framework also refers to change of perceptions influenced of non-experienced users by the perception of experienced users. This happens by communication and exchange of knowledge about BEV usage, in which different ways are possible to bring non-experienced users in touch with experienced users. I recommend using the continuous flow of experienced users who are charging their vehicle at super charger stations for certain events where they can interact with non-experienced users. Obviously, this is brand dependent, but as current BEV-users are limited it is an easy way to create the possibility of interaction.

This study can also serve as a starting point in understanding BEV usage perceptions. It also can contribute to a broader context understanding how perception, experience, attitude and behavior are related in the adoption process of electric mobility. Looking into the discussion chapter, further research can be proposed. As explained in the study of Rogers (1995), a requirement for successful adoption is the acceptance of the critical mass. Reproducing this Q-experiment with a wider public that doesn't predominantly consist of innovators and early adopters might produce a different result as presented here. Hereby it can be asked: *Which perceptions exists in further adoption categories as early and late majority, and how do they relate to the perceptions of innovators and early adopters?*

Additionally, this study focused in perceptions of experienced users, in which they were also related to perceptions found in literature. Hereby the suggestion is made that there is a causality between experience and perception on an individual level. It is interesting to find a certain group of potential users, and question them before and after adoption to see if inconsistencies really exist which might proof the relation between experience and perception. The part of potential users who don't decide to adopt a BEV, could be used as a benchmark by measuring their perception again as well. *Does the perception on BEV usage change on an individual level after adopting a BEV?*

It was established that BEV user experience is an important factor for user perceptions on BEV attributes. However, a German field study indicates that attitudes, knowledge and perceptions differ across gender, age and education, with males and higher educated individuals being more interested. (Plötz, Schneider, Globisch, & Dütschke, 2014). Therefore, it is important to consider that user experience is not the only relevant factor. If mass market adoption becomes reality, future quantitative empirical studies will have to prove the most important factors. *Which other factors are relevant* in *understanding adoption behaviour if it comes to battery electric vehicles?*

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Appendix A: Expert interview question sheet with answers

Expert Interview 1

Name: Martijn Duivenvoorden
Age: 49

1. How would you describe your job?

From when I am young I am working in the car industry. From 2013 I started my own company selling new Teslas and other hybrid cars. From 2014 on I also started selling used Teslas and other hybrid cars. Because of limited availability of used Tesla's in 2014 I started importing them from foreign countries. On a yearly basis, I sell around 40 used Teslas at the moment.

2. Thinking about positive and negative associations you have with Tesla's, which ones are coming up first?

When a prospect is contacting us when they are interested in buying a Tesla, the first questions they ask is: what the range of the car is. Not the range they advertise with, but the real range. And what should I do at home to charge the car at home. So, I think charging is the big issue, the financial advantages, people know about that. Furthermore, it's an expensive car, so that's why I provide the possibility to lease a car. User costs are very low compared to conventional cars.

3. What was the main driver that made you decide to buy a Tesla?

Since a year I am driving a Tesla. The main driver was to always have the possibility to let people do a test drive. Furthermore, Tesla's are my main product, so I want to drive my main product as well. I also sell V60 hybrids, but looking into that, they use even more fuel than a comparable car because they are heavier. And the battery range is around 30-40 km's only. So those cars are only made based on regulation, and they only perform during tests. It was a mistake of our government to subsidize those. Because those subsidies on hybrids are disappearing, you see a lot of entrepreneurs who are looking for a full electric car as those still have subsidies.

4. On a technical perspective, how would you compare a Tesla with conventional cars?

The amount of moving parts is ridiculously low compared to a conventional car. I have to say Tesla is premium American, so there are some shortcomings. But because there are less things in a Tesla that can break, compared to a conventional car I see it as positive. The advantage of Tesla is that it is one big computer with very little things that can break or need maintenance.

5. Has your opinion on Electric vehicles and its specifications changed since you start driving your Tesla?

When Tesla had less guarantee, I had my doubts about Tesla. Fischker just went bankrupt, and I was worried the same for Tesla. And that would bring a risk having such a car as the parts are very specific. But I found it amazing how Elon Musk convinced investors to invest and make the company successful. These days the *company is that big, as I feel more comfortable now. In short, I think that risk has disappeared.*

6. What is your perception on the current charging infrastructure within the Netherlands, and which developments do you think are necessary to make electric driving a success?

Tesla is different than other providers of electric cars, as they have an own supercharger network. I think that is very sufficient. When you need to drive more than 400km this is very convenient. If you look to other brands like Nissan or Renault, the only network to fast charge is fastned, but that is quite limited. This is slower and the coverage for this limited range vehicles is not sufficient enough. I think that is the reason that those cars are only bought for ''second car'', they need to improve the range to 400 km, that would be good enough but still you cannot go on holiday with such a car. Tesla mentioned to other brands to use their infrastructure, but so far other brands didn't use their competitor's infrastructure. I understood that other German car brands also want to invest in charging infrastructure. This is necessary to start selling cars successfully.

7. What do you think the social opinion is about electric driving in your direct environment?

I don't have a lot of negative reactions. They know it is an expensive car, but it is the future. It has good range, it is fast, there is charging infrastructure. Some of them can be jealous, but they also know it is my kind of business. Before this I drove a big Toyota Tundra, with a big engine, then I did feel less acceptance. So, I think with a Tesla, even though it is expensive, people accept it faster as it such a ''innovative'' and ''clean'' concept. In my opinion, the successful entrepreneur in the Netherlands, drives a Tesla.

Expert Interview 2

Name: Pointer de Jager
Age: 27

1. How would you describe your job?

I am a director of a company in the Restaurant and Hotel business. I am responsible for the financial department within this company.

2. How would you describe your direct experience with Electric Vehicles and specifically Tesla's?

Very positive, I love cars, but a Tesla is unique. The simplicity is great. Its silent and clean that feels very comfortable. My previous car was an old Volvo, now I'm driving electric I do realize how polluting it was. I do feel that now very strongly, it makes my experience with Tesla very positive.

3. Thinking about positive and negative associations you have with Tesla's, which ones are coming up first?

I'm driving my car now for 1,5 years. The only really thing with this car, also the main reason for a lot of people to say it is not for them, is that you have to plan better. But I don't think it is very negative. I can charge at work, and at tesla superchargers you can charge for free. But you do have to plan better when you have to drive a lot on a day.

4. What was the main driver that made you decide to buy a Tesla?

Actually, I was quite skeptical about driving an electric car. But after experiencing a car from a family member I start getting excited about it. It gave me a very positive experience, this in combination with the financial aspects and the sustainability made me decide to drive a Tesla.

So, what was the main driver of those?

The financial aspect was the decider. But when using it, every aspect feels positive to me.

5. Has your opinion on Electric vehicles and its specifications changed since you start driving your Tesla?

As I said, I was very sceptical. But after start using this car, I felt becoming more positive towards electric cars. Now if I look to a normal car, I see costs, maintenance, complexity in the engine. This all makes me feel better that I drive an electric vehicle. I won't turn back to a normal car so fast anymore I guess!

6. What is your perception on the current charging infrastructure within the Netherlands, and which developments do you think are necessary to make electric driving a success?

I think the current infrastructure for Tesla's is sufficient. But that is because of the supercharger stations. But when more cars are sold, it can get busier at chargers which I think they should increase the number of chargers. With certain apps there are also a lot of public chargers that are easy to find. You have to pay for them, but I see it as a second solution when I need to charge an extra bit.

7. What do you think the social opinion is about electric driving in your direct environment?

I think socially people are really open towards the concept of electric driving, but I do feel an undernote socially that people think, it is not something for me. I hear arguments like, but when I am going on holiday, or when I am almost empty and there is no charger. I think the saying is right, unknown makes it unpopular. And also, I hear people that they think Tesla is a good possibility, but that is too expensive.

Appendix B: Statement selection

Below the statements from literature and conducted interviews are categorized in four categories. Hereby a good balance on different aspects on electric driving can be used in the formation of the Q-sorts.

Perceptions on Electric vehicles

Below the statements from literature and conducted interviews are categorized in four categories. Hereby a good balance on different aspects on electric driving can be used in the formation of the Q-sorts.

Perceptions on Electric vehicles

Technical factors

Positive

1. Faster acceleration/more horse power (Lelij, 2013)
2. Relaxed driving because of no engine sound (Nu elektrisch, 2015)
3. Full electric cars only have 10% of moving parts compared to conventional cars, that makes it more reliable (Duivenvoorden, 2017)

Negative

4. Not possible to drive long distances (Lelij, 2013)
5. Mileage is limited(ANWB, 2015)
6. Charging takes too long(Lelij, 2013)(ANWB, 2015)
7. I'm afraid that the car will stop during a trip (Lelij, 2013)
8. The time it takes to fully charge the battery has limited my use of the EV (Bunce et al., 2014)
9. Adapting to charging the vehicle is a difficult task (Bunce et al., 2014)
10. Relatively new technology, specific parts and dependency on supplier (Duivenvoorden, 2017)

Contextual factors

Positive

11. Less dependency on fossil fuels (Lelij, 2013)
12. Available parking spot specific for electric vehicles (Lelij, 2013)
13. I can complete my daily trips without a public charging infrastructure (Bunce et al., 2014)
14. Charging infrastructure for specific BEVs (superchargers Tesla) is sufficient (Duivenvoorden, 2017)

Negative

15. Charging infrastructure is not sufficient enough (Lelij, 2013)
16. I would prefer an automatic charging system (Bunce et al., 2014)
17. Charging point can be occupied when you need it (ANWB, 2015)
18. More planning is required for traveling by car (de Jager, 2017)

Cost factors

Positive

19. Saving money on petrol (Lelij, 2013)
20. The government makes electric driving financially attractive (Duivenvoorden, 2017)
21. The cost on maintenance is low compared to maintenance of conventional cars (de Jager, 2017)
22. Government subsidies when purchasing an EV (Lelij, 2013) (Duivenvoorden, 2017)

23. Tax advantage on purchase (BPM) (Lelij, 2013)
24. Low tax on usage (bijtelling + discount road tax) (Lelij, 2013)(ANWB, 2015)

Negative

25. Expensive to purchase a BEV (Lelij, 2013) (ANWB, 2015)(Duivenvoorden, 2017)
26. I have no clear overview on costs of usage (Lelij, 2013)

Individual and Social factors

Positive

27. Driving an electric vehicle is cool (Lelij, 2013)
28. Contribute to cleaner air (Lelij, 2013)
29. Contribute towards less CO_2 emissions (Lelij, 2013)
30. Contribute to more silent vehicles (Lelij, 2013)
31. Good for my reputation (Lelij, 2013)
32. I would be willing to pay more for a vehicle that I knew was less harmful to the environment (Bunce et al., 2014)
33. I prefer charging my car than going to a petrol station (Bunce et al., 2014)
34. There is higher acceptance towards an expensive BEV compared to expensive conventional cars (Duivenvoorden, 2017)
35. Driving a Tesla is an unique driving experience (de Jager, 2017)

Negative

36. People in my surrounding are a bit jealous because it is an expensive car (Duivenvoorden, 2017)

Q-set composition procedure

Before conducting the Q-sorting, decisions must be made on which perceptions will be included. Based on the 36 perceptions found in literature and conducted interviews, a selection will be composed of 24 perceptions that will cover all four categories positive and negative. The Q-sample will consist of six technical, six contextual, six costs, and six individual and social factors. The statements are randomly numbered between 1 to 24 in the final Q-sorting that is presented to respondents.

For each sub-category with three or less perceptions, all of them automatically will be added to the Q-sort. For the categories with more than three perceptions a substantiated selection is made.

In ''technical – negative'', perception 4 and 5 are similar as perception 4 is excluded. Perceptions 6 and 8 also has similarities as I chose for perception 6 because it is a very clear statement. From perceptions 7,9 and 10, I chose to include 7 and 10 as it seems most relevant where 9 is implicated already by other perceptions about charging.

In ''contextual – positive'', perceptions 11,12 and 13 are included in the Q-sorting. Perception 14 is the inverse of perception 15 which is included in the Q-sorting within ''contextual – negative''.

For ''contextual – negative'' perception 16 is excluded as the concept of ''automatic charging system'' can raise questions at respondents. The concept itself is not operational for users at this moment in time, which makes it irrelevant for the actual user experience.

Within ''cost – positive'' four perceptions were included in the Q-sorting. Perceptions 19 and 21 have no overlap with the other perceptions and are relevant for this case study. The other perceptions (20, 22, 23 and 24) are about government incentives. Taking the difference into account between incentives for purchasing, or incentives for using I included one of both (22 and 24).

For ‘’Individual and social – positive’’ four out of nine perceptions are selected. Based on overlap and my own opinion as a Tesla driver on relevance of these perceptions, four of them are included in the Q-sorting. Perception 27 gives a good indication about respondents and their self-identity with their EV. Perception 28 is not included as it has overlap with 29. Perceptions 30 and 31 in my opinion is less relevant, and perception 32 gives information about the environmental awareness of the users and their considerations when they purchased their EV. Perception 33 has overlap with contextual perceptions 6 and 9, and perception 34 has overlap with perception 36 that is also included in the Q-sorting under ‘’Individual and social – negative’’. I found perception 35 interesting as it also gives an indication of user’s opinion of comparing EV’s with conventional cars. Giving insight if respondents think having a BEV is rather a new concept of using a car, or just an improvement or stagnation of the existing concept.

Appendix C: Data collection

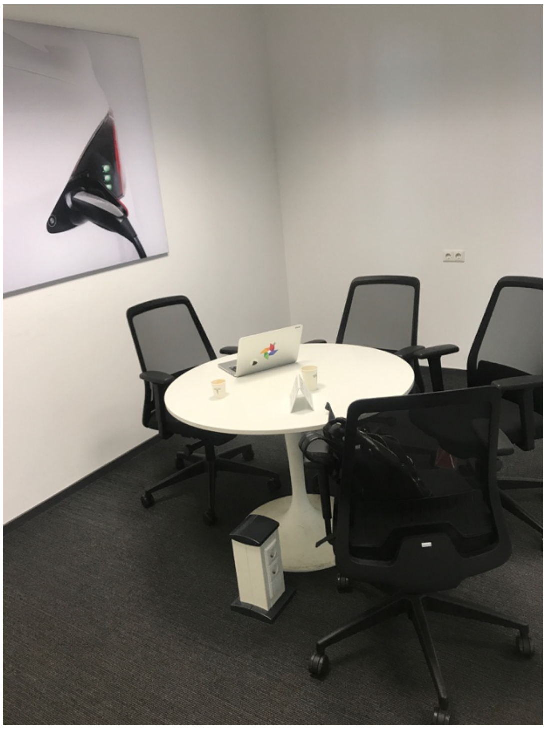


Image 1: Office at Supercharger Amsterdam

Image 2: Outside Q-sorts collection at Supercharger Zwolle

Image 3: Charging Tesla next to Q-sort collection

Appendix D: Data

Table 15 Correlation Matrix Between Sorts

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1		59	-6	19	49	9	28	26	1	32	38	31	-1	9	21	35	7	31	38	21	21	24	-6	22	10	-6	13	10	-7	18	-16	35	10	6	16	15	-15	-1	-15	-10
2	59		15	41	49	28	56	18	37	43	38	47	13	31	46	50	37	37	46	31	40	41	29	40	3	34	32	18	25	49	12	31	9	4	35	26	13	38	4	9
3	-6	15		54	26	57	44	35	-1	28	40	34	32	51	26	34	57	38	37	44	24	51	60	51	59	56	72	9	43	25	54	6	35	40	59	31	35	62	65	56
4	19	41	54		43	66	81	46	6	71	71	35	46	37	25	28	78	60	44	56	47	47	50	63	59	54	60	-3	62	-7	24	43	13	24	47	22	24	66	38	29
5	49	49	26	43		49	56	38	3	47	66	21	18	6	32	15	31	71	25	53	7	32	24	19	21	37	19	10	25	-7	7	54	10	-1	31	9	13	40	-1	19
6	9	28	57	66	49		69	57	6	68	60	28	41	43	38	35	59	46	40	43	51	50	56	65	47	56	44	34	59	13	41	44	24	32	54	31	35	56	44	47
7	28	56	44	81	56	69		41	7	71	71	37	44	29	44	29	65	57	37	60	47	54	57	59	37	65	56	26	66	3	26	51	18	31	54	28	34	59	38	32
8	26	18	35	46	38	57	41		-12	49	59	25	26	4	37	44	28	31	15	43	46	32	18	57	43	6	21	-9	43	-3	49	51	53	25	38	4	-15	25	19	46
9	1	37	-1	6	3	6	7	-12		24	0	28	-13	12	25	22	22	7	40	25	13	-13	-3	13	-18	18	-9	-15	18	43	-3	-1	-16	7	-22	-24	1	19	-10	-10
10	32	43	28	71	47	68	71	49	24		60	49	37	21	37	44	69	46	47	53	44	47	47	65	47	60	38	9	38	3	34	28	35	34	47	9	16	44	22	38
11	38	38	40	71	66	60	71	59	0	60		21	22	7	34	12	37	59	37	72	37	40	22	62	57	38	38	3	51	-16	18	54	28	6	49	9	19	54	26	37
12	31	47	34	35	21	28	37	25	28	49	21		31	60	32	75	49	37	62	40	13	32	50	38	44	41	50	15	43	29	31	-7	38	59	28	32	31	19	12	25
13	-1	13	32	46	18	41	44	26	-13	37	22	31		44	35	28	34	24	4	38	6	21	31	21	35	31	40	-18	32	13	31	32	41	49	9	25	-10	16	38	32
14	9	31	51	37	6	43	29	4	12	21	7	60	44		38	63	41	28	54	16	10	35	54	34	47	35	60	19	49	54	28	7	16	54	10	47	43	16	40	28
15	21	46	26	25	32	38	44	37	25	37	34	32	35	38		50	35	38	26	38	29	44	35	56	12	32	29	18	37	57	28	40	13	44	24	26	18	24	22	34
16	35	50	34	28	15	35	29	44	22	44	12	75	28	63	50		49	15	43	26	29	32	46	47	44	9	35	9	31	59	41	12	46	59	21	29	15	3	16	31
17	7	37	57	78	31	59	65	28	22	69	37	49	34	41	35	49		56	46	46	35	57	69	62	50	59	56	18	41	18	35	13	13	44	54	21	34	60	38	38
18	31	37	38	60	71	46	57	31	7	46	59	37	24	28	38	15	56		47	44	21	38	47	44	41	53	31	7	51	-15	16	28	-3	29	38	3	34	65	12	22
19	38	46	37	44	25	40	37	15	40	47	37	62	4	54	26	43	46	47		41	16	38	49	51	44	47	40	19	49	31	12	1	16	44	26	16	29	29	1	21
20	21	31	44	56	53	43	60	43	25	53	72	40	38	16	38	26	46	44	41		16	38	16	38	53	43	35	-3	49	1	10	38	43	26	31	-3	7	28	28	34

21	21	40	24	47	7	51	47	46	13	44	37	13	6	10	29	29	35	21	16	16		24	15	60	24	25	13	19	46	4	4	24	-6	15	47	18	29	47	21	0
22	24	41	51	47	32	50	54	32	-13	47	40	32	21	35	44	32	57	38	38	38	24		54	51	29	62	68	46	24	29	40	18	29	18	75	25	24	40	50	49
23	-6	29	60	50	24	56	57	18	-3	47	22	50	31	54	35	46	69	47	49	16	15	54		51	46	63	59	29	51	21	60	-3	26	63	53	37	56	57	26	50
24	22	40	51	63	19	65	59	57	13	65	62	38	21	34	56	47	62	44	51	38	60	51	51		56	46	51	26	50	29	49	25	31	43	68	29	32	56	47	60
25	10	3	59	59	21	47	37	43	-18	47	57	44	35	47	12	44	50	41	44	53	24	29	46	56		26	44	-9	49	-10	35	4	53	51	38	12	34	34	35	47
26	-6	34	56	54	37	56	65	6	18	60	38	41	31	35	32	9	59	53	47	43	25	62	63	46	26		62	35	44	7	37	-3	15	26	62	25	50	65	47	44
27	13	32	72	60	19	44	56	21	-9	38	38	50	40	60	29	35	56	31	40	35	13	68	59	51	44	62		31	40	29	43	24	28	37	60	63	43	46	59	56
28	10	18	9	-3	10	34	26	-9	-15	9	3	15	-18	19	18	9	18	7	19	-3	19	46	29	26	-9	35	31		10	21	-4	7	-15	9	54	57	57	3	22	22
29	-7	25	43	62	25	59	66	43	18	38	51	43	32	49	37	31	41	51	49	49	46	24	51	50	49	44	40	10		-4	21	40	9	51	24	22	51	47	15	22
30	18	49	25	-7	-7	13	3	-3	43	3	-16	29	13	54	57	59	18	-15	31	1	4	29	21	29	-10	7	29	21	-4		26	6	13	24	6	29	-1	-6	29	25
31	-16	12	54	24	7	41	26	49	-3	34	18	31	31	28	28	41	35	16	12	10	4	40	60	49	35	37	43	-4	21	26		-6	71	38	43	7	6	41	50	82
32	35	31	6	43	54	44	51	51	-1	28	54	-7	32	7	40	12	13	28	1	38	24	18	-3	25	4	-3	24	7	40	6	-6		-1	4	6	31	-3	10	-1	15
33	10	9	35	13	10	24	18	53	-16	35	28	38	41	16	13	46	13	-3	16	43	-6	29	26	31	53	15	28	-15	9	13	71	-1		38	29	-1	-19	-1	34	71
34	6	4	40	24	-1	32	31	25	7	34	6	59	49	54	44	59	44	29	44	26	15	18	63	43	51	26	37	9	51	24	38	4	38		16	31	35	15	9	37
35	16	35	59	47	31	54	54	38	-22	47	49	28	9	10	24	21	54	38	26	31	47	75	53	68	38	62	60	54	24	6	43	6	29	16		37	41	60	51	56
36	15	26	31	22	9	31	28	4	-24	9	9	32	25	47	26	29	21	3	16	-3	18	25	37	29	12	25	63	57	22	29	7	31	-1	31	37		54	12	16	29
37	-15	13	35	24	13	35	34	-15	1	16	19	31	-10	43	18	15	34	34	29	7	29	24	56	32	34	50	43	57	51	-1	6	-3	-19	35	41	54		44	12	21
38	-1	38	62	66	40	56	59	25	19	44	54	19	16	16	24	3	60	65	29	28	47	40	57	56	34	65	46	3	47	-6	41	10	-1	15	60	12	44		34	32
39	-15	4	65	38	-1	44	38	19	-10	22	26	12	38	40	22	16	38	12	1	28	21	50	26	47	35	47	59	22	15	29	50	-1	34	9	51	16	12	34		57
40	-10	9	56	29	19	47	32	46	-10	38	37	25	32	28	34	31	38	22	21	34	0	49	50	60	47	44	56	22	22	25	82	15	71	37	56	29	21	32	57	

Appendix E: Factor loadings without rotation

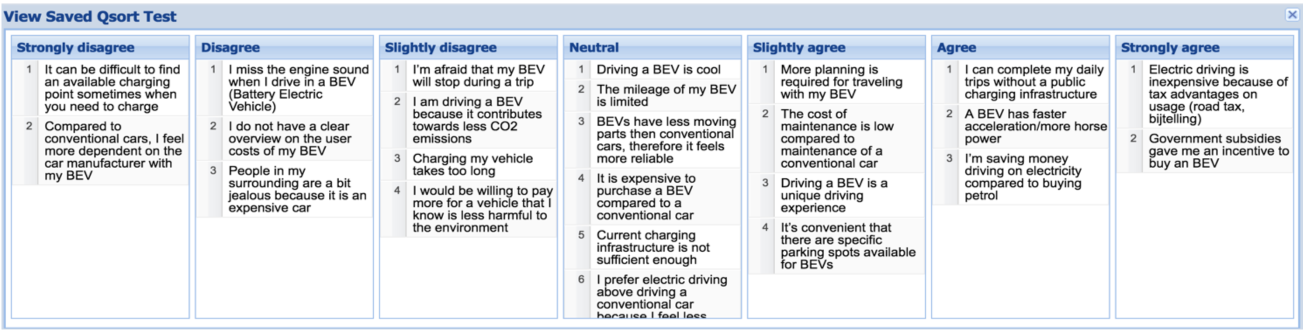
	Factor loadings							
SORTS	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	0,25090	0,40260	0,45430	0,22750	0,37140	0,02380	-0,41960	0,14040
2	0,52730	0,23610	0,55060	0,01850	0,26770	-0,26160	-0,05670	-0,07190
3	0,72570	-0,26890	-0,27200	-0,06180	-0,08300	-0,05310	0,02770	-0,13600
4	0,79410	0,32950	-0,12190	-0,05280	-0,18720	0,05700	0,09330	-0,09880
5	0,49700	0,57870	0,05180	0,01930	0,13750	0,02970	-0,32490	-0,24570
6	0,79510	0,13140	-0,12510	-0,07300	0,05660	0,09230	0,23330	0,05200
7	0,81730	0,33210	-0,00370	-0,12380	0,03410	0,06840	0,07700	-0,14220
8	0,54590	0,28140	-0,25430	0,48030	0,21120	0,11340	0,16100	0,33790
9	0,10600	0,10090	0,54990	0,09720	-0,31970	-0,52810	0,31400	-0,11800
10	0,74300	0,27160	0,02010	0,14230	-0,06750	-0,17550	-0,03880	0,11930
11	0,67760	0,57250	-0,20400	0,07540	0,06030	0,05100	-0,08870	0,02590
12	0,61030	-0,24520	0,41810	0,20710	-0,22480	0,00910	-0,30380	0,10030
13	0,46880	-0,10130	-0,13800	0,36200	-0,07770	0,34150	0,16050	-0,46040
14	0,57530	-0,47100	0,36500	0,03360	-0,15840	0,25900	0,03390	-0,19820
15	0,56170	-0,01150	0,34100	0,17680	0,23360	-0,00920	0,31320	-0,14300
16	0,57040	-0,30450	0,44970	0,44570	0,05330	0,03940	0,00920	0,23910
17	0,77990	-0,01790	0,02970	-0,10950	-0,20330	-0,17790	0,03540	-0,03500
18	0,63630	0,38990	0,03360	-0,14970	-0,26070	-0,00730	-0,21940	-0,11900
19	0,59500	-0,01820	0,43780	0,00810	-0,27890	-0,14220	-0,28320	0,11290
20	0,61390	0,34490	-0,05670	0,28210	-0,12420	-0,02150	-0,12570	-0,21870
21	0,46450	0,27780	0,08850	-0,17010	0,09390	-0,03630	0,48740	0,49770
22	0,69570	-0,10230	-0,07580	-0,15680	0,36280	-0,19980	-0,19680	-0,09440
23	0,73840	-0,34710	-0,00440	-0,20050	-0,21360	0,00480	-0,09680	0,02690
24	0,80810	0,00200	-0,02890	0,02280	0,11760	-0,13390	0,21940	0,34040
25	0,64560	-0,07070	-0,26580	0,23150	-0,33520	0,22220	-0,20550	0,24140
26	0,71380	-0,06480	-0,09040	-0,38870	-0,13350	-0,26310	-0,09590	-0,24440
27	0,74530	-0,30490	-0,06180	-0,17380	0,14590	0,12370	-0,12800	-0,25020
28	0,28090	-0,21190	0,18090	-0,59430	0,46280	0,12630	-0,13180	0,17260
29	0,66290	0,14400	0,07280	-0,07650	-0,38960	0,32500	0,27260	0,07390
30	0,26170	-0,47190	0,55360	0,20450	0,35910	-0,25220	0,25080	-0,20080
31	0,53680	-0,43500	-0,38300	0,30410	0,06230	-0,26160	0,07070	0,05480
32	0,34810	0,52980	0,08670	0,15550	0,36090	0,45040	0,25550	-0,21890
33	0,40630	-0,28030	-0,34820	0,66330	0,11100	-0,06260	-0,25420	0,11170
34	0,54000	-0,39370	0,18460	0,23690	-0,33260	0,31610	0,01810	0,15330
35	0,69890	-0,04680	-0,28640	-0,33530	0,34220	-0,19520	-0,15700	0,24480
36	0,40210	-0,31690	0,22130	-0,32810	0,36340	0,51930	-0,01230	-0,01920
37	0,44820	-0,20810	0,12880	-0,65410	-0,19900	0,24620	-0,03160	0,19300
38	0,66030	0,19990	-0,20880	-0,36240	-0,21350	-0,29120	0,15270	-0,02580
39	0,51070	-0,33420	-0,40690	-0,04590	0,22430	-0,17420	0,20570	-0,24820

40	0,62150	-0,36240	-0,41110	0,19430	0,22640	-0,08870	-0,04730	-0,01020
Eigenvalues	14,44	3,74	3,15	3,03	2,31	1,90	1,64	1,57
expl.Var. %	36	9	8	8	6	5	4	4

-

Appendix F: Interview procedure Q-sort

- At supercharger stations users were asked if they have ten minutes of their time for a survey about their battery electric vehicle. Users were randomly asked by walk in and availability of myself.
- Following I asked if they are the main user of the vehicle and have at least six months of experience. If so they were invited to participate to be part of the research.
- In a 1-minute introduction, I explained about the research topic and their role in the research explaining I will be there to answer any questions that may arise during the survey.
- The respondents were first asked by the PQ-method software to fill in the pre-Q-sort response sheet as shown in Appendix F.
- In two phases, the Q-sort is executed, first a pre-selection took place in which respondents dragged that statements into three categories: Disagree, Neutral and Agree.
- Secondly the final Q-sort is conducted, in which participants dragged statements into categories which all had a fixed number of statements possible, see example:



- Finalizing this Q-sort, the post survey questions as in Appendix G were filled in.

Appendix G: Response sheet Q-sort interview

Response sheet:

Interviewee code: ______

First word that comes to mind when you think about electric driving: __________

Short questions:

Age: ______

What is your highest level of education?

- Up to high school graduate
- College graduate
- Graduate degree or higher
- I don't wish to share

Short job description: ______________________________
______

Years of experience with Tesla? _____

What was your previous type of car? ______________________________

Post survey questions (filled in by interviewer):

Explanation of statement in category strongly agree:

____

Explanation of statement in category strongly disagree:

____

Is there anything missing in this survey?

____

Do you have any other questions related to this survey?

____

Appendix H: Disagreement vs consensus

Group	1	2	3	4
BEV will stop during a trip	-2	-3	-3	-3
People in my surrounding are a bit jealous	0	0	0	-1
Less moving parts, feels more reliable	1	0	2	1
Driving a BEV is a unique driving experience	2	1	0	2
The cost of maintenance is low	1	1	0	0
Acceleration/power	2	3	3	3
Specific parking spots are convenient	0	1	0	-1
Difficult to find available charging point	0	-2	-1	-1
Miss the engine sound	-1	-2	-3	-3
I can complete my daily trips without public charging	0	2	-1	0
Driving a BEV is cool	0	0	2	3
Less dependency on fossil fuels	2	0	0	1
Saving money compared to petrol	1	2	-1	2
Feel more dependent on the car manufacturer	-2	-2	0	1
No overview on costs of BEV	-3	-3	-2	0
Charging my vehicle takes too long	-2	-1	1	-2
It is expensive to purchase a BEV	0	0	2	-2
More planning required	-1	1	3	1
Contributes towards less CO_2	3	-1	1	0
Pay more for environment	3	-1	1	0
Tax advantages on usage	1	2	-1	-1
Charging infrastructure not sufficient	-1	0	1	-2
Mileage is limited	-3	-1	-2	2
Government subsidies	-1	3	-2	0