User-Centered Design and Development of a Gamified Hybrid Mobile Application

With the Goal of Encouraging eCar Owners to Share Charging Points

Ronja Rogerdatter Knudtsen and Ida Herigstad Lothe

Master Thesis
Informatics: Design, Use and Interaction
60 credits

Department of Informatics
The Faculty of Mathematics and Natural Sciences

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http://www.duo.uio.no/

Print: University Print Centre, University of Oslo

Abstract

Electric automobiles (eCars) are considered less harmful to the environment than conventional, fossil-fueled vehicles. Due to economic incentives provided by the Norwegian government, eCars have enjoyed great success in Norway. Because of this, the number of eCars now outnumbers the number of publicly available charging points. This charging point shortage is further exacerbated by eCar drivers that occupy charging points without needing electricity.

The premise of this thesis has been to research how a mobile application can be designed and developed so as to encourage eCar drivers to move their cars so that other, more needy eCar drivers get access to charging points. In addition, our research has uncovered a list of user requirements that, among other things, reveal user needs that are not currently being met by current technology aimed at eCar owners.

The research has been done through a user-centered design process, and the problem area has been investigated by triangulating three research methods, namely an online survey, twelve interviews with eCar drivers in which prototypes have been utilized as a means for evaluating design ideas and functionalities, and a document analysis of an online forum for eCar enthusiasts. The design and development processes have been concurrent and continually guided by user feedback. Throughout the design process, concepts from Self-Determination Theory, Persuasive Technology, and Gamification have been used in order to explore how the app can facilitate the sharing of charging points between eCar drivers.

The findings suggested that some eCar drivers are motivated to move their eCars to let other eCar drivers charge, but lack a simple means to tell them when other eCar owners need charging. Furthermore, the results suggest that points, badges, and leaderboards, which are frequently used in gamified systems, are insufficient as motivators on their own. Rather than implementing points, badges, and leaderboards in the belief that this will change user behaviour, a thorough understanding of the users is necessary in order to design technology that is perceived as informative rather than controlling, and that supports the users' needs for competence, relatedness, and autonomy.

Acknowledgements (Ronja)

Firstly I want to thank my supervisor Gisle Hannemyr. Both for offering me the opportunity to work for you during the summer, for giving me a good job reference and for honest help and guidance throughout the work on this thesis.

I also want to thank Ida Lothe for great companionship and collaboration, without you the final thesis would have a number of spelling mistakes, the theory work would not be nearly as thorough and most of all, the last years would have been much more boring.

I also want to thank my other friends in the “squad” (Mathias Olaussen Rove, Marit Kilde Mjelva, Helene Isaksen, and Mari Iversen) for all their positive energy, stupid jokes, our fun taco evenings and the best five years of school.

I want to thank my mother and father for encouraging me to pursue my own interests and dreams. You didn’t dissapoint me, even when other kids wanted to go out and play, and I wanted to stay inside with my computer. Without you I would not be alive, and with other parents I would most likely not have finished this thesis, or applied to a bachelor in Informatics.

I want to thank my wonderful boyfriend for supporting me when everything seemed impossible. For feeding me chocolate and tucking me in like a baby when everything seemed dark, for applauding me when I succeeded and for always believing in me.

Acknowledgements (Ida)

First and foremost, I want to thank Gisle Hannemyr, our supervisor, for providing constructive feedback and interesting discussions throughout the writing process.

I also want to thank my big sister, Siv, for inspiring me to study technology in the first place. If I didn't have you in my life, I never would have considered IT as a field of study. On the subject of family, I want to leverage a huge "thank you" to my mom, Else (Elfi), for having two full-time jobs, namely as an anesthetic nurse and as my 24/7 mom. Thank you for enduring countless hours listening to me complaining, fretting, and in other ways venting my frustrations and anxieties throughout my university years. Thank you for always listening and for always believing in me, even when I haven't been able to do so.

I also want to thank "the squad" (Ronja Knudtsen, Mathias Olaussen Rove, Marit Kilde Mjelva, Helene Isaksen, and Mari Iversen), for being the best friends I could ever have hoped for at IFI. Honestly, I think I would have given up on my education a long time ago, and I certainly would never have pursued a master's degree, if it weren't for you. Thank you for all the fun times we have shared over the past years and for all the avocadoes you have brought to our biannual "sumotaco" parties. A special thanks is owed to the co-author of this thesis, Ronja, in addition to numerous apologies for all the times I have, to put it in your words, been "overly negative" about certain aspects of our research effort. Thank you for keeping my spirits high and for never giving up.

Finally, in this conclusion (which, from what I understand, is usually reserved for thanking significant others), I want to thank my dog, Lucky. Thank you for being the best friend a person could ever ask for during the past fourteen years. The relentless joy you have displayed each and every day I have returned home, exhausted from a long day of writing, has meant more to me than you can ever imagine, (and much more than you can ever hope to read in a written language).

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1 Introduction

In this chapter we will present our motivation for writing this thesis, our research questions, the terminology used throughout this thesis, the current electric car landscape in Norway, as well as the challenges we set out to solve through our project and how our solution contrasts to the technical solutions that already exist for our target population.

1.1 Our motivation

The main motivation behind this thesis is to research how technology can be designed and developed to promote more sustainable behaviour in its users.

In environmental sciences, sustainability can be defined as "the quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance" (Dictionary.com, n.d.).

Particulate matter (PM) and nitrogen dioxide (NO2) are considered by the Norwegian Institute of Public Health as two of the three primary air pollutants leading to harm, sickness, and death in our part of the world (Norsk Folkehelseinstitutt, 2017). Both of these substances are primarily emitted through road traffic by conventional automobiles that run on fossil fuels such as gasoline and diesel. In addition to PM and NO2, traffic is cited by Statistics Norway (Statistisk sentralbyrå) as the third largest source for the environmentally detrimental carbon dioxide (CO2) emissions in Norway, accounting for 10,3 million metric tons of CO2 and CO2 equivalent emissions in 2015 (Statistisk Sentralbyrå, 2016b).

According to United Nations (n.d.), global emissions of carbon dioxide (CO2) have increased by nearly 50 per cent in the past 16 years, which has resulted in a rise in average global temperature which in turn cause dire environmental consequences such as yield reduction of major crops and rising sea levels. Climate change is widely recognized as one of the major challenges of our time, and as recently as a few months ago at the time of writing Norway ratified the Paris Agreement: the first universal, legally binding global treaty to combat climate change. As a means to reach the goals set forth in the Paris agreement, the Norwegian government's budget for 2017 focus heavily on green technology and cleaner energy (Klima- og miljødepartementet, 2016). In a related news bulletin, the Norwegian Minister of Climate and the Environment states that the government will continue with the incentives for electric

vehicles until 2020, and suggests an increase in fuel surcharge. Further he states that Norway will invest 71,5 million kroner for low-emission research in 2017, particularly in relation to transport, adding that technological development is necessary to reduce the emissions (Regjeringen.no, 2016).

Electric vehicles are vehicles that are capable of running on electricity rather than fossil fuels. When such a vehicle runs on pure electricity they are often referred to as "zero emission vehicles" because they do not emit any air pollutant, and are as a result much less harmful to the environment than conventional vehicles. Electric vehicles have enjoyed great success in Norway and as a result the country's politics, which offer various incentives to eCar drivers, is frequently hailed internationally as a model for how to encourage sustainable behaviour (Jolly, 2015; Barnato, 2016; Hockenos, 2017). Despite various politicians talking about removing the eCar incentives sometime in the near future, EVs accounted for approximately 40 per cent of new car sales in Norway in early 2017 (Bellona, 2017). However, the rapidly growing number of electric vehicles in Norway also present a problem in the form of that the public charging points providing the vehicles with electricity have become a scarce resource. Some electric car owners exacerbate this charging point shortage by needlessly occupying the charging spots when they don't need them. The motivations behind this thesis is to research how technology can be developed to help ease the charging point shortage by motivating the drivers of electric vehicles to move their cars and otherwise support them in the challenges they meet, so that future prospective electric vehicles owners to a lesser degree are deterred from choosing the more sustainable option of vehicle.

1.2 Terminology

Electric vehicles (EVs) encompasses any vehicles that are capable of running on electricity, rather than fossil fuels. Pure electric cars are automobiles that run exclusively on electricity and is an instance of EVs. In Norway, pure electric cars are denoted with registration plates with the letters "EL" or "EK" to differentiate them from other vehicles. Many of the public charging points in Norway are reserved for cars with "EL" or "EK" registration plates.

Hybrid electric vehicles (HEVs) are vehicles that have a conventional internal combustion engines in addition to being capable of running on electricity. Plug-in hybrid vehicles (PHEVs) are hybrid EVs that can be plugged into a power outlet in order to recharge. In

Norway, PHEVs are required to utilize the power outlets while parked at a charging point, while no such requirement exist for pure electric vehicles. For the purposes of our thesis, we will refer to pure electric cars and PHEVs collectively as "eCars" henceforth.

A charging point is a power outlet with a parking spot reserved for eCars, while a charging station is a location with one or more charging points. Different charging point have different charging capacities, depending on how many kilowatt (kW) of energy they produce. So-called "rapid charging points" ("hurtigladere" in Norwegian) have a nominal charging effect of more than 23 kilowatts and are typically capable of charging an average eCar up to 80% during the course of half an hour (Ladestasjoner.no, n.d.; ZapMap, n.d.). Different charging capacities and different makes and models of eCars also require different cables for charging, and these cables need to be compatible with the outlet at a charging point in order to charge an eCar. At the time of writing, Type 2 outlets (also nicknamed "the new eCar outlet") is replacing Schuko outlets (often called "household outlets" or "husholdningskontakt" in Norwegian) as a new standard, which may cause problems for drivers of older eCars that are not compatible with Type 2 outlets (Norsk elbilforening, n.d.).

1.3 Current eCar Landscape in Norway

According to the New York Times, 29.800 new eCars were registered in Norway in 2015, making up for 22.2 per cent of all car registrations countrywide that same year, which made Norway the leading country in the world in terms of percentage of eCars versus conventional vehicles (Jolly, 2015). In early 2017, eCars accounted for roughly 40 per cent of new car sales in Norway (Bellona, 2017).

The explosive sales of eCars in Norway have resulted in a shortage of public charging points as compared to the number of eCar owners in need of electricity. As of May 1, 2017, there were 8085 public charging stations (Nobil, 2017), while the number of eCars registered in Norway has surpassed 100.000 (Statistisk Sentralbyrå, 2017). In Oslo the number of eCars has increased by over 100 per cent every year since 2011, but the construction of new, public charging stations has failed to catch up with the rapid growth of people driving eCars (Borgersrud, 2016). According to a 2017 newspaper article, the number of pure eCars in Oslo increased almost fourfold between 2013 and 2016, and as a result the number of eCars per publicly available charging point has jumped from four to ten (Bugge, 2017). Most eCar

owners situated outside the larger cities have their own private charging points at home, but according to the Secretary General of the Norwegian Electric Vehicle Association many eCar owners in Oslo buy eCars without having access to a private charging station at home (Bugge, 2017). Only about 64 per cent of eCar owners in Oslo reports charging at home, meaning that approximately one third of Oslo based eCar owners are dependent on the availability of public charging points (Borgersrud, 2016).

One main problem that exacerbate the challenge of there being only one publicly available charging point per ten eCars in Oslo is that some eCar drivers occupy charging points without needing them. An informal review done by the Norwegian eCar association in 2014 found that one third of the eCars parked at charging points did not utilize the power outlet, while another third of the eCars were fully charged (Norsk elbilforening, 2014). As a way to combat this, the Norwegian eCar association made a flyer for eCar drivers to print out and leave in the windshield of eCars parked at charging points without needing them. Based on the continually reported shortage of publicly available charging points, however, this has not been an effective solution (Norsk elbilforening, 2016; Bugge, 2017).

1.4 Pre-Existing Apps and Services for eCar Drivers

Several existing services in Norway provide maps showing the existing charging stations in the country. Perhaps the largest of these is ladestasjoner.no, which has its own application and provides online maps to the Norwegian Electric Vehicle Association, in addition to being referred to by NAF (Norwegian Automobile Association) as the source for locating eCar charging points (NAF, n.d.). Oslo municipality also maintains its own online map over the charging stations available within the city. In addition, private operators of charging stations such as Grønn Kontakt and Fortum provide their own maps over the stations they maintain both online and through apps. Many modern eCars are also outfitted with GPS that show the car's position in relation to compatible charging stations.

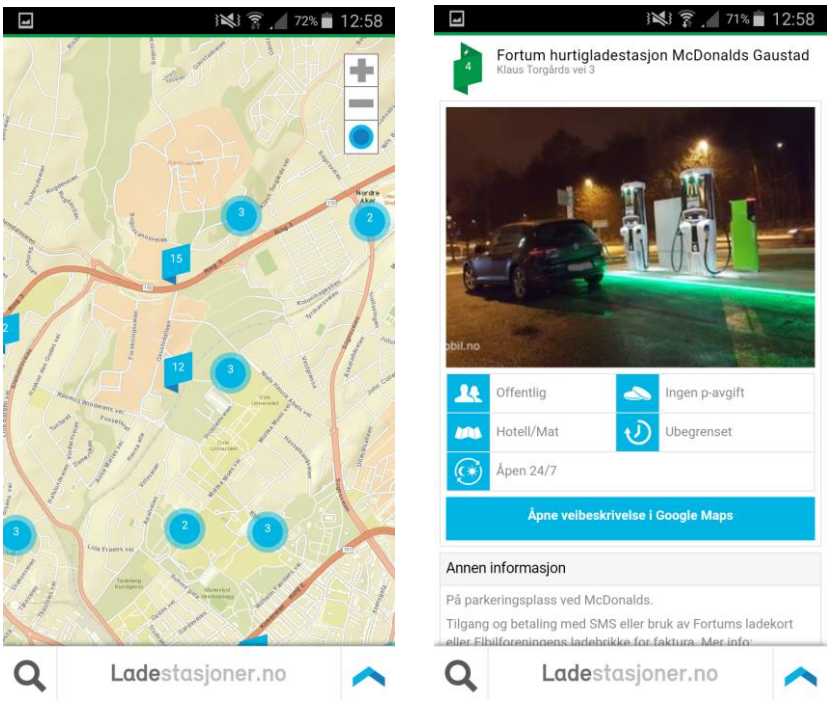

Figure 1: Screenshots of the user interfaces of two existing apps for eCar drivers with similar functionality. Fortum Charge & Drive (top) and Ladestasjoner.no (bottom).

While applications such as Ladestasjoner.no gives the user a comprehensive overview over charging stations across the country, it does not offer any incentive for eCar drivers to move their car once the vehicle has been fully charged.

1.5 Research Question

The premise of our thesis is to research how we can design and develop an app that responds to any needs eCar drivers have that they do not feel are being met by current solutions, and that also encourages eCar drivers to share charging points with one another to help ease the charging point shortage described in section 1.3. Our assumption at the onset of the research process was that physically moving a car requires time and effort, and as such a person who has parked at a charging station seems unlikely to relinquish the spot to a more needy eCar owner without an incentive. The app's basic utility, we imagined, would be similar to that of the eCar apps presented in section 1.4 of this thesis, but with added components that correspond to the needs uncovered during the research and mechanics aimed at making eCar drivers more conscious of the charging point shortage and thus more inclined to move their eCars to give other, more needy eCar drivers access to electricity. In order to do this we will

explore elements from gamification and persuasive technology in a user-centered design process order to investigate how eCar drivers can become more inclined to move their eCars to give more needy eCar drivers access to the limited amount of charging points.

Our research questions read as follows:

- What do eCar drivers in Norway want from an eCar application?
    - Do eCar drivers have any needs that are not met by currently existing applications and services?
- What are the main challenges of driving an eCar, and how can we design and develop technology to help our users overcome these challenges?
- Can gamification and persuasive technology be used to motivate users into a more sustainable behaviour that focuses on sharing resources (in this case, charging points for eCars)?

It should be noted that these three questions are somewhat interrelated, as users are likely to want solutions to their challenges, and we already know that there is a shortage of charging points that result in a challenge of finding available charging points.

1.6 Structure

This thesis is organized into six chapters, excluding this introductory chapter.

- **Chapter 2: Motivation, persuasive technology, and gamification** discusses the underlying concepts we have built upon during the design and development of our application, including motivational theories, persuasive technology and gamification.
- **Chapter 3: Research paradigm, methodology, and design** presents the methodological leanings of this thesis and the research methods we have employed throughout the research process.
- **Chapter 4: Design process** deals with the data collection and analysis and how this has influenced the design of the app.

- **Chapter 5: Development process** outlines the technical development of the app, including reflection on which frameworks and tools for development has been considered and tried, as well as a description of how the app is actually implemented.

- **Chapter 6: Discussion and reflections attempt** to summarize and discuss our most important findings and discuss how these relate to our research questions outlined in this introductory chapter. We also reflect on and discuss different aspects of the research process as a whole, such as limitations, possible future work, ethics, potential biases, and sampling.

- **Chapter 7: Conclusion** we summarize what we feel are the most important findings of this study, what we have learned, and why we believe our app can be a valuable contribution to the eCar community.

It should be noted that the design and development of the app have been two concurrent processes that have influenced each other throughout the research effort, but for the purposes of legibility we have split them into two separate chapters.

Also note, because we have used an iterative user-centered design approach to our data collection and analysis, we do not have a separate analysis chapter.

Additionally, it bears mentioning that we have had distinct roles throughout much of the research process. While Ronja has done most of the actual development, Ida has worked more with prototyping, researching the theoretical background, and proofreading. However all data collection, design decisions, and discussions have been as a collaborative effort between the two writers.

2 Motivation, Persuasive Technology and Gamification

We consider motivational theories to be the cornerstone to answering our research question, as the key is to find out how we can motivate eCar drivers to do a task that require both time and effort (moving a car from one place to another), and thus help ease the charging point shortage described in section 1.3. As described in section 1.4, a number of technical solutions already exist to inform eCar drivers of nearby charging stations and their specifications, but none exist that can actually motivate the users to move their cars when they no longer need electricity. We believe that understanding motivation is at the core of our project, and as such we need to look at the psychology behind motivation.

2.1 Motivation in Self-Determination Theory (SDT)

Self-determination theory (SDT) can be described as "an empirically based theory of human motivation, development, and wellness" that is focused on different types of motivation rather than just the amount of motivation (Deci & Ryan, 2008, p. 182).

2.1.1 Fundamental Psychological Needs

SDT postulates that humans have three fundamental psychological needs: the need for competence, the need for relatedness, and the need for autonomy.

The *need* for *competence* refers to the need to feel like you are effective when dealing with the social environment and to exercise your capabilities. The need for competence leads humans to seek challenges and strive for self-improvement, and relates to your sense of confidence (Ryan & Deci, 2002, p. 7).

The *need* for *relatedness* refers to the human propensity to connect with, and feel connected to, other human beings. Humans need to feel a sense of belongingness, both with other individuals and their community (Ryan & Deci, 2002, p. 7). The need for relatedness does not concern the attainment of a certain outcome or some formal status, but rather the psychological sense of being with others (Ryan & Deci, 2002, p. 7).

The third and final psychological need in SDT is the *need* for *autonomy*. In SDT, the term autonomy refers to "the feeling of volition that can accompany any act, whether dependent or independent, collectivist or individualist", rather than being selfish, independent or detached (Deci & Ryan, 2000, p. 74). The need for autonomy refers to human's universal urge as causal agents to act in accordance with their interests or values (Deci & Vansteenkiste, 2004, p. 25). As Ryan and Deci (2002) put it, "[w]hen autonomous, individuals experience their behaviour as an expression of the self, such that, even when actions are influenced by outside sources, the actors concur with those influences, feeling both initiative and value with regard to them" (p. 8).

SDT holds that humans are born with an innate tendency to behave in ways or seek out activities that satisfy these needs. In other words, people tend to be *intrinsically* motivated to do tasks that satisfy the needs for competence, relatedness, and autonomy, and thus do them for their own sake (Deci & Vansteenkiste, 2004, p. 25-27; Werbach & Hunter, 2012, p. 57).

2.1.2 Intrinsic Motivation and Cognitive Evaluation Theory (CET)

Intrinsic motivation comes from within, and you perform actions for their inherent enjoyment, satisfaction, or interest. As noted in the previous section, people tend to be intrinsically motivated for tasks that satisfy their fundamental needs for competence, relatedness, and autonomy. SDT views intrinsic motivation as an evolved propensity, albeit one that requires supportive conditions to be maintained and enhanced (Ryan & Deci, 2000, p. 70). As such, SDT is less concerned with what causes intrinsic motivation, but rather how it can be elicited and sustained, or subdued and diminished (Ryan & Deci, 2000, p. 70).

Cognitive evaluation theory (CET) is a subtheory of SDT that postulates that "the effects on intrinsic motivation of external events [...] are a function of how these events influence a person's perceptions of competence and self-determination" (Deci, Koestner & Ryan, 2001, p. 3). In other words, events that increase a person's perceived competence and autonomy will enhance his intrinsic motivation, while events that decrease his perceived competence and autonomy will undermine it. CET holds that rewards and other external events have two aspects, namely the informational aspect and the controlling aspect. The informational aspect can enhance intrinsic motivation through relaying information to a person that boosts his sense of competence and autonomy, while the controlling aspect may undermine intrinsic motivation by lessening a person's sense of autonomy (Deci, Koestner & Ryan, 2001, p. 3).

This is backed up by research that indicates that "threats, deadlines, directives, pressured evaluations, and imposed goals" have a negative impact on intrinsic motivation, while "choice, acknowledgment of feelings, and opportunities for self-direction" enhance it (Ryan & Deci, 2000, p. 70). Thus, if a reward or another external event is perceived as controlling rather than informational, it is likely to decrease intrinsic motivation rather than enhance it (Deci, Koestner & Ryan, 2001, p. 3).

However, when people who are intrinsically motivated to do some activity and receives rewards for doing it on a regular basis, they have a tendency to start perceiving that they are doing it for the reward rather than for the inherent enjoyment of the task itself. This phenomenon is sometimes referred to as "crowding-out", that is that extrinsic motivators tend to "crowd out" intrinsic motivation (Werbach & Hunter, 2012, p. 60). A similar phenomena is described in Motivation Crowding Theory, but unlike CET this theory mainly pertains to how economic rewards and deterrents, such as imposing fees for certain behaviours, are unlikely to cause long-term behavioural change (Frey & Jegen, 2001). However, if the external rewards are unexpected, SDT holds that a person is less likely to perceive that he is doing the activity for said rewards and thus intrinsic motivation will not be crowded out by the reward (Deci, Cascio & Krusell, 1975, p. 83).

2.1.3 Nonintrinsic motivation and organismic integration theory (OIT)

When a person is *extrinsically motivated*, as opposed to intrinsically motivated, he will perform an action to attain some outcome that is extraneous to the activity in and of itself, rather than the inherent enjoyment or satisfaction of the activity (Ryan & Deci, 2000, p. 71). If a person is neither motivated intrinsically nor extrinsically, he is *amotivated* and will either not perform the action in question or perform it without intent, either because he does not value it, because he feels incompetent in face of the action, or because he does not perceive the action to yield a desirable outcome (Ryan & Deci, 2000, p. 72). It should be noted that there are different degrees of extrinsic motivation between the extreme ends of the motivational spectrum (amotivation and intrinsic motivation), with four degrees of extrinsic motivation being identified within SDT (see figure 2). The processes of internalization and integration refers to "people "taking in" a value or regulation" and "the further transformation of that regulation into their own so that, subsequently, it will emanate from their sense of

self", respectively (Ryan & Deci, 2000, p. 71). The degree to which a person is extrinsically motivated for some action depends on how the person has internalized and integrated the underlying value and regulation of the requested behaviour (Ryan & Deci, 2000, p. 71).

Organismic integration theory (OIT) is a subtheory of SDT that posits that it is possible to be autonomously extrinsically motivated, despite studies that have indicated that working towards extrinsic rewards is nonautonomous and thus undermines intrinsic motivation (Ryan & Deci, 2002, p. 15). The premise of OIT is that people are naturally inclined to "internalize an activity's initially external regulation" under the right circumstances, and that the degree to which a person is extrinsically motivated derives from contextual factors that either promote or hinder the person's internalization and integration of a given behaviour (Ryan & Deci, 2002, p. 15; Ryan & Deci, 2000, p. 72).

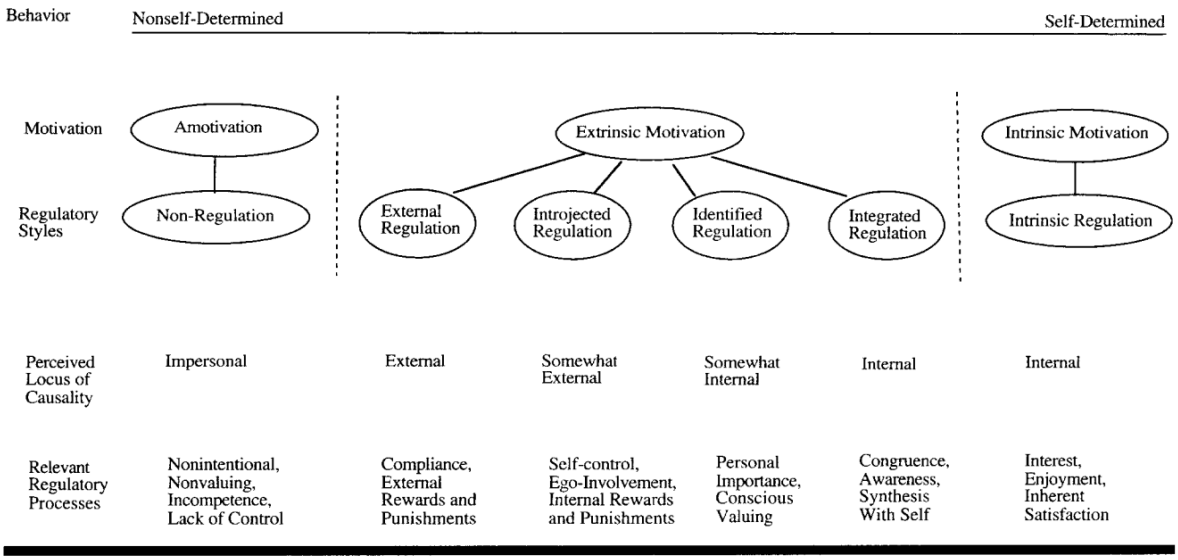

Figure 2: OIT taxonomy of motivational types, arranged from left to right in terms of the degree to which the motivation emanates from the self. Reprinted from Deci & Ryan (2000).

Figure 2 provides a graphical illustration of the six degrees of motivation in OIT, ranging from amotivated to intrinsically motivated. The term "perceived locus of causality" refers to where the person experiencing the motivation perceives it to emanate from.

Extrinsically motivated activities are rarely interesting in and of themselves, and according to SDT the reason people initially do them is "because the behaviors are prompted, modeled, or valued by significant others to whom they feel (or want to feel) attached or related" (Ryan & Deci, 2000, p. 73), suggesting that the the need for relatedness (see subsection 2.1.1) is of crucial importance to the internalization of extrinsically motivated behaviours. However, competence and autonomy are also important factors to facilitate the internalization of extrinsically motivated behaviours, and OIT suggests that in order for a person to progress towards the internalization of extrinsic motivation, supports for the feelings of relatedness, competence, and autonomy should be in place (Ryan & Deci, 2000, p. 73-74).

2.2 Persuasive Technology

Persuasive technology, although not inherently linked to sustainability, has nevertheless received major attention in research field sustainable human-computer interaction circles in the last decade (see chapter 3.2 for a more detailed explanation of sustainable human-computer interaction). A 2010 review of the literature produced within the field found that about 45% of the sustainable HCI corpus was comprised of papers grounded in B. J. Fogg's theory of persuasive technology (DiSalvo, Sengers & Brynjarsdóttir, 2010, p. 1977).

Fogg (1998) defines persuasion as "an attempt to shape, reinforce, or change behaviours, feelings, or thoughts about an issue, object, or action" (p. 225). It follows from this definition that persuasive technology is any technology which is purposefully designed to shape, reinforce, or change the user's behaviour, feelings, or thoughts on something.

Fogg's Behaviour Model (FBM) is a model for understanding human behaviour, which asserts that a target behaviour is the product of three concurrent factors: motivation, ability, and triggers (Fogg, 2009).

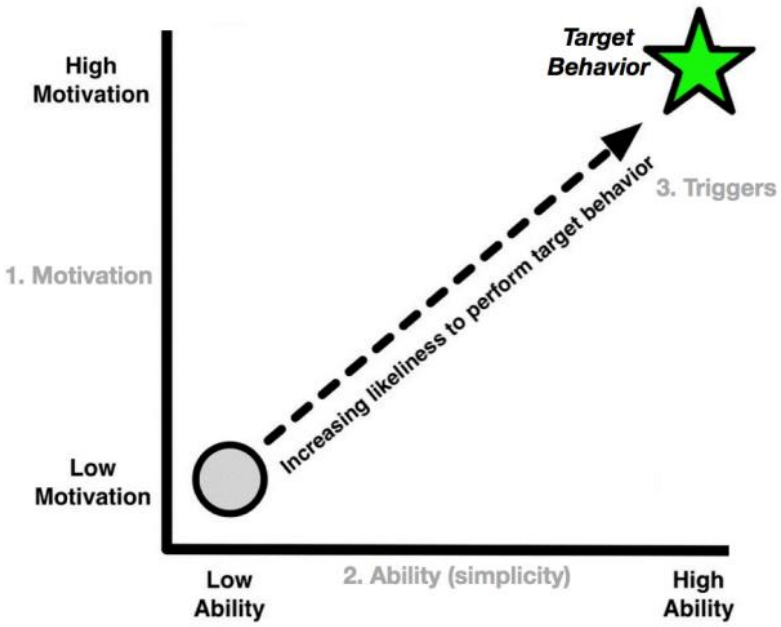

Figure 3: The Fogg Behaviour Model. Reprinted from Fogg (2009).

Figure 3 is an illustration of the FBM, illustrating how the motivation and the ability need to be sufficiently high in order for the target behaviour to be executed. In addition, Fogg states that the behaviour will not occur despite sufficient motivation and ability, unless an appropriate trigger is present to alert the user of the behaviour. In terms of applications, an obvious trigger for eliciting the target behaviour may be push notifications, in order to remind the user of the target behaviour.

Motivation is perhaps the most interesting aspect for our research, as what motivates users is highly individual, and as such a core issue for our research effort will be to investigate what can be used to motivate eCar owners to share charging points with one another. According to the FBM, a target behaviour (in this case, the sharing of charging points) will not occur despite ability (a readily available application with a simple interface design) and appropriate triggers (for instance push notifications) unless the motivation for using the technology is sufficiently high.

In addition to motivation, ability, and triggers, there are other factors that will influence how persuasive a technology is. Fogg (2003) describes five primary types of "social clues" that can be incorporated into technology and used to motivate and persuade: physical,

psychological, language, social dynamics, and social roles (p. 91). Physical attractiveness significantly impacts social influence, and the more visually attractive the technology is the more persuasive it will be. If designers wish to make persuasive technology, it is important that they understand the aesthetic of the target audience in order to make products that the target audience find appealing (p. 94). Furthermore, understanding the target audience allows the designer to make technology that is "similar" to them in some way, because perceived similarity affects the degree to which the user will be persuaded by the product (Fogg, 2003, p. 99).

Regarding the psychological type of social clues, Fogg (2003) found that humans infer a psychological aspect to computers regardless of whether the designers intended it or not (p. 100-101). In actuality technology neither has a personality nor a psyche, but by putting thought into how to convey information and error messages, designers can make technology that is perceived by its users as either friendly or unfriendly. This is obviously also linked to language, as the language used in the technology influences how the users perceive it and how persuasive it will be. For instance, Fogg (2003) describes how the e-commerce site Amazon.com uses language by addressing the user by name and offers recommendation based on his preference in order to persuade its users to maximize their online purchases (p. 102). Language can also be utilized to praise the users, which according to Fogg (2003) "open[s] the door to persuasion" (p. 105).

Social dynamics can be utilized by embedding social norms and codes of conduct into the technology, for instance an eCommerce website can be made to mirror a typical interaction at a grocery store by asking the customer if he has bought everything he needs prior to checking out, and wishing him a nice day once the transaction is carried out. In addition, computers can be designed to take on certain social roles that make them more persuasive, such as that of a teacher or a judge (Fogg, 2003, 111).

2.3 Gamification

According to Deterding, Dixon, Khaled, and Nacke (2011), the first documented usage of the term "gamification" appeared in 2008, but the concept did not receive widespread interest in design oriented communities until the latter half of 2010 (p. 9). Once the word reached

popularity, it gained momentum so quickly that it was shortlisted for Oxford Dictionaries' Word of the Year by the end of 2011 (OUPBlog, 2011).

In order to understand the term gamification, we must first understand what constitutes a game. Juul (2003), building on the existing definitions of the term "game" in an attempt to define the commonalities between computer games and other, more traditional games came up with the following definition:

> *A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable.* (p. 15).

Statistics from 2016 suggest that four out of five American households own at least one gaming console, that as many as 48% of females and 50% of males play games, and that the average age of these gamers is 35 years (Lofgren, 2017). Gamification is in essence an approach to leverage that which makes games fun and engaging when designing and developing non-gaming systems, although different researchers have different definitions.

Deterding, Sicart, Nacke, O'Hara, and Dixon, and Nacke (2011) define gamification as "an informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (UX) and user engagement" (p. 2425). Huotari and Hamari (2012), taking umbrage to Deterding et al.'s proposed definition's lack of focus on value creation and the goals of gamification, redefines gamification from a service marketing perspective as "a process of enhancing a service with affordances for gameful experiences in order to support user's overall value creation" (p. 19). While these seem to be the two most widely cited definitions of gamification, other definitions exist, such as "the process of game-thinking and game mechanics to engage users and solve problems" (Zichermann & Cunningham, 2011, pp. xiv), "[t]he use of game elements and game-design techniques in non-game contexts (Werbach & Hunter, 2012, p. 26), "the process of making activities more game-like" (Werbach, 2014, p. 266), and "the application of lessons from the gaming domain to change behaviours in non-game situations" (Robson, Plangger, Kietzmann, McCarthy & Pitt, 2015, p. 412).

It follows from these definitions that gamification is seen as a process of enhancing non-gaming systems, services, or activities by introducing elements of gameplay into them, with the overall goal of improving the user experience and engaging the user while supporting his or her value creation. In other words, gamified systems are not games, but rather other services that draw on and incorporates the elements of games that make the games fun and enjoyable. For the purposes of our research, we feel that the definition offered by Robson et. al (2015), i.e. "the application of lessons from the gaming domain to change behaviours in non-game situations" is fitting.

A literature review of empirical studies on gamification conducted by Hamari, Koivisto, and Sarsa (2014) found that a majority of the studies reviewed reported that gamification does heighten user motivation, engagement, and enjoyment (p. 3028).

As discussed in chapter 2 of this thesis, we believe that motivation is of critical importance for making a user actually use a technology. Gamification is one approach to heighten user motivation. As Werbach and Hunter (2012) put it, "motivation is at the heart of sustained behaviour change, and games are amongst the most powerful motivational tools" (p. 25). Fundamentally, gamification is a form of motivational design and a means to getting people interested in behaving in a certain way (Werbach & Hunter, 2012, p. 45).

2.3.1 Extrinsic Motivators in Gamification

In gamification, virtual rewards are often used as a means to motivate player behaviour. These rewards often constitute of points and badges, and are virtual, meaning they are of no use outside the gamified system. In combination with points, leaderboards are typically used to compare players and motivate competition. Werbach and Hunter (2012) refer to points, badges, and leaderboards collectively as the PBL triad or PBLs, stating that the vast majority of gamified systems and services employ these three mechanics (p. 71). Beyond PBLs, here are other game mechanics that can also be utilized in gamification. For instance can challenges and quests be used to add depth and meaning by giving players a direction, something meaningful and substantial to do, within the gamified system (Zichermann & Cunningham, 2011, p. 64-65). What would constitute a fitting challenge or quest would naturally hinge on what kind of game or gamified system is being developed. Challenge completion can yield the player points, badges, or other rewards within the context of the gamified system.

Some researchers within the field of game design and gamification explicitly warn against using PBLs as the sole means to engage users. For instance, Kim (2014c) calls PBLs the "low-hanging fruit of simple gamification" and warns that "[i]f you shove them [PBLs] into your application without thoughtful design, you may see a short-term lift—but you won't get longterm engagement". Robertson (2010) is similarly sceptical to relying on points and badges and believing that their inclusion in a project will be enough to motivate and engage users, stating that "[w]hat we're currently terming gamification is in fact the process of taking the thing that is least essential to games and representing it as the core of the experience" and that "[t]hey [points and badges] are the least important bit of a game, the bit that has the least to do with all of the rich cognitive, emotional and social drivers which gamifiers are intending to connect with.". Werbach and Hunter (2012) also warns against relying solely on PBLs, stating that "PBLs aren't right for every project, and they're not the only features you can deploy in a gamified system" (p. 77).

As mentioned in chapter 2.1.2, extrinsic rewards can also be perceived as demotivating and crowd out intrinsic motivation, and the intrinsic motivation for interesting tasks is likely to dissipate if the user receives tangible, expected, or contingent rewards (Werbach & Hunter, 2012, p. 60). The proposed solution to this dilemma is to not attach extrinsic motivators to activities that can be intrinsically motivated (Werbach & Hunter, 2012, p. 62). On the flip side, extrinsic rewards can be employed to encourage amotivated people to do boring, repetitive, and tedious activities (Werbach & Hunter, 2012, p. 62). It has also been found that people's intrinsic motivation can increase if the rewards are unexpected and take them by surprise, a tendency which can be leveraged through employing a mechanism of delivering rewards or prizes on an unpredictable basis known as a "variable reward schedule" (Werbach & Hunter, 2012, p. 65-66, 133).

2.3.2 Player Type Theories

What motivates someone is highly subjective, as this quote from Kim (2015) illustrates: "people seek out a wide variety of different experiences. Just look at today's gaming landscape—from adrenaline-pumping shooters to candy-coated puzzlers to the creative freedom of Minecraft, one person's beloved game is another's worst nightmare".

In order to be able to motivate eCar drivers to move their cars, we believed it was of central importance to learn what they are engaged and motivated by. One way to try to categorize

users and what motivates them in terms of mechanics is to utilize a framework describing different types of players. In this chapter we will therefore present past research on the characteristics of different types of players and the theories behind what motivates them.

Bartle's Player Type Theory

The most widely known, and perhaps oldest taxonomy of player types was identified and described by Bartle (1996) in an attempt to answer the question of why people play Multi User Dungeon games (MUDs). MUDs are typically text-based fantasy role-playing games in which multiple players can interact with each other and the environment by typing commands. Bartle (1996) identified four distinct player types, namely achievers (who motivated by achieving game-related goals), explorers (who are motivated by exploring the game world) , socializers (who are motivated by interacting with the other players of the MUD), and killers (who are motivated by demonstrating superiority over the other players), and developed an two-dimensional graph in order to explain how these relate to one another and their respective interests as related to how they played the game (see figure 4). He further discusses how the different player types relates to and affect each other, how to increase the prevalence of the different player types in the MUDs, and how to emphasize the aspects of acting over interacting, and world over players, and vice versa. The player types in the games speak directly to the fundamental motivation that make different people play MUDs.

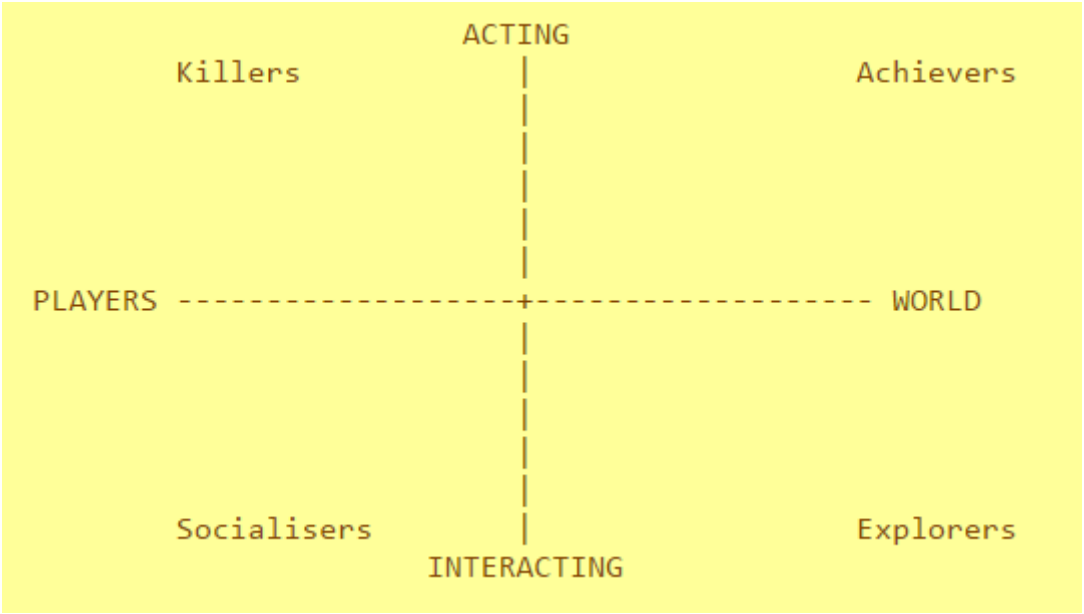

Figure 4: Bartle's player type interest graph. Reprinted from Bartle (1996).

Bartle's player type theory has been specifically constructed based on MUDs, and while it has been widely popular and frequently referenced in game literature, its utility for modern games bears questioning as it was designed specifically around old-fashioned, text-based adventure games. Indeed, Bartle himself have given speeches where he warns against usage of the player types in any other games than Massive(ly) Multiplayer Online Role-Playing Games or "MMORPGs", which he views as a modernized version the older MUDs. During a conference in 2012, Bartle seemed to question his player types' utility in terms of gamification, stating "it's [the player types theory] been used for gamification. God knows why, but it has" (9:08). A few minutes later he further clarified that "there is no reason why it [the player types theory] should apply to anything other than virtual worlds" (11:36). He further points to the fact that if you design a game for four player types, you will inevitably only get the four types which you have designed for and therefore end up ignoring other types of players that might exist within your target population (Bartle, 2012, 14:10).

Although Bartle's theory might prove a bad fit as a framework for understanding modern technology users' motivation, it seems to have inspired other researchers to look into the question and formulate their own, alternative theories on what motivates players to play games, for instance Yee (2006) and Kim (2014a).

Kim's Social Action Matrix

Building on Bartle's original player types, Kim (2014a) created a graph similar to Bartle's to illustrate player types which she calls the "social action matrix". Kim created the social action matrix after experiencing that Bartle's player types, which were designed for the much more primitive MUDs, were ill suited to describe the motivations of people engaging in "casual, social and serious games and gaming systems" (Kim, 2012).

The social action matrix is a grid of social actions or verbs based on four key motivational patterns observed by Kim in modern social games and services. Each of these social actions or verbs can be viewed as a player type in order to better understand the different kinds of players' motivations.

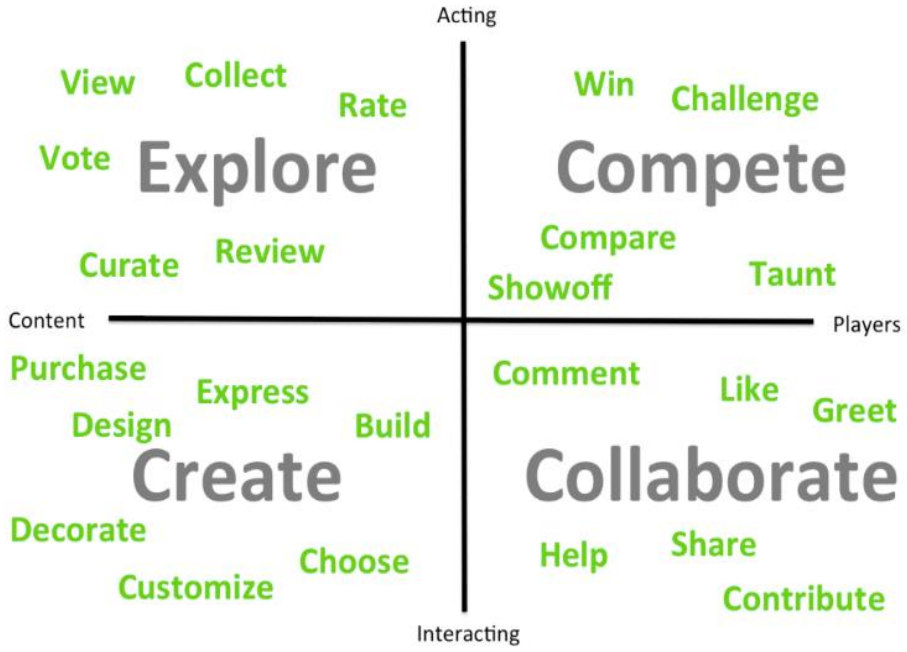

Figure 5: Amy Jo Kim's Social Action Matrix. Reprinted from Kim (2014).

- Explorers are motivated by exploring the game and gaining knowledge, much like Bartle's Explorer player type. They like to accumulate and exchange knowledge, and value clever design and accurate information. They may enjoy exploring with others, but their main motivation is to act on the content.

- Creators are the creative people who are motivated by expressing themselves and love tools that enable them to do so. They value customization and like to showcase their creativity and uniqueness, and value original ideas and personal style.

- Competitors are similar to Bartle's Achiever archetype in that they favor competition and the ability to challenge others and improve their own skills. They enjoy ranking systems and zero-sum game mechanics, and value mastery, learning and relationship-building. In addition to competing with others Kim (2012) points out that competing with oneself for self improvement is also a enjoyable for competitive players.

- Collaborators are similar to Bartle's Socializer player type, and are motivated by working in together with others towards a common goal. They like to build relationships through teamwork and form friendships.

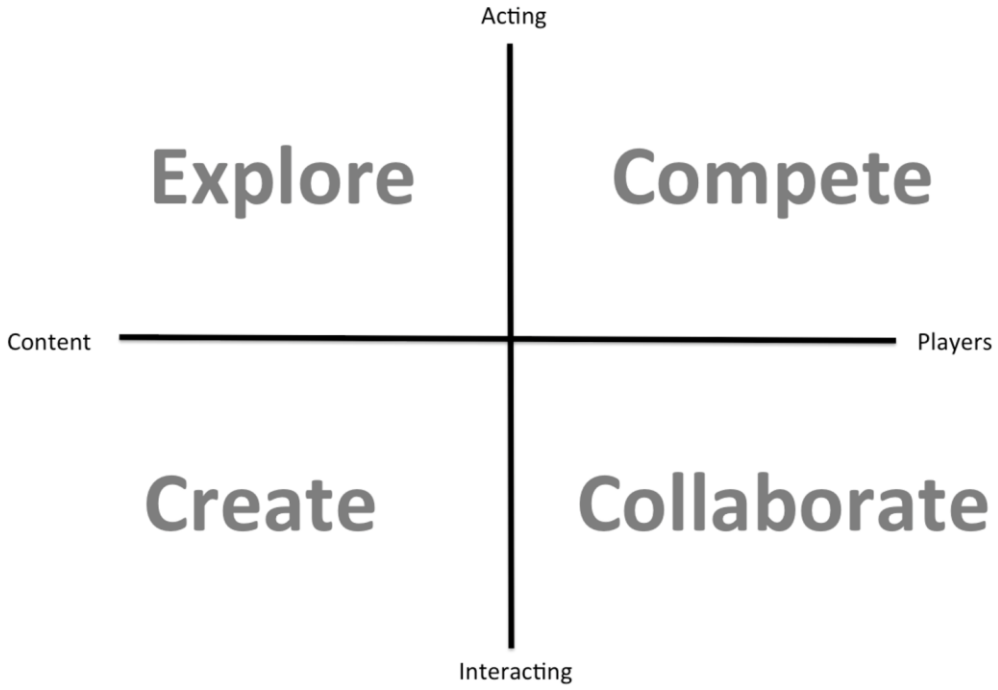

Figure 6: Blank social action matrix. Reprinted from Kim (2014b).

Kim (2014b) suggest an application of the social action matrix, wherein you use the blank template (see figure 6) to fill in the social actions enabled by your product, and then fill in the users' main motivators and unmet needs in a different color afterwards in an attempt visualize and identify the core social actions to be implemented in the product and how well these corresponds with the core motivators of your user base. It is important to note that, unlike Bartle's player types, the four social actions in the template are not mutually exclusive, and one user might enjoy activities from multiple or all of the categories.

2.4 The Difference Between Gamification and Persuasive Technology

Gamification seeks to influence behaviour, and as such it is closely related to persuasive technology (Werbach, 2014, p. 271). Gamification and persuasive technology may seem similar at a glance, and in fact they are similar in that both take aim at designing technology that changes user behaviour. According to Hamari, Koivisto, and Pakkanen (2014), the main

difference lays in that persuasive technology is focused on social and communicative persuasion and general attitude change, while gamification focuses on invoking the user's intrinsic motivation through gameful experiences and affordances (p. 119).

From our viewpoint, FBM (see section 2.2) is a framework for how to increase the likeliness of your users performing a target behaviour through rising their ability and motivation and providing appropriate triggers, whilst gamification is an approach to heighten the users' motivation. The focus of our study is not to compare or contrast these two somewhat overlapping strategies, so for the purposes of our thesis we will attempt to use persuasive technology as a general framework for how to change our users' behaviour and attitudes when it comes to the sharing of charging points, and gamification as a tactic to increase the users' motivation (i.e. one of the factors from FBM) to behave more sustainably in terms of sharing the limited amount of charging points.

3 Research Paradigm and Methodology

In this chapter we present the methodological frameworks we have based our research on and the pros and cons of the data collection methods we have used. Note that this chapter does not describe how we have applied the research frameworks, but rather describes these as they are explained in the literature. For a thorough description about our research effort, refer to chapter 4.

3.1 Interpretive Research

Our approach to the actual fieldwork, data collection, and analysis will be based on the assumptions of the interpretive research philosophy. Interpretive research contradicts the classical positivistic assumption that research can uncover objective "truths" about the world, by asserting that social realities may only be interpreted (Orlikowski & Baroudi, 1991, p. 14). In our minds, interpretive studies are better suited for research projects such as ours, as emphasis is placed on understanding human thoughts and actions in light of their contexts (Klein & Myers, 1999, p. 67).

One of the pitfalls of grounding work in interpretivism is that it relies on the researchers' subjective interpretation of the data collected. In order to allow others to make their own interpretations of interpretive studies, it is of crucial importance to document your findings, allowing others to understand how you came to your conclusions. As such, we will strive to be as transparent as possible about how we have conducted our research and the results thereof. All the raw data from our data collection is therefore included in appendix F of this thesis.

3.2 Human Computer Interaction (HCI) and Sustainable HCI (SHCI)

Human-computer interaction (HCI) is a multidisciplinary research field focused, as the name implies, on the interaction between people and technology. However, HCI does not have an

inherent focus on design, nor does it prescribe any specific strategy on how to gain knowledge of the interactions between humans and computers.

Sustainable HCI is the term used to describe a subfield of HCI research that is focused on designing technology to promote sustainability. Several authors emphasize the importance of including a focus on sustainability in HCI projects (Blevis, 2007; Culén, 2014; Mankoff et al., 2007).

Mankoff et al. (2007) divide sustainability into two categories which they call sustainability in *design and sustainability through design*. Sustainability in design refers to the material design of products with a focus on energy preservation, and reduction, reuse and recycling of materials. SHCI projects have focus on the sustainability in the design process itself, through being conscious about waste, disposal, renewal, and obsolescence, fall under the term of sustainability in design (Blevis, 2007, p. 503; Culén, 2014).

Our project, however, falls under sustainability through design, that is technology that is designed to promote a more sustainable lifestyle, either on an individual level, group level, or societal level (Mankoff et al., 2007, p. 2122 - 2123).

3.3 User-Centered Design

User-centered design (UCD) is a software design methodology that emerged from HCI and can be employed to ensure that developers and designers understand user behaviour and thus create products that respond effectively to the users' needs (Lowdermilk, 2013, p. 6-13). Involving the right users is crucial in successful user-centered design projects (Rogers, Sharp & Preece, 2011, p. 333). The most straightforward definition of users is that the users are those people who will interact directly with the product that is under development, albeit some authors differentiate between primary, secondary, and tertiary users, or refer to all parties that are affected in some way by the system collectively as stakeholders (Rogers, Sharp & Preece, 2011, p. 333). For the purposes of our thesis, the term "users" will henceforth be used to refer to eCar drivers who might one day interact directly with our application.

The collection of user requirements is the cornerstone of any UCD process, as these requirements shape and guide the entire design effort. Rogers, Sharp, and Preece (2011)

defines a requirement as “a statement about an intended product that specifies what it should do or how it should perform” (p. 355). Collecting user requirements, or “requirement engineering”, essentially boils down to creating a summarized list of the users’ needs that can be used in further dialog with the users in order to refine these requirements until they are as specific, unambiguous, and clear as possible (Lowdermilk, 2013, p. 33; Rogers, Sharp & Preece, 2011, p. 355-356). Once the user requirements are reasonably stable, they then form the basis for the design and development of some system or solution.

The degree of user involvement in UCD processes vary, from participatory design processes (PD), in which the users are heavily involved in every step of the design process and are considered co-designers, to approaches in which the user mainly provide feedback through user-testing. For our project we would like to involve users, because we believe that it is crucial to understand the users in order to design something they will actually use, but we will not utilize a fully participatory design method as this will be very time consuming and require the long-term commitment of users. Nevertheless, we will strive to be in frequent contact with users throughout each step of the design process, which will be documented in chapter 4 of this report.

User-centered design approaches *rarely* follow the classic “waterfall model” of systems design and development, in which all the activities of the design and development process come in sequential order (see figure 7).

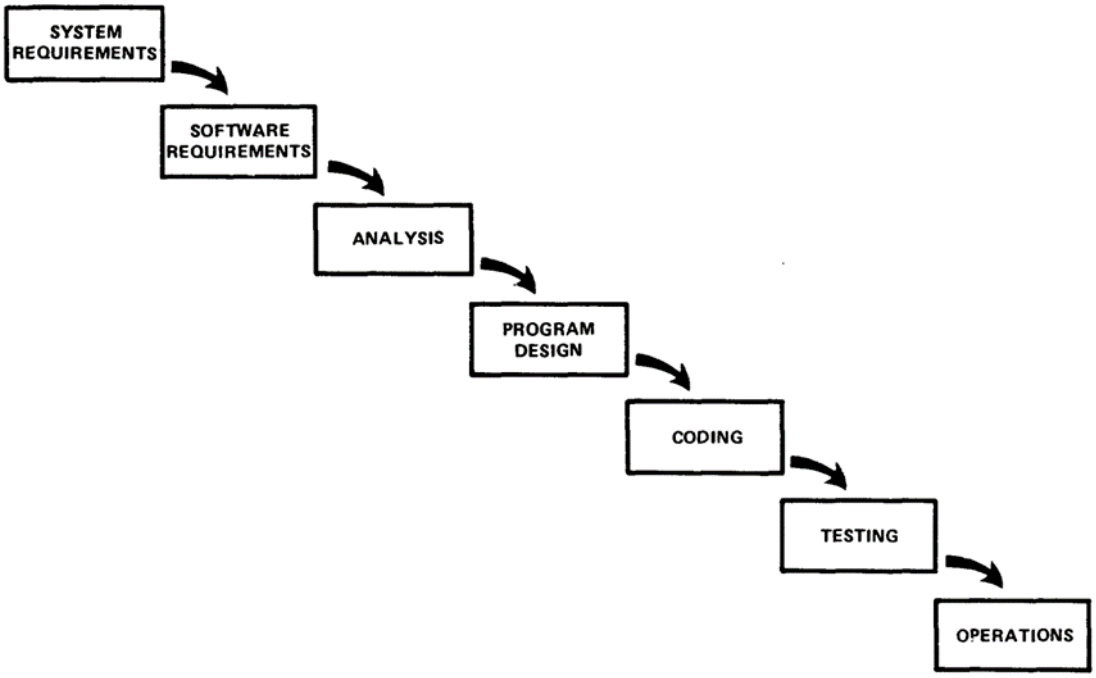

Figure 7: The Waterfall model for systems development. Reprinted from Royce (1970)

Rather, user-centered design processes are typically iterative in nature, and involves going back and repeating activities when new requirements or ideas emerge (see figure 8). Note that UCD does not specify how many requirements or users are to be involved, but rather leaves it up to the discretion of the designers and developers to decide when the user requirements are considered sufficient.

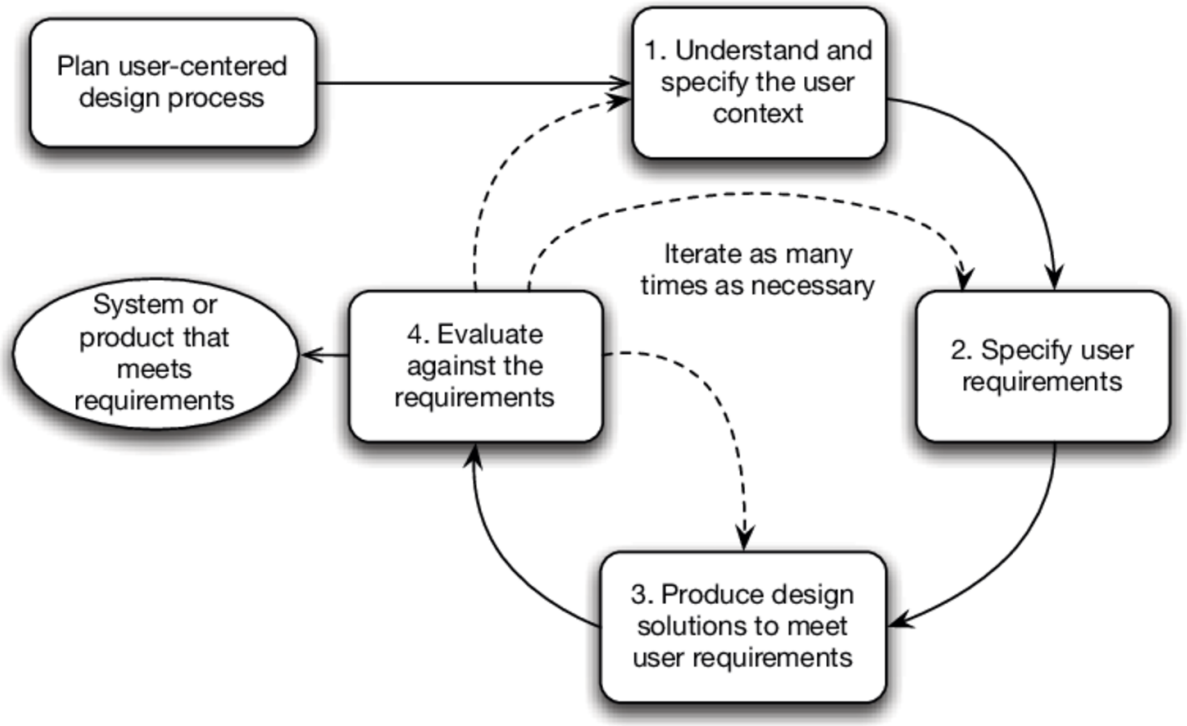

Figure 8: Example of a user-centered design process based on ISO 9241-210. Reprinted from Researchgate.net.

Design processes involving users can vary depending on many factors, but typically includes four activities that should inform each other and be repeated whenever necessary, namely: establishing requirements; designing alternatives; prototyping; and evaluating (Rogers, Sharp & Preece, 2011, p. 15).

It might seem logical to start off by establishing requirements, and end up with evaluation, but the design process accounts for the fact that the user requirements are unlikely to be clear and readily available in the early phases of the process, but rather are formed or emerge throughout the entirety of the design process. In user-centered design, the designers might misunderstand the users' needs and design a prototype based on their wrongful perception these, and this dissonance might only be cleared up when the user is presented with the prototype, forcing the designer to go back and redesigning a new prototype that better responds to the users' needs.

3.3.1 UCD and Gamification

The iterative nature of the UCD process works well with some suggested methods for how to employ gamification. Marache-Francisco and Brangier (2013) present a gamification design process consisting of two steps: context analysis and iterative conception (p. 127). During context analysis, UCD methods are utilized to gain a better understanding of the users, namely their intent, situation and task, while the iterative conception phase is concerned with designing and refining mockups and prototypes to be tested with users within the user group. Similarly, Zichermann and Cunningham (2011) emphasize the importance of iterative development in gamified systems, stating that "[b]y avoiding iteration, the system is certain to end up exactly where you don't want it to be" (p. 73).

This suggests that when designing gamified systems and services, a thorough understanding of the users are also necessary. Some researchers within the gamification literature refers to the process whereby gamified systems are designed and developed as "player-centered design", where what would have been referred to as users in a UCD process are instead referred to as "players". As far as we can tell, the term "player-centered design" first began to garner attention in the mid-2000s, then referring exclusively to the design of games (Koster, 2005; Taylor, 2005), but the concept has since been adopted by gamification theorists as an approach to designing gamified systems and services (Kumar & Herger, 2013; Werbach & Hunter, 2012).

Werbach and Hunter (2012) claims that thinking about the participants in any gamified system as players rather than users can have "salutary effects" because "[p]layers are at the centre of a game, and they have a sense of being in control" (p. 43). Both Kumar and Herger, and Werbach and Hunter have written books around the concept of player-centered design in gamification, and both propose similar approaches to designing gamified systems for "players", presented in figure 9.

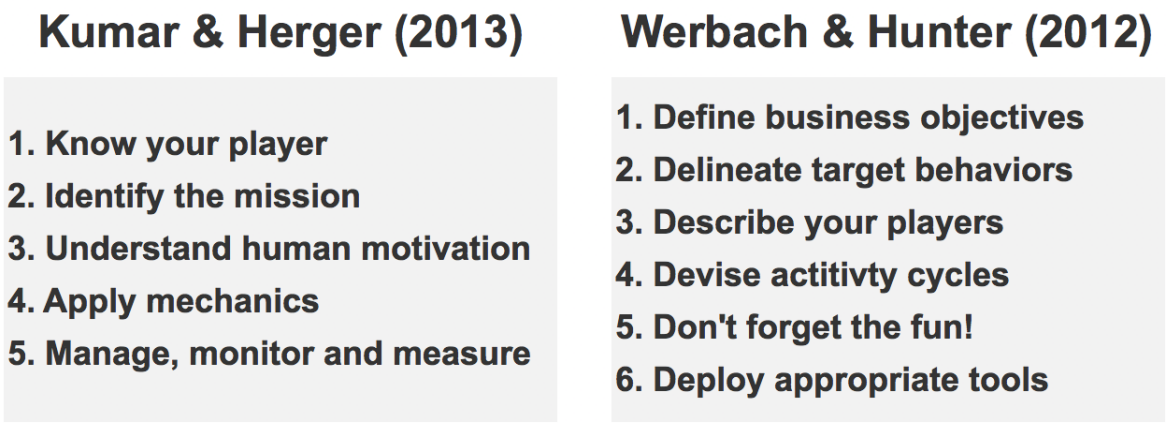

Figure 9: Player-centered design processes as described by Kumar & Herger and Werbach & Hunter. Adapted from Kumar & Herger (2013, p. 5-6) and Werbach & Hunter (2012, p. 86).

While pure UCD processes seem more concerned with gaining a deep understanding of the target population through an iterative cycle of user studies, the player-centered design processes as described in figure 9 seem more concerned with identifying objectives and missions, and applying various mechanics and other gamification related concepts to reach the goals initially specified. We believe this to be a result of much of the literature on gamification being oriented towards how it can be utilized to improve businesses and organizations. This is reflected in the above books' titles, i.e. "Gamification at Work: Designing Engaging Business Software" by Kumar and Herger (2013) and "For the Win: How Game Thinking Can Revolutionize Your Business" by Werbach and Hunter (2012).

Another approach for uniting gamification and user-centered thinking is by so-called "meaningful gamification", a term that refers to "the integration of user-centered game design elements into non-game contexts" (Nicholson, 2012). According to Nicholson (2012), using external rewards such as points and badges to control user behaviour is inherently not a user-centered approach to gamification, and rather than using extrinsic motivators to reward "correct behaviour", the designers of user-centered gamified systems should strive to answer the question of "How does this benefit the user?" when implementing gamification mechanics. Nicholson (2012) further elaborates on the importance of designing and implementing gamification that is informational to the user, rather than controlling (see subsection 2.1.2).

Both Hunter and Werbach (2012) and Kumar and Hergers' (2013) approaches involve steps pertaining to the organizational interests of business managers, and thus borders closer to

what Nicholson (2012) refers to as “organization-centered design”. Because of this we feel that the meaningful gamification approach to integrating user-centered design and gamification is a better suited approach for our project than the player-centered design approaches described earlier in this chapter. Thus, we will continue to describe the participating eCar drivers as our “users” rather than referring to them as “players”.

3.4 Sampling and Bias

Sue and Ritter (2007) define a sample as “a group of participants selected from a larger group (population) in hopes that studying the smaller group will yield information about the larger group”. Sampling is the method whereby the sample is determined or recruited, and the sampling can either be probabilistic (when participants are selected randomly from a well-defined list and you know the likelihood of a participant being selected) or non-probabilistic (when participants are selected based on convenience or ability and the chance of an individual’s selection cannot be computed) (Lazar, Feng & Hochheiser, 2010, p. 106; Sue & Ritter, 2007, p. 25-26).

Within the HCI community, non-probabilistic sampling is considered valid and acceptable, as HCI researchers typically are required to recruit users and to collect and analyze the data themselves without a large, well-structured data set from which participants may be randomly drawn (Lazar, Feng & Hochheiser, 2010, p. 107).

Bias, on the other hand, can be defined as “any tendency which prevents unprejudiced consideration of a question” (Pannucci & Wilkins, 2010, p. 619). Biases are a type of error that skew results in a certain direction and can be introduced into a research project at any phase of the project by either the researchers themselves or the research participants. Biases come in many different forms. Selection bias refers to bias that is introduced during sampling, that is when participants are being recruited to participate in the study. For instance, our study would have been compromised by selection bias if we only recruited eCar drivers in their twenties while the target population included eCar drivers of all ages. Studies relying on participants volunteering to participate in the research projects also run the risk of being compromised by selection bias, because the volunteers may share some characteristics that differentiate them from the non-participants (Institute for Work & Health, 2014, p. 2) Another form of bias that can be introduced by the researchers during the project is known as

confirmation bias, that is “the seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand” (Nickerson, 1998, p. 175).

Social desirability bias refers to “the tendency to respond in a socially acceptable manner rather than according to how one truly feels or behaves” (Holt, Bremner, Sutherland, Vliek, Passer & Smith, 2010, p. 40). Because of social desirability bias and other factors introduced by the research participants, it is important not to “judge people’s views or attitudes solely on what they say” (Walsham, 2006, p. 323). Social desirability bias can be reduced by promising confidentiality and anonymity to the participants, but cannot truly be eradicated in research projects that rely on self-report measures for data collection (Holt, Bremner, Sutherland, Vliek, Passer & Smith, 2010, p. 40).

In addition to the different form of biases described above, a multitude of other biases exist, and we believe it is important, as researchers, to be aware of the existence of biases and to take precautions to guard against them.

3.5 Research Methods

As all data collection methods, approaches, and projects have their flaws, a good research approach in HCI projects is triangulation (Lazar, Feng & Hochheiser, 2010, p. 6). Triangulation can be described as the process of investigating a phenomenon from multiple perspectives, such as using data from different sources at different times, using different researchers to collect and interpret the data, using different theoretical frameworks for analyzing the data or findings, or employing different data gathering methods in the research (Rogers, Sharp & Preece, 2011, p. 225). In the following we will briefly present and discuss the research methods we have used in our project from a theoretical perspective. For a thorough description of how we have applied these methods throughout the design process, see chapter 4.

3.5.1 Questionnaires

A questionnaire is a fixed set of questions to which an individual is asked to respond, and the data collected is typically neither as deep or rich as with other research methods (Lazar, Feng & Hochheiser, 2010, p. 100). Questionnaires are quick and cheap to produce and distribute, and based on our experience from previous design projects, questionnaires can be a decent

starting point for a design project as they can help lay the groundwork for future, more in-depth research methods. The number of respondents to a questionnaire is directly correlated to the questionnaires' level of confidence and margin of error (Lazar, Feng & Hochheiser, 2010, p. 106). Questionnaires can either be a distributed on paper or online, but online questionnaires are typically a more effective way of distributing a questionnaire to large, geographically dispersed target population (Rogers, Sharp & Preece, 2011, p. 244). Online questionnaires can be distributed in two ways: either by e-mail or by a web-based form.

3.5.2 Interviews

Interviews are a common data gathering technique in most research fields, including HCI. In contrast to questionnaires, the nature of interviews affords the researcher the ability to discuss and explore questions with the interviewee in more depth, as well as to freely pursue novel information and ideas that emerge during the interview by posing follow-up questions. As an added benefit, interviews, since they are often conducted face-to-face with the informant, allows the researcher to note facial expressions and reactions to the questions, which often leads to a richer understanding about the interviewee's attitudes and beliefs.

Interviews are usually categorized into three types. In structured or fully structured interviews the interviewer has a predefined list of ordered questions, similar to a questionnaire, that he poses to the interviewee. The data from structured interviews are often easier to analyze because all the interviewees are asked the same questions, but the resulting data is often less rich and exploratory in nature. The opposite, unstructured interviews, is often based on an incomplete and loosely list of questions known as an interview guide, and the underlying philosophy is that the interviewer and interviewee have a general topic at hand and that the interviewer act more like a listener than an interviewer in the conventional sense, allowing the interviewee to focus on the issues he or she finds most important. The middle ground between these two interview styles is known as semi-structured interviews, which start with a list of questions, but allows the conversation to build ecologically and the interviewer to ask follow-up questions whenever points of interest are brought up.

Interviews might be taped using recording equipment. Tape recordings of interviews provide a more complete record of what was being said than you are able to capture by taking notes and may be helpful later in the research process if you want to use direct quotations from the interviews to illustrate key points (Walsham, 2006, p. 323). However, as Walsham (2006)

points out, transcribing interviews is a time-consuming process that takes away time that could be spent elsewhere in the research effort, records do not reflect the non-verbal elements of the interview such as the interviewees' gestures or facial expressions, and finally recording the interview may make the interviewees less open and honest in their answers (p. 323).

3.5.3 Prototyping

Buchenau and Suri (2000) define prototypes as "representations of a design made before final artifacts exist" (p. 424). Prototypes provides a means for examining, exploring, and expressing design problems and potential solutions (Houde & Hill, 1997, p. 367-368). A prototype is limited in the sense that a prototype typically emphasizes some product characteristics while de-emphasizing others (Rogers, Sharp & Preece, 2011, p. 390).

According to Houde and Hill (1997), prototypes can be used to examine three distinct aspects of the system under development: "role prototypes", that primarily investigates what the product can do for the user; "look and feel prototypes", which are used to simulate the product's look and interaction; and "implementation prototypes", which usually requires a working system to be built in order to answer technical questions about the product's viability (p. 369-376). These aspects of prototypes are not necessarily mutually exclusive, but if a prototype is built to examine all three of them simultaneously it is called an "integration prototype" (Houde & Hill, 1997, p. 377).

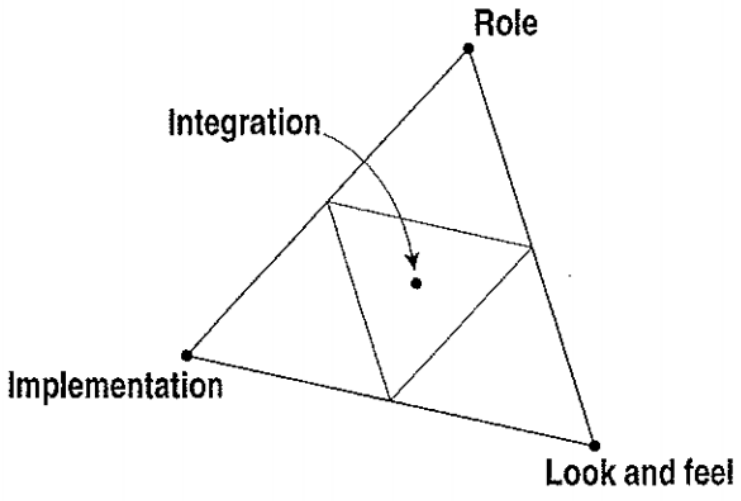

Figure 10: Model for "what prototypes prototype". Reprinted from Houde & Hill (1997).

Buchenau and Suri (2000) introduces a fifth type of prototype, which they term an "experience prototype", which is an amalgamation of the role prototypes and look and feel prototypes introduced by Houde and Hill (1997). An experience prototypes emphasizes the experiential aspect of the system under development and can be defined as "any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system we are designing" (Buchenau & Suri, 2000, p. 424-425).

3.5.4 Document Analysis and Coding of Textual Data

Bowen (2009) defines document analysis as "a systematic procedure for reviewing or evaluating documents - both printed and electronic (computer-based and Internet-transmitted) material" (p. 27). Document analysis is frequently used in combination with other data collection methods as a means to achieve triangulation (see the start of the chapter), and is in itself an iterative process of skimming, reading, and interpreting data (Bowen, 2009, p. 28, 32).

According to Lazar, Feng, and Hochheiser (2010), you need to ask yourself certain question prior to performing a document analysis, namely a clear definition of which data is to be analyzed, a clear definition of the population from which to draw the data, and develop a clear understanding of the context of the data set (p. 287-288).

Textual data, such as interview transcriptions and the content examined during a document analysis, is usually analyzed through a process known as "coding", which involves deriving and developing concepts from raw data (Lazar, Feng & Hochheiser, 2010, p. 289: Corbin & Strauss, 2008, p. 66). When these concepts are abstract (higher-level concepts), they are called "categories" or "themes" (Corbin & Strauss, 2008, p. 160).

Coding can be done in different ways. Lazar Feng, and Hochheiser (2010) describe two approaches to content analysis of textual data: a priori coding, in which categories are identified by the researchers based on existing theories prior to coding, and emergent coding, in which the researchers independently examine a subset of the data to develop coding categories based on their interpretations before consolidating their lists (p. 289). In either

case, the data is placed into categories or "codes" based on the researcher's understanding or interpretation of the data (Corbin & Strauss, 2008, p. 160), and in the case of emergent coding the data is placed into researcher-denoted concepts that are developed by the researchers to describe their understanding of the phenomena under scrutiny (Corbin & Strauss, 2008, p. 160; Lazar, Feng & Hochheiser, 2010, p. 291). As the key concepts begin to take form, they may be organized in a code list or a nomenclature that can allow the researcher to group responses that are similar or related in a hierarchical fashion ranging from the abstract to the concrete (Lazar Feng & Hochheiser, 2010, p. 291). According to Corbin and Strauss (2008), an analyst should try to understand the underlying issues behind what is being said, rather than focusing on every little concept (p. 182-183).

The actual coding of the data can be done be done by either subjective or objective coders. When the coders are the same people who developed the coding scheme they are known as subjective or inside coders, which means that they already have knowledge of the field under study that might aid them in understanding and detect underlying themes in the text that is analyzed, but on the downside subjective coders have pre-acquired knowledge that might constrain their ability to think beyond the pre-established concepts or subconsciously prescribe hidden meanings to the codes, which might inflate the reliability reported by the coders (Lazar,Feng & Hochheiser, 2010, p. 299). Objective or outside coders are neither involved in the design of the study nor the development of the coding scheme and thus have no pre-acquired knowledge of the domain under study. This might make them more open to potential instances of the data thus running less of a risk of inflated reliability, but because they lack knowledge of the domain their ability to understand the data might be compromised (Lazar, Feng & Hochheiser, 2010, p. 299).

4 Design Process

In this chapter we will present the work we have done to answer our research questions in chronological order.

Because of the iterative nature of the UCD process (see section 3.3), we do not feel that it is appropriate for our project to clearly separate the data collection and analysis. Between each bout of data collection, the data has been analyzed, the lessons learned have given rise to prototype designs and redesigns, which then have been utilized in the next bout of data collection.

The goal of the design process has been to answer the research questions outlined in the introductory chapter of this thesis. The informal survey done by the Norwegian Electric Vehicle Association in 2014 which found that two thirds of all eCars parked at public charging stations do not need electricity, suggested to us at the onset of the research process that eCar drivers were *amotivated* to move their vehicles in order to allow others to charge (see subsection 2.1.3).

4.1 Initial Requirements

The tentative thesis description provided by our supervisor already gave us some requirements to work with (see Appendix A). These requirements were that we should build on principles from gamification and persuasive technology to create a native app (or alternatively a location aware responsive web page) aimed at motivating eCar drivers to hand over charging points when they no longer needed them. As discussed in section 2.2, the FBM sets forth a framework for designing persuasive technology wherein one factor that determines whether a target behaviour will be performed is the users' motivation for performing said behaviour. As mentioned in section 2.4, we view gamification as a tool to heighten user motivation, and thus increasing the likelihood of them performing a given action (in this case, move a fully charged eCar). However, the remaining question was how gamification should be employed in order to heighten our users motivation to move their eCars.

As neither of us are eCar owners ourselves, and knew little about eCars when taking on this project, we figured the first step would be to gain a better understanding of the users' context

in order to better understand their needs and how technology could be designed to support them. This first step of understanding the users' context is also reflected in the user-centered design process model (see figure 8), and forms a basis for establishing more concrete user requirements than those specified by the project description.

4.2 Questionnaire

The first data we collected for this project was done through an online questionnaire. As mentioned in subsection 3.5.1, the data collected using questionnaires are typically neither as in depth nor rich in comparison to that collected through other research methods, but we nevertheless thought it would be an appropriate first step in order to get an overview of the target population.

In the questionnaire we asked the respondents different questions regarding their demographic (i.e. their gender, age range, and their county of residence), their usage of eCars, as well as some questions related to what makes them motivated and engaged, so as to get a better idea of which concepts from gamification and persuasive technology should be incorporated into the app.

For the purposes of gauging an idea of which gamification elements would be most engaging or interesting to the users within our target group, we chose to base this part of the questionnaire on Kim's social action matrix (see subsection 2.3.2). The reason for this choice was that we felt Kim's "player types" were better suited to describe the motivations of people who engage in social, gamified systems and services than Bartle's player types. We based the questions relating to the respondents' engagement and motivation on the social actions described within Kim's Social Action Matrix, in order see which activities appealed the most to the responding eCar owners, while also testing the validity of the Social Action Matrix in relation to eCar owners. The purpose of this was to lay the groundwork for further reflection on the Social Action Matrix's applicability to our project, as well as to gain an understanding of which social actions the app should include.

4.2.1 Designing the Questionnaire

We decided to use Google forms (https://www.google.com/forms/about/) in order to create, design, and distribute our online questionnaire.

In order to design the questionnaire so we could assess how the members of our target population were distributed within Kim's Social Action Matrix, we started by analyzing the different verbs Kim uses to illustrate the social actions that engage different users (see figure 5). After noting these down in a document we started to construct different questions based on these verbs.

We discovered that most of the verbs could relate to a person's daily life, and did not necessarily have to refer to how people behave in game-like contexts. This was important because we can't assume that the responding eCar owners are gamers or have knowledge of gaming. Where in a game you might like to collect badges and explore the in-game world, we directly interpreted this into more casual, non-gaming activities such as collecting stamps and exploring the real world by physically traveling.

We also found that the verbs in the Social Action Matrix could be used to gauge why people use apps and social media, and to gain a deeper understanding of what motivates them to do so. This assumes that the members of the target population have smartphones and use apps, but we felt it was appropriate to include the question as the goal of the project is to design an app for eCar owners.

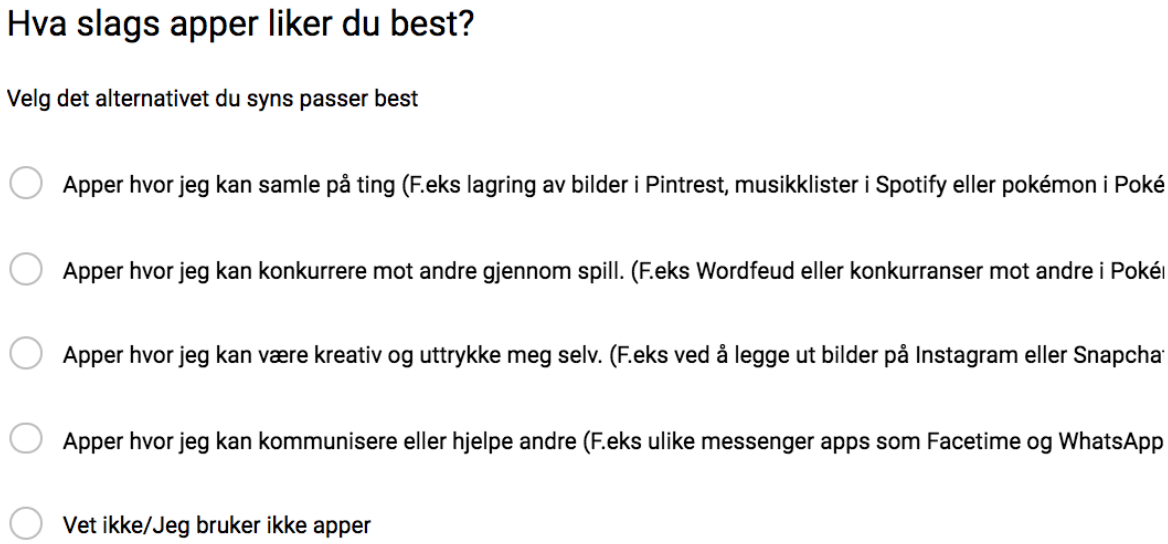

Figure 11: Sample question on questionnaire about what people use apps for.

We decided to present the questions in a couple of different ways. On some of the question the respondent was only allowed to pick one alternative, whilst on others they were encouraged to tick off on all the alternatives that applied.

On four of the questions we asked the respondents to place themselves on a ranges according to how engaged they were by the core activities presented in Kim's matrix (i.e. exploring, creating, competing or collaborating), where 1 represented "engaged to a small extent" while 5 represented "very engaged". This method of designing questionnaire questions is known as a "Likert" scale and can be used to measure "opinions, attitudes, and belief" (Rogers, Sharp & Preece, 2011, p. 241).

At the end of the questionnaire we placed one final, bigger question where we tried to incorporate all of the aspects which would engage the "player types" in Kim's Social Action Matrix. We presented the respondents with descriptions of four fictional games, asking them which of them they would play if given the choice (see figure 12). We decided not to use any existing games because it was difficult to find games wherein only the action in one quadrant of the matrix are represented.

Figure 12: Fictional games created for the questionnaire in an attempt to gauge which kinds of game elements eCar owners are most engaged by.

We also decided to exclude any words that might suggest the games' genre of the games (i.e fantasy or science fiction), since we didn't want our users to be biased and choose one alternative based on their favorite genre. As noted by Bartle (see subsection 2.3.2), games should incorporate different kinds of elements that appeal to different people in order to satisfy as many players as possible.

4.2.2 Pilot Testing the Questionnaire

Before we published the questionnaire, we performed a pilot tested the questionnaire with four fellow students in groups of two, using thinking-aloud as a method for evaluating our questions. Pilot studies are done prior to commencing the actual data collection as a means to ensure that questions clear and not ambiguous (Rogers, Sharp & Preece, 2011, 225). Jørgensen (1990) describes thinking-aloud as a tool consisting of users working on a computer system and at the same time talking about the "ideas, facts, plans, beliefs, expectations, doubt, anxiety, etc" which comes to the users' mind (p.502). He further states that thinking-aloud is a good tool for uncovering user experience because it gives immediate and specific information when you need it. Rogers, Sharp and Preece describe pilot studies as "a small trial run of the main study" and emphasize that pilot studies are important so that potential problems are identified and resolved before the real study commences (p. 225). We chose to pilot test our questionnaire as we needed quick feedback on any potential issues with the questions or whether the formulation of the questions seemed unambiguous. As Rogers, Sharp, and Preece (2011) note, "[c]learly worded questions are particularly important when there is no researcher present to encourage the respondent and to resolve any ambiguities or misunderstandings" (p. 238).

Even though the students that participated in the pilot study did not drive eCars themselves, they acted out as if they were eCar owners by drawing on their own driving experiences and imaginations. We also asked them to assist us in validating whether the questions seemed leading or were unclear in any way. Having our pilot testers also being interaction design master students only seemed to enhance their ability to properly criticize our work as they found multiple points to where we could improve.

After the first group had tested the questionnaire and provided us with feedback, we did a few adjustments to it in preparation for the second pilot testing session. Firstly we were told to shorten some of the questions and question alternatives which they found too long and bothersome to read. Using Google Forms, each question is consists of a question, an optional descriptive help text, and the alternatives or input fields from the users. The master students that evaluated our questionnaire suggested that we split up some of the questions, and that we to a bigger extent utilized the optional descriptive help text feature to clarify what we meant by some of the terms or provide additional information on some of the questions. For some of the questions where they felt respondents might feel uncomfortable choosing one alternative

over another, they also us told us that it would have been better to include a “I don't know” or “no opinion” alternative. This is in line with the recommendation made my Rogers, Sharp, and Preece (2011) for questionnaire design, when they state that “closed questions should be asked and a range of answers offered, including a “no opinion” or “none of these” option” (p. 238).

Before testing with the second group of students, we adjusted the questionnaire based on the first group’s response. The second group seemed more happy with the questionnaire, apart from one of the questions which they felt listed too many alternatives based off of the activities in Kim’s Social Action Matrix. They told us they found themselves either spending too much time choosing between them, or just choosing from the first five alternatives and skipping the rest of the alternatives. We ended up shortening this down to two questions with eight multiple choice alternatives for each.

4.2.3 Distributing the Questionnaire

In the hopes of reaching as many eCar owners as possible, we distributed the online questionnaire via the Norwegian Electric Vehicle Association’s Facebook group (https://www.facebook.com/Elbilforeningen/), and also had some of our fellow students who personally knew eCar owners distribute the questionnaire through social media. However, we were disappointed when we only had a few respondents several days after we posted the questionnaire. We received a tip that distributing the questionnaire through the website elbilforum.no, an online discussion forum for eCar drivers, might be a worth a try, and so we decided to post the questionnaire on the forums to see if this yielded more responses to our questionnaire.

Distributing a questionnaire online through social medias does not necessarily mean that we reach out to all eCar owners, and thus all prospective users of our application, so we need to remain sensitive to the possibility that the members of the Norwegian Electric Vehicle Association’s Facebook group and elbilforum.no do not necessarily constitute a representative sample of eCar owners in Norway as a whole (see section 3.4). This was also pointed out to us by one of the users of elbilforum.no, who stated that the users of the site were likely to be more enthusiastic than the average eCar owner.

4.2.4 Questionnaire Analysis and Results

In total, we had 62 responses to the questionnaire, but because we did not choose to have all the questions be mandatory the following figures show a slightly lower number of responses . The vast majority of the respondents were male (83,9%) and drove pure eCars (98,3%). The respondents were spread across 14 of the country's 19 counties, which could be relevant for why some of the questionnaire results were different from the impressions we later got through the interviewees who were exclusively living in or around the Oslo area.

Figure 13: Results of questionnaire question on the perceived availability of charging points

On the question on whether it could be hard to find unoccupied charging points at communal charging stations, we got the results as shown in figure 13. As the figure suggests, the majority of the respondents answered that it was "sometimes" or "often" difficult to find available charging points at public parking spots. These findings seem to be somewhat at odds with the shortage of charging stations as portrayed by the press (see section 1.3). Again, this might be a result of the respondents coming from a multitude of the Norwegian counties, while the national press and newspapers mainly focuses on charging difficulties in the larger cities.

Another question we posed to the respondents was whether they usually moved their vehicles once they no longer needed it themselves.

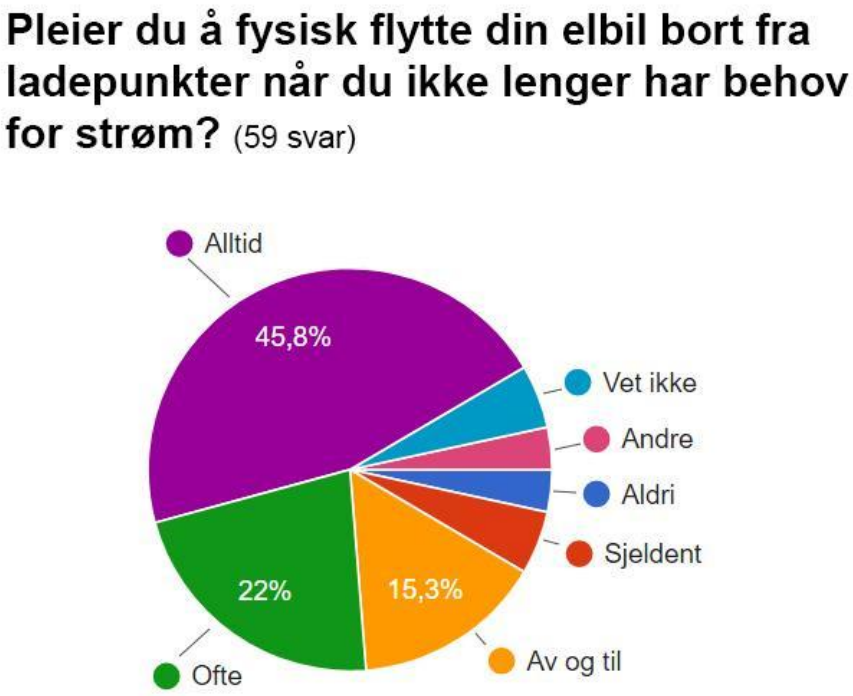

Figure 14: Results of questionnaire question on whether the respondents' moved their cars once they no longer needed access to electricity.

As figure 14 reflects, the majority of the people who responded to our questionnaire reported that they "always" moved their eCars in order to relinquish charging points to allow other eCar owners access to charging. As the data collected through the questionnaire was completely anonymized, we have no way of knowing whether these results are accurate, but if the respondents to the questionnaire were representative of all eCar owners we figured that there shouldn't be a shortage of charging points in the first place. As mentioned in section 3.4, sometimes, people answer questions based on what they consider will portray them in the best possible light, rather than being truthful. However, the users of elbilforum.no are eCar enthusiasts and are perhaps more concerned with the charging point shortage than an average eCar owner. So whether this finding is a result of social desirability bias or the eCar drivers that utilize the forum are very conscientious, but we have reason to believe that these results do not reflect the behaviour of the average eCar owner.

As stated at the beginning of this section, we designed part of our questionnaire based on the social action verbs in Kim's Social Action Matrix in an attempt to investigate whether a majority of the eCar driving respondents fell into one or two of the motivational patterns described by Kim. However, the results indicated that the respondents were spread across the matrix and none of the categories were significantly more populous than any of the others. This finding is perhaps best illustrated in the results wherein we asked the respondents to reply to four questions of how motivated they felt they were by different actions by placing means of self-reporting their level of motivation within a range.

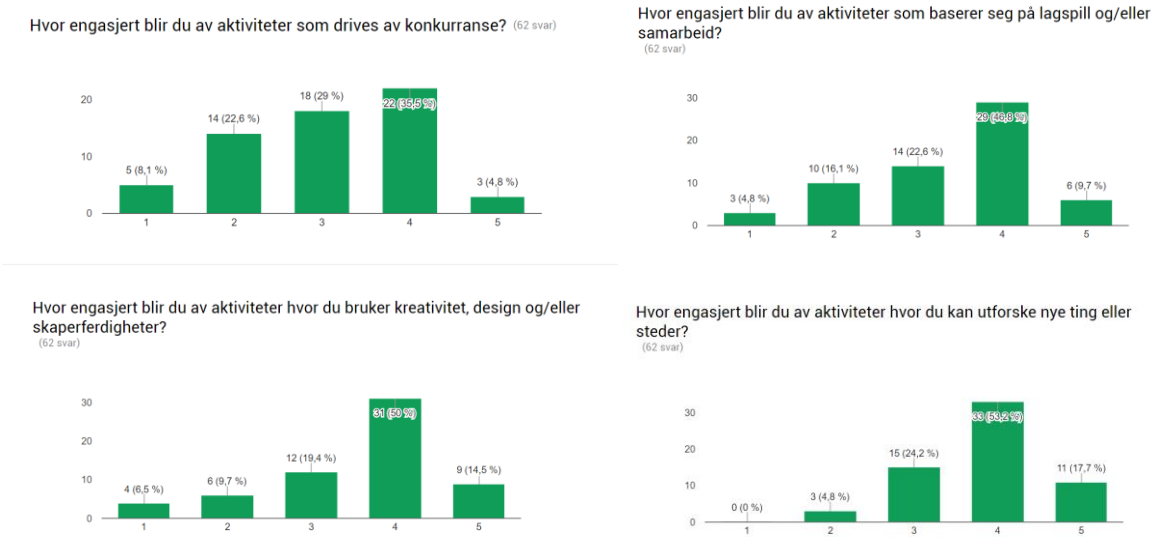

Figure 15: Respondents to questionnaire reporting their level of "engagement" in response to different forms of activities.

As figure 15 illustrates, the vast majority of the respondents ranked themselves as being very engaged (a four out of five) on all the social actions. Similarly, in the questions which allowed them to choose multiple alternatives from lists of activities, the respondents seemed spread out across the different activities we had listed with no clear pattern emerging.

The point should be reiterated that our main source of respondents were recruited through elbilforum.no, which may well be a group of eCar enthusiasts and thus do not necessarily represent eCar owners as a whole, but nevertheless the results did not indicate that one motivational pattern was predominant among the respondents and as such we did not think it appropriate to design the app to appeal to one motivational pattern above the rest. Rather, this

indicated to us that it was important to incorporate elements that appeal to all potential player types, i.e. the same approach recommended by Bartle (see subsection 2.3.2).

4.3 First Interview Round and Prototyping

For the purposes of our exploration of eCar owners, we felt that it will be most fruitful for us to do semi-structured interviews, as this would allow us to ask follow-up questions and to focus on the issues that the interviewees find the most important, without letting the conversation get off track. As Lazar, Feng, and Hochheiser (2010) point out, the search for requirements require an open-ended interview style in which the interviewers ask broader questions about the interviewees' current situation, needs, and concerns (p. 184). In preparation for the interviews we prepared a consent form and an interview guide consisting of questions and topics that we wished to cover during the interview sessions. Note that the interview guide did not necessarily cover every subject brought up during the interviews, but rather that it was used as a loose outline of ideas we wished to explore during the interviews. The interview guide was also altered between interviews, either because we realized through interviewing that some of the questions weren't necessary and could be omitted, or because some of the subjects mentioned by the interviewees that we thought were interesting and could be explored in future interviews. For instance, the first draft of the interview guide included a question in which Kim's social actions (see subsection 2.3.2) were explained and the interviewee was asked to identify which social actions he or she found most motivating. While this approach looked okay on paper and had worked in questionnaire format, explaining the player types and asking the interviewee to place himself within the matrix was awkward in person and the question was promptly cut from the revised interview guide.

In order to recruit informants to the first interview round, we physically went to different charging stations in Oslo, explained the purpose of our project to the eCar owners we encountered, and requested their contact information so that we could get in touch to schedule the interviews in the case they wanted to participate.

We decided not to use any recording equipment for the interviews for two reasons. Firstly, and most importantly, we feared people might be more reluctant to participate and less open and honest in their responses if we asked to record and store a recording of the interview, and that this thus might dissuade participants from agreeing to the interview (see subsection

3.5.2). Secondly, being two researchers allowed one of us to keep a rather detailed record of the conversation, the interviewee's tone, and his or her body language, while the other could focus on asking the questions. Directly after each interview session, we sat down together and transcribed the interviews in their entirety based on the notes and our memory. These transcriptions are included in appendix D.

In total we interviewed five eCar drivers ranging in age from their twenties to late fifties during this interview round, but already after the first interview we realized that it might be useful to make some prototypes to demonstrate the different functionalities we envisioned the finished app having to the remaining interviewees. The prototypes were specifically designed to function primarily as "role prototypes" (see subsection 3.5.3), although elements of the application's look and feel are inevitably also questioned when the prototypes are presented in a visual medium. The main idea behind their creation and design was to conceptualize our ideas for discussions with users. The prototypes were used in the subsequent interviews to spark conversation with the interviewees about what the application ought to be able to do and how it should be designed to be as intuitive as possible.To create the prototypes we used the prototyping tool Axure RP 8 Enterprise Edition (https://www.axure.com/), for which we obtained a student license. Houde and Hill (1997) suggest that higher resolution prototypes may work better for a general audience without technical or design experience (p. 15). Axure allows for the creation of "clickable" prototypes, which we felt would better simulate how the app would be to interact with when it was finished than paper prototypes could.

The prototypes were designed based on the responses we received on the online questionnaire, typical game elements in gamification, Kim's social action matrix, and the design of other apps. From what we had come to learn through studying other apps aimed at eCar owners, we noticed that all of them utilized a map for showing the distribution of charging stations (see figure 1). This seemed a logical starting point for the prototype, and we also decided that the app should utilize the geolocation functionality of the users' smartphones and provide nearby charging stations, but that we additionally should add a search bar that would allow the user to enter any other address in order to plan ahead. Additionally, each charging station should be clickable on the map in order for the user to gain more information about it and make an informed decision as to which charging station he wanted to utilize it. These are pretty standard functionalities found in most eCar apps, but we felt like they needed to be included in the prototype in order to increase the utility of the app.

However, our research questions deal more specifically with whether and how we can encourage eCar owners to share charging points with each other, and this proved to be a much more challenging task.

The solution we came up with for the actual sharing of charging points was a manual check-in and check-out solution, where other users have the ability to request a charging point at a given charging station (see figure 16).

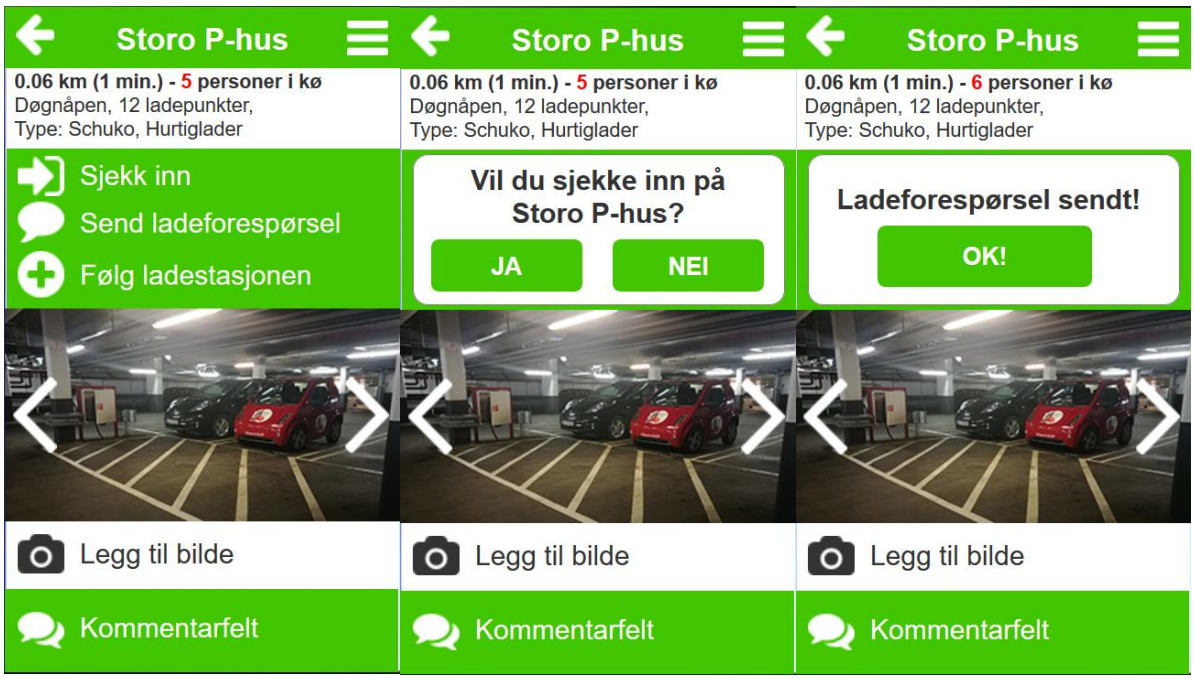

Figure 16: Prototype of proposed checking in and sending charging request functions.

The idea is that if you are checked in at a charging station and another user sends a charging request to that charging station, you would get a push notification on your phone alerting you that someone else was in need of charging.

The obvious challenge with this solution leads back to motivation. How can eCar owners be motivated to move their vehicles out of the way when they are finished charging? At this early stage of the design process we had many potential ideas for how elements of and lessons from gamification could be incorporated into the app in order to heighten motivation and encourage sharing, but we wished to discuss their appeal and viability with the users before incorporating them into the prototypes.

As a way to get the interviewees talking about games, engagement, and sharing with the users we chose to include some elements of gamification in the prototype order to further explore how and if gamification could heighten user motivation (see figure 17). As mentioned in subsection 4.2.4, our questionnaire results indicated that the responding eCar owners were distributed almost evenly across all four quadrants of Kim's Social Action Matrix, suggesting a diverse range of users and thus a diverse range of applicable social actions. During prototyping we brainstormed to come up with different potential functionalities to appeal to the different core social actions described in Kim's matrix, and even though we did not implement the majority of these in the prototype, we included questions about them on the interview guide to discuss them with the interviewees. During this process we found it useful to use Kim's matrix to see how well the proposed functionalities aligned with the different player motivations (see figure 17).

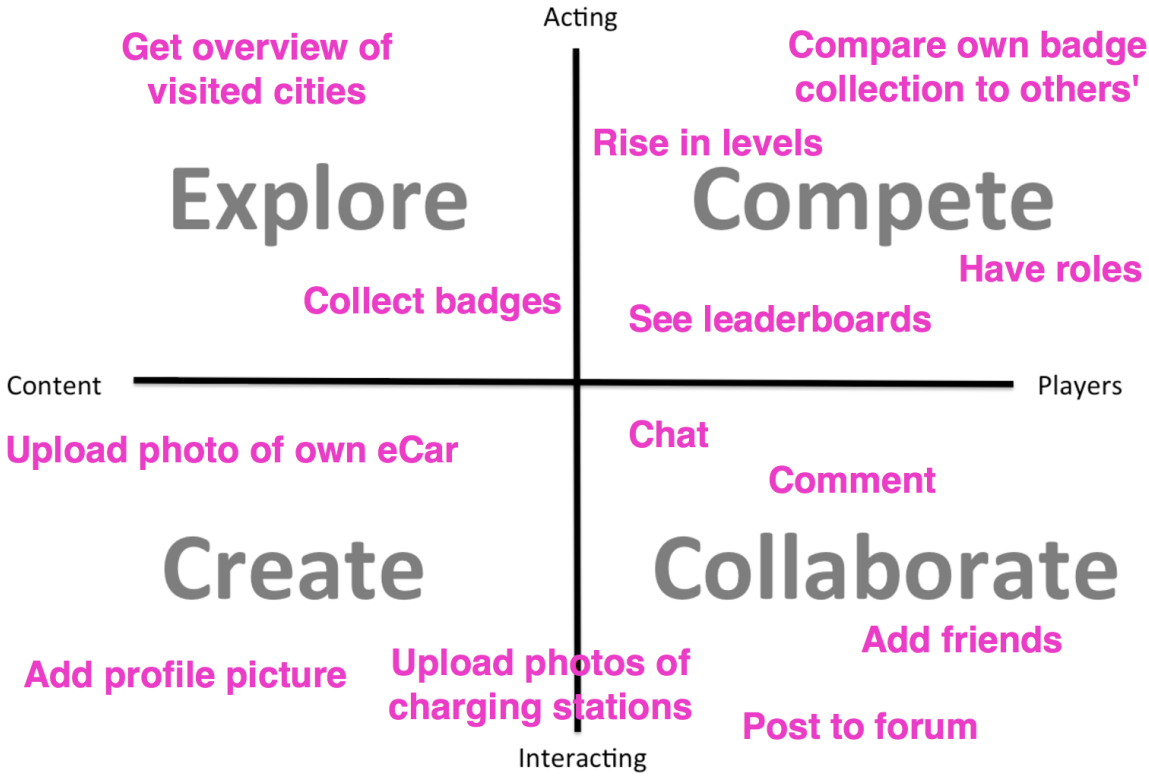

Figure 17: Social actions discussed in the first interview round. Adapted from Kim (2014b).

Since we had a limited amount of data to work with before the interviews, we felt it was a more strategic choice to discuss these functionalities with the users, rather than spending time prototyping them in case the users told us they did not want them in the app. Nevertheless, we

did incorporate a simple “friending” function and a badge collection in the prototype, in order to introduce the interviewees to the concept of gamification and to spark the discussions of the additional functionalities mentioned above.

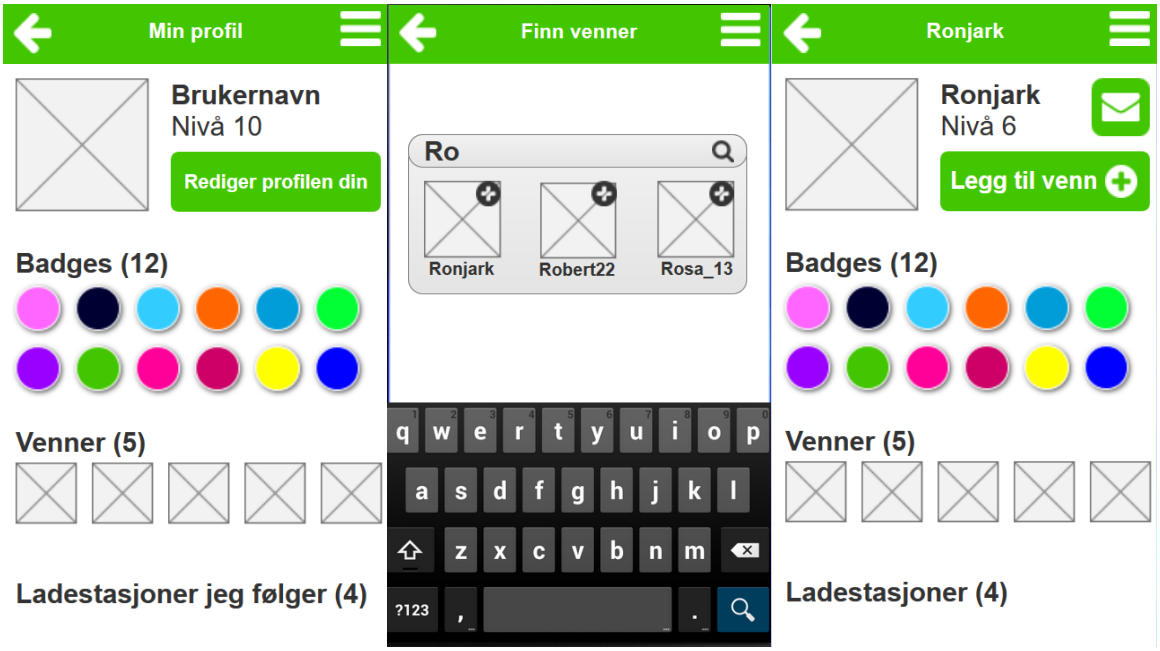

Figure 18: Prototypes for the user profile with badges and adding friends.

For the functionalities we were uncertain of how best to implement, we designed multiple alternatives to show the intervieewes, in order to elicit their opinions on which constituted the best design. For instance, one of the functionalities highlighted by the first interviewee as the most important to her was that the outlet type at the charging point was compatible with the plug for her charger. This told us that we needed some functionality in the app to allow the users to filter out incompatible charging stations, but we were unsure of the best way to implement this. In order to investigate this further, we designed multiple design alternatives to present to future interviewees to discuss which approach would be the most efficient and intuitive (see figure 19).

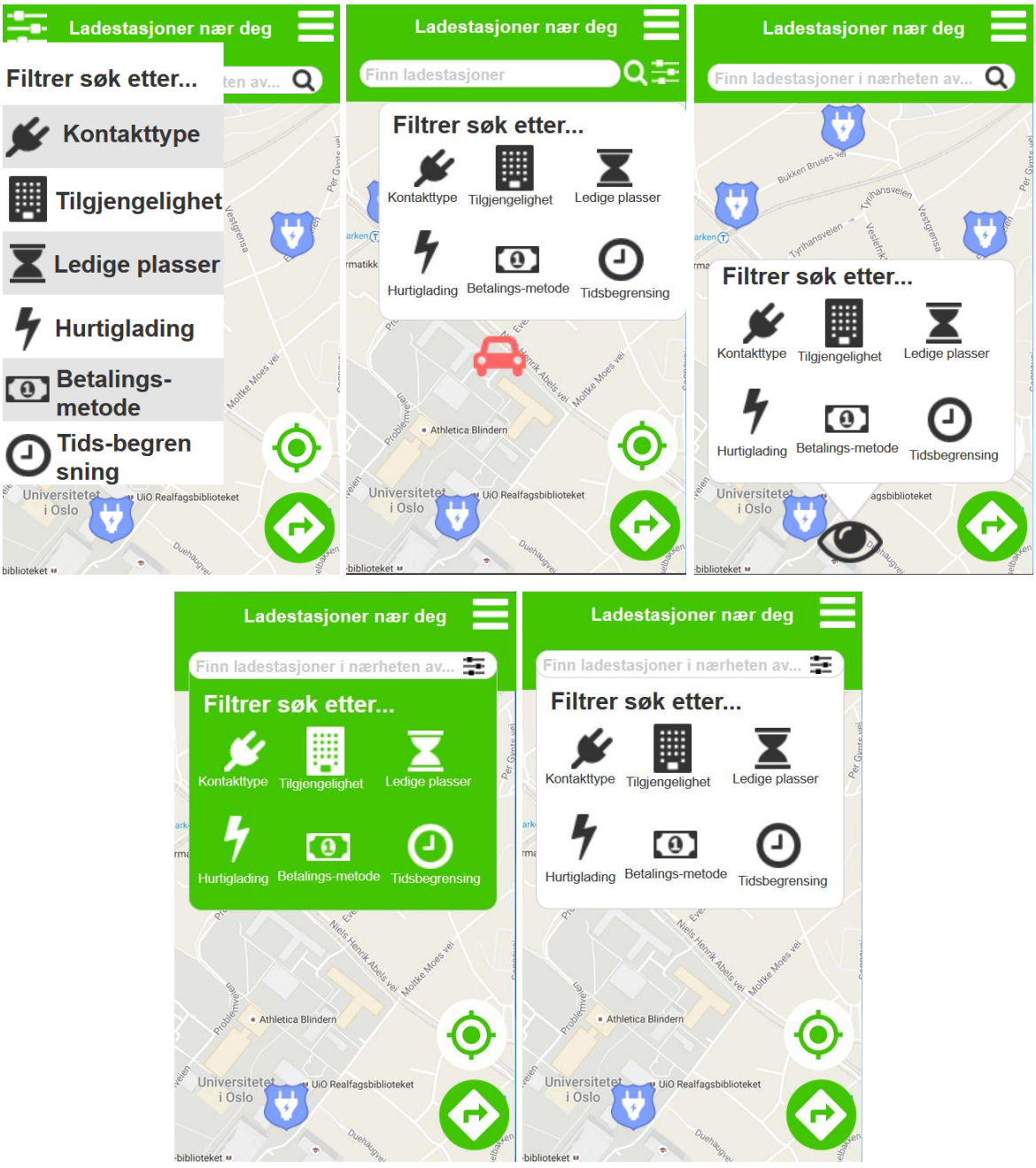

Figure 19: Design alternatives for the app's search filter functionality.

4.4 Document Analysis of eCar Forums

Walsham (2006) states that within interpretive research, interviews should be supplemented by other forms of field data, and specifically points to web-based data being a "very valuable" source for this (p. 323). Building on this, in order to get a better understanding of the target population, we decided to do a document analysis of the webpage elbilforum.no. Elbilforum.no is an online discussion forum for eCar owners with almost 15.000 members at

the time of writing (early 2017). We thought that if we analyzed discussions of the past year on elbilforum.no, we might get a better understanding of the challenges facing eCar owners through observing what they discuss amongst each other.

Drawing on Lazar et al.s (2010) questions to consider before content analysis, we set a clear definition beforehand of what we were to analyze, namely all public forum threads in two subcategories of the forum posted within the year 2016 (p. 288). The two subcategories of the forums that we chose to analyze were "Elbilen i samfunnet" (The eCar in society) and "Lading og ladestasjoner" (Charging and charging stations). The reason for this was that we felt these two subcategories would fit best with the research questions at hand, as many of the other subforums were dedicated to discussing the pros and cons of various makes and models of eCars, as well as different local branches of the Norwegian Electric Vehicle Association. The data was drawn from the public forum threads and posts made by members of elbilforum.no during the past year, and as such does not necessarily reflect the needs or requirements of all 15.000 members. Because of the vast number of members and posts, the fact that members post under their usernames and rarely divulge information beyond their immediate eCar questions, issues, concerns, or tips, it was not feasible for us to establish a clear, specific context for each user, but we have made the assumption that they most likely are within our target group of eCar owners (with a few prospective eCar owners thrown into the mix).

Lazar, Feng, and Hochheiser (2010) recommend using the emergent coding approach to analyze data when there is no well of related studies and established theories about the topic at hand on which to draw upon to establish a priori coding categories (p. 189). As far as we could tell, there is little or no research done on the habits and behaviours of eCar owners in Norway from a design-oriented stance. For this reason, decided to use the emergent coding approach. We each skimmed through one subforum and wrote down tentative coding categories, before we switched forums to allow the other to change, expand upon, or narrow down the categories until we reached a consolidated list of codes for each of the forums that we could agree upon.

We chose to do the actual coding as subjective or inside coders (see subsection 3.5.4), because we felt that a thorough understanding of the eCar community was necessary to understand the terminology used. For the actual coding we separately and manually went through each subforum and placed the forum threads under the code(s) we felt best described

the discussions we analyzed. When we were uncertain about which category to place a forum thread in, we consulted each other and discussed which code(s) were best suited. In a couple of instances this led to us creating a new code, as none of the ones we agreed upon seemed to match the forum thread. It should be noted that one thread could fall into multiple categories, depending on the themes discussed therein.

In total, we analyzed 582 threads on the two forums combined, 440 of which were in the "Charging and charging stations" subforum.

4.5 Analysis, Relevant Findings, and Reestablishment of Requirements

Based on the results of the questionnaire, the interviews, and the document analysis, we discussed what we had learned and how we could use these new insights to inform the design of our application. Although five people are far from enough to proclaim as a representative sample of the entire target population, we were satisfied that the interviews at the very least had presented us with new ideas, feedback on our prototypes and design alternatives, and a better understanding of the issues faced today by urban eCar users in and around the Oslo area. Based on the suggestions that had emerged through the interviews, we had a number of new functionalities we wished explore through prototyping and future interviews. In addition, we had made a few important discoveries during the document analysis that could be incorporated into the app as additional functionality.

4.5.1 Analysis of First Interviews and Relevant Findings

Through the interview process we felt we got a much better understanding of what it is like to be an eCar driver. Ultimately, what separates pure eCar owners from the owners of fossil fueled vehicles is that they are dependent on available charging points. "Range anxiety" is the fear or worry that the battery will run out before you are able to charge your car, thus leaving the eCar owner stranded. This was a concept we knew nothing about before the interviews, but that most of the interviewees spoke of in some way or another. Because of the eCar's dependency on available charging points, driving an eCar, particularly if you are driving to a new, unfamiliar, or rural place, requires some amount of planning, and this further cemented

to us that a map of charging stations is an essential functionality that must be included in the finalized version of the app.

We also got a better idea of how different makes and models of eCars vary. For instance, one of the interviewee reported that it took 22 hours to fully charge his eCar, whilst most of the other interviewees reported much faster charging speeds, typically about five to seven hours. As noted in section 1.2, different eCar cables are compatible with different charging point outlets, so having functionality that allows the users to filter out some of the 8000 different charging stations in Norway based on some criteria. Which criteria this should be was a harder question to answer, as there was little consensus between the different interviewees. In four out of the five initial interviews we provided the interviewee with a list over the attributes in Nobil's database translated from English to Norwegian (see appendix E), in an attempt to gauge which were deciding factors in terms of which filter criteria should be included in the final product. We had expected there to be a certain consensus among the eCar owners, but rather we got a wildly different responses from interviewee to interviewee. Almost all of them mentioned "rapid charging" and "real-time information", but for the remaining attributes the interviewees seemed split. There also seemed to be much confusion among the eCar owners we interviewed with regard to the attributes listed as "connector type", "charging capacity", and "charge mode", so these properties should ideally be given more meaningful names in the finished product. It was also suggested during one interview that the user could select the connectors when he registered on the app, thus automatically filtering out incompatible charging stations in future use.

We were surprised to learn that the eCar owners we spoke to seemed rather uninterested in the environmental aspect of driving an eCar, looking at this as a bonus rather than their main motive for getting an eCar. In terms of why they decided to drive an eCar, they instead focused on other aspects such as the economic incentives provided by the government, the efficiency of being able to use the carpool lane, or their personal fascination with the technology that goes into making an eCar run. We were also surprised that the majority of the interviewees reported seldomly charging at public charging stations, and rather charged at home or at work. However, as noted in chapter 1.3, approximately one third of Oslo based residents do not have a private charging station set up at home and as such they are dependent on available charging stations outside of their garage.

All the interviewed eCar owners seemed to like the idea behind our app and spoke of sharing in a positive way. For instance, the first interviewee said that she felt the app could "encourage and foster solidarity" and motivate the users to "share the goods", and the fifth interviewee, although he openly admitted to never moving his car out of consideration for other eCar owners, stated that it would be to "everyone's benefit if people shared". They were however sceptical of the proposed checking in and out of charging stations functionality, for fear of it being too time-consuming or complex. However, in lieu of setting up sensors at every charging station, we didn't really see another conceivable solution, so the challenge would be to make the checking in and out functionality as simple to use as possible.

Another key finding was that the interviewees seemed to feel there was no need to add friends or have a friending functionality within the app. Two of the interviewees suggested that it would be much easier if the friends were imported from Facebook, rather than the user having to search for them in the app via usernames. The first interviewee liked the idea of being able to have "a group of eCar owners" at work in which they could facilitate the sharing of charging point at the workplace, but apart from this we felt that the responses in the interviews indicated that adding friends within the app was an expendable feature. In one of the interviews, however, it was suggested that communication with others could be done via your GPS location, that you could send out a message about needing charging to nearby people in the hopes of them moving their cars. We see this as an alternative to the proposed "charging request" functionality, in which rather than sending a request to a specific charging station, you send it to all the users in your area.

When asked about the function of lending out your own, private charging station, three of the interviewees said that this was out of the question for them. Of the remaining two interviewee, one was only interested if he could earn money by lending out the upcoming charging points in his building's garage, while the other was only willing to do it in emergency situations.

Another key finding during the interview sessions was that interviewees believed that gamification would not motivate them to use the app or move their cars to allow others to charge. Out of the five people interviewed, only one of them reported playing games. However, two of the interviewees liked the idea of leaderboards, stating that nobody wanted to be publicly outed at work as the selfish one who occupies the charging station and doesn't share with others, and seemed to believe that might be a good motivator.

We believe that the interviewees' belief that gamification would not motivate them might be a result of us explaining it to them, rather than letting them test out the finished app and experience the motivational factors for themselves. However, in lieu of a finished and functional app, this theory can neither be proven true nor rejected.

In terms of the prototypes, these were used in the interviews to gain more specific feedback on imagined functionalities and design elements. One interviewee requested the ability to add more than one eCar in the app, as her household had two. A majority of the people asked preferred a "balance" between the icons for the menu and filter function, i.e. one button in each corner of the screen, but one also noted that the icons we had used were too similar to one another. There seemed to be consensus that the app's design should not be "messy", or difficult to navigate, and that checkboxes were a better choice than navigating deeper into the filtering options. There was also a concern about keeping the charging stations "up to date", as several of the users had experienced outdated maps that included now defunct or permanently closed charging stations, while not including new charging stations.

4.5.2 Results of Document Analysis and their Design Implications

Table 1 represents the codes we used for the document analysis, the findings of both coders, and the average number of forum threads placed within the category across the two coders. C1 stands for "Coder 1" and C2 is "Coder 2".

In the subforum "Charging and charging stations" we quickly realized that the vast majority of the threads were dedicated to asking questions about the installation of charging stations in private garages or other questions of a very technical nature. Similarly, we found that almost all of the threads in "The eCar in society" were complaints about the Norwegian eCar politics and the impending revocation of certain incentives for eCar owners. We consider neither of these issues to be "solvable" through the development of our application, but have included them here to paint an accurate picture of the discussions on forums.

The document analysis of the subforum "The eCar in society" was somewhat more difficult, as there was a much broader range in what was discussed and thus more codes with fewer threads. Ultimately, we did not consider much if any of the data on this subforum to be applicable to our project, and thus we have omitted these results.

Table 1: Results of document analysis of subforum "Charging and charging stations" of elbilforum.no

Codes	**C1**	**C2**	**Mean**
Technical questions about various eCar paraphernalia and private charging stations	191	198	**194.5**
Exchange of charging experiences at specific locations or with specific charging stations	47	53	**50**
Questions about the charging possibilities along specific routes	37	32	**34.5**
Discussions about apps, services, or GPS	33	34	**33.5**
Discussions about different charging station operators	26	29	**27.5**
Users spreading the word about new charging stations	24	25	**24.5**
Other things not covered by the main categories	28	15	**21.5**
Informing other users of defunct or otherwise problematic charging stations	20	16	**18**
Complaints about the shortage of charging points	19	13	**16**
Discussions about charging etiquette and those who break it	15	16	**15.5**
Charging outside of Norway and on boats or ferries	15	16	**15.5**
Questions or discussions about cost of charging	13	16	**14.5**
Questions and answers about how to get access to certain charging stations (how to obtain keys or RFID chips)	14	12	**13**
Confusion about laws and rules concerning eCars	11	8	**9.5**
Discussions about the future of eCars	6	11	**8.5**
Warnings about theft and vandalism	7	8	**7.5**

Overnight charging possibilities at specific hotels	8	5	**6.5**

Through the document analysis, we surmised several things about our target population, or at least those members of the target population that utilizes elbilforum.no. This is a list of what we consider the most important findings in terms of their potential impact on the design and functionality for our app:

- Many eCar owners on the forum exchange experiences regarding specific charging stations
- Several eCar owners on the forum seek information about charging possibilities on routes ahead of trips
- The eCar owners on the forum warn each other about charging stations that are problematic or out of order
- The eCar owners on the forum inform each other about new charging stations
- Lack of charging stations is a recognized problem among eCar owners on the forum
- eCar owners on the forum are annoyed when other eCar owners don't charge at charging point (or when fossil fueled vehicles park at the charging points)
- In general, there seems to be many practical questions within the community with regards to eCars in terms of driving, parking, and charging

That the forum functions as a platform to discuss experiences with charging stations, spread news of upcoming charging stations, and warn others against certain charging stations is particularly interesting to us.

> *According to ladestasjoner.no there are supposed to be twelve free [charging stations] at [address] and 12 free at [place], but those two place are right next to each other. Does anyone know if there are actually that many there, and how busy it usually is at these charging points?* (Forum post on elbilforum.no, own translation).

This is a functionality could feasibly be implemented into the application. We could see this being done in several ways, such as through a like or dislike feature, through a rating system

of some sort, or through old-fashioned reviews or comments. There were also many threads regarding new charging stations or charging stations under construction, so it could be an idea to have a feature in the app where new or upcoming charging stations are clearly marked on the map. The document analysis also confirmed that finding available charging stations is a valid concern, and that eCar owners dislike people who exacerbate this problem by parking at charging points without utilizing it.

> *[...] But when I turned around and looked at the [eCar] that damn idiot [the driver] had put a charging cable in the car without plugging it into the rapid charging station just to get to park there free of charge!!! How idiotic is it possible to be?[...]* (Forum post on elbilforum.no, own translation).

If the app could allow eCar owners to contact and communicate with these people perhaps the situation could be eased, although the question remains of whether it is smart from an ethical standpoint to allow annoyed eCar owners to get in touch directly with people they are annoyed at.

Additionally, we noted that many people were asking others about the charging possibilities between point A and point B.

> *[...] Is there anyone who knows if you can check on a map online or something similar if I want to drive from [point A] to [point B] and see where the different charging stations are? I'm terrified of getting stranded in no man's land.* (Forum post on elbilforum.no, own translation).

At the time we conducted the document analysis, we had already planned a functionality for this in the app, where you can enter where you are travelling to and from and get directions, as well as an overview of all the charging stations along the route. The fact that people used the forums to ask these questions affirmed to us that this functionality should be included in the finished application.

Obviously, there is little or nothing we can do to change the Norwegian legislation, but the app could potentially be extended to include information on impending changes that will affect eCar owners, for instance through a calendar function that would mark the days the changes are supposed to happen. We did not, however, consider this as being of high priority.

We also discovered during this process that several threads on the subforum were dedicated to discussing the different eCar apps that already exist, so an idea for future research and design inputs could be to analyze these to gain a better understanding of what they value in an app. As we learned during the interviews, eCars are only allowed to utilize the carpool lanes now if there is at least one additional passenger in the car. We noticed a few people on the forums that specifically asked if someone there needed rides, because they wanted to use the carpool lane. The app could also feasibly be extended to include functionality that would allow people to find each other in order to commute together.

4.6 Reestablished Requirements

In the following, we present a table of the user requirements elicited through the analysis of the first round of interviews and the document analysis of elbilforum.no. Each requirement has a short name and a more detailed description. In addition, the requirements have a priority (Pri.) denoted by a value (1 meaning top priority, 5 meaning of low priority) based on how many users requested the functionality or how important we believe it to be to the utility of the app (or a mix of both), in addition to a reference to where the requirement emanated from (FI for first interview round (subsection 4.5.1) and DA for document analysis (subsection 4.5.2)).

Table 2: New requirements

Requirement	**Description**	**Pri.**	**Source**
Map	The app should have a map with charging stations on it	1	FI
Geolocation	The app should give the user an overview of nearby charging stations based on his proximity to these	1	FI
“Directions”	The users need to be able to plan trips by searching for places and see charging stations along a route	1	FI, DA
Filter	The users need to be able to filter out charging station based on some criteria, for instance charging effect (rapid charging)	1	FI, DA
“Clean” design	The users do not want the app to be too “messy”	1	FI

Simple check-in & out	Checking-in and out should be easier than the proposed solution	1	FI
Exchange experiences	The app should allow users to exchange their experiences with charging stations	2	DA
Easy navigation	Navigation should be easy and multi tiered menus should be avoided	2	FI
“Balanced” icons	Icons should be placed in balance, i.e. one in each corner of the screen rather than on top of one another	2	FI
Up to date	Charging station data should be kept up to date and new charging stations should be added quickly	2	FI, DA
Meaningful names	Charging station names should be given meaningful, unambigious name	2	FI
Pricing	Charging stations should have information about how much it costs to charge	3	DA
Leaderboard	Should have a leaderboard for who has most frequently shared charging points to facilitate this same sharing	3	FI
Distinct icons	Icons should not be too similar in design	3	FI
Register plug	App should allow you to register the outlet types your cable is compatible with when signing up	3	FI
Facebook friends	Friends should be imported from Facebook rather than proposed search for username if friends are included	4	FI
Multiple eCars	Should be able to add more than one eCar to your profile on the app	4	FI
GPS based charging requests	It should be possible to send charging requests to people nearby based on GPS location, not just one specific charging station	4	FI
Contact other eCar drivers	App should offer ability to contact other eCar drivers, in case they park without charging or otherwise violate the	5	DA

	eCar etiquette		
Groups	The app should facilitate the formation of groups, for instance colleagues sharing a parking garage	5	FI
Private charging station specifications	If functionality for lending/renting out private charging stations is included, it should be possible to specify price and whether it is for emergencies only	5	FI

As noted in section 3.3, user requirements in UCD are written down and used to prompt further discussions with users, in order to refine them. As such, this list worked as a starting point for the second round of interviews

4.7 Second Round of Prototyping and Interviews

Because prototypes had proved a useful tool for sparking conversations in the initial interviews, we chose to create new prototypes for the second interview round based on the research we had done and the feedback we had received during the first interviews (see section 4.5). This was also around the same time we changed development platform from DrupalGap to AngularJS and Firebase (see chapter 5.3.2), and as such we felt less constrained by the limitations of the previous platform during the design of the prototypes, resulting in more explorative design ideas. Like the first prototypes, these were also designed to be tool to investigate the app's role and look and feel, but perhaps leaning on the look and feel aspect of the app more so than the first prototypes (see subsection 3.5.3 for the various aspects a prototype can be designed to investigate and section 4.3 for the first prototyping session).

In the first interview round, we learned that people tended to prefer that the filtering functionality and the menu icon were "balanced" on either side of the screen, and that having the filtering functionality within the search bar proved an unpopular idea. As a new design alternative, we created a prototype in which the menu is fixed at the bottom of the screen and a separate one that had the menu icon in the corner where the menu could "slide in" from the side.

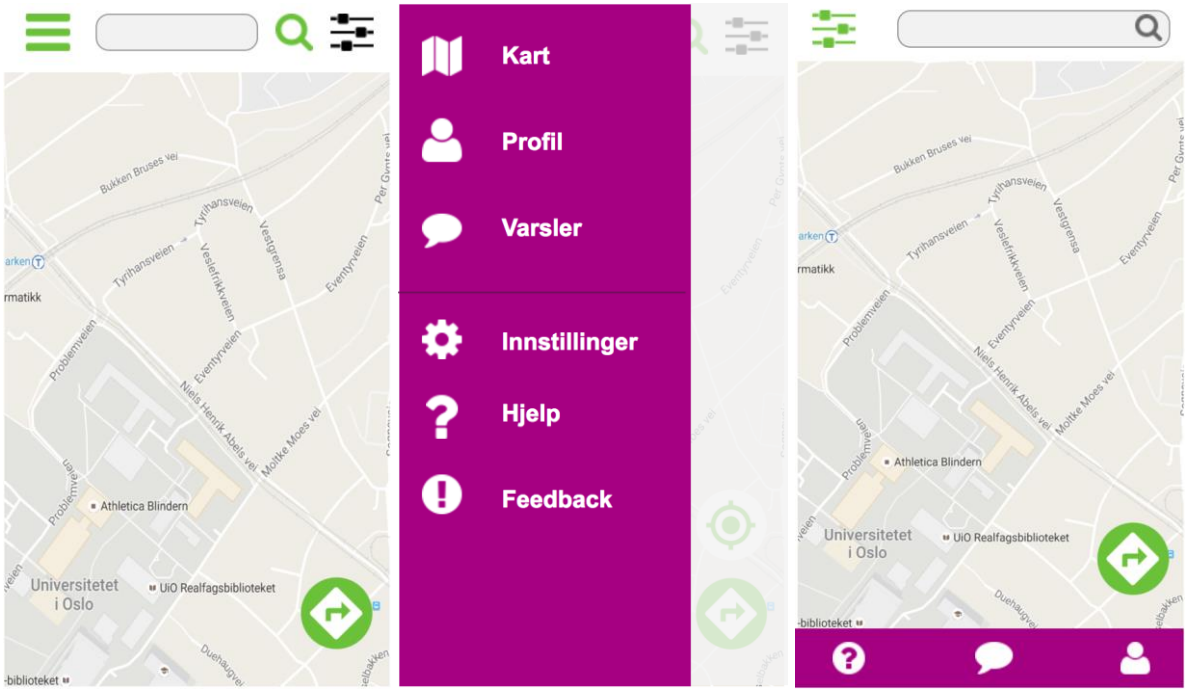

Figure 20: Prototypes to explore different design alternatives for menu functionality.

For the prototype with the menu affixed to the bottom of the screen, one of our main concern was that the icons would not communicate their utility clearly to the user, so we decided to test this by adding questions about these icons to our interview guide. In addition, we made other versions of the prototype, one with labels beneath the icons (is understandability increased with labels?), other color schemes to probe discussions on color (should everything be shades of green, or is the use of complementary colors a more interesting choice?), and one for testing where the directions button should be placed (on the map like in Google Maps or in the menu at the bottom to avoid obscuring part of the map?).

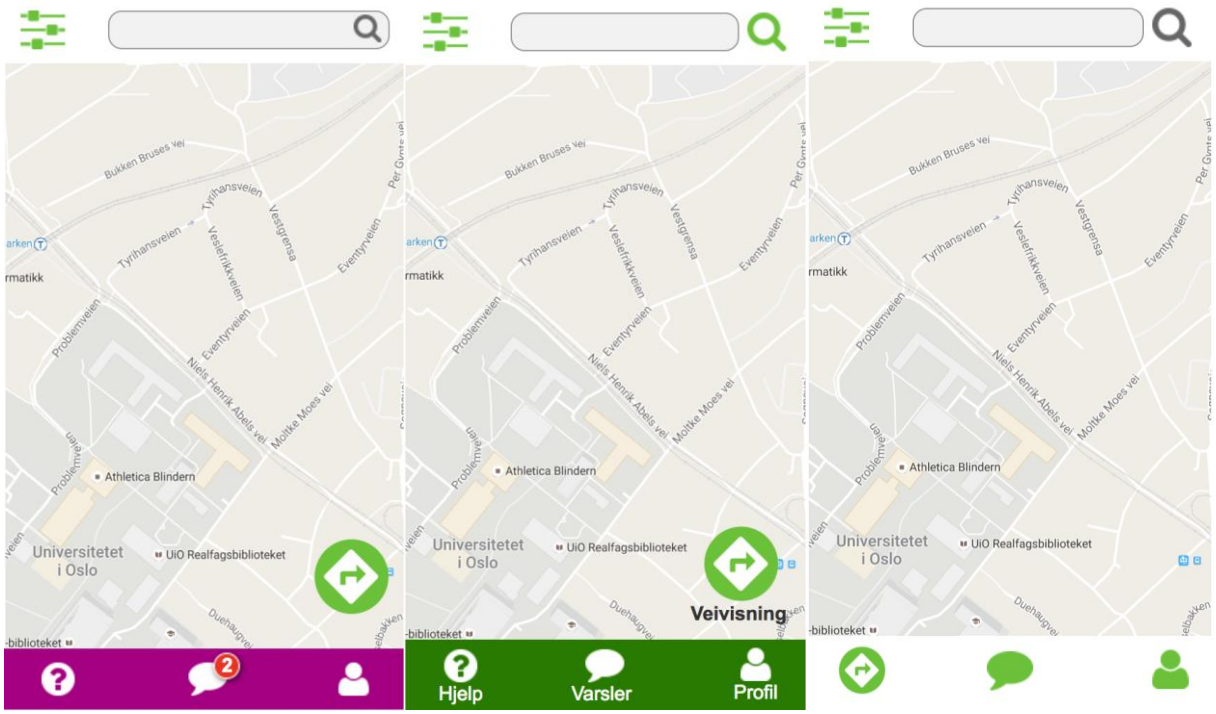

Figure 21: Prototypes with and without labels, in different colors, and different button placements

As both the initial interviews and the document analysis confirmed, being able to use the app to plan trips by searching for places and seeing charging stations along a route is functionality that should be implemented. As such, we also designed prototypes for how we envisioned this functionality might look in the finalized app in order to get the users' input on this.

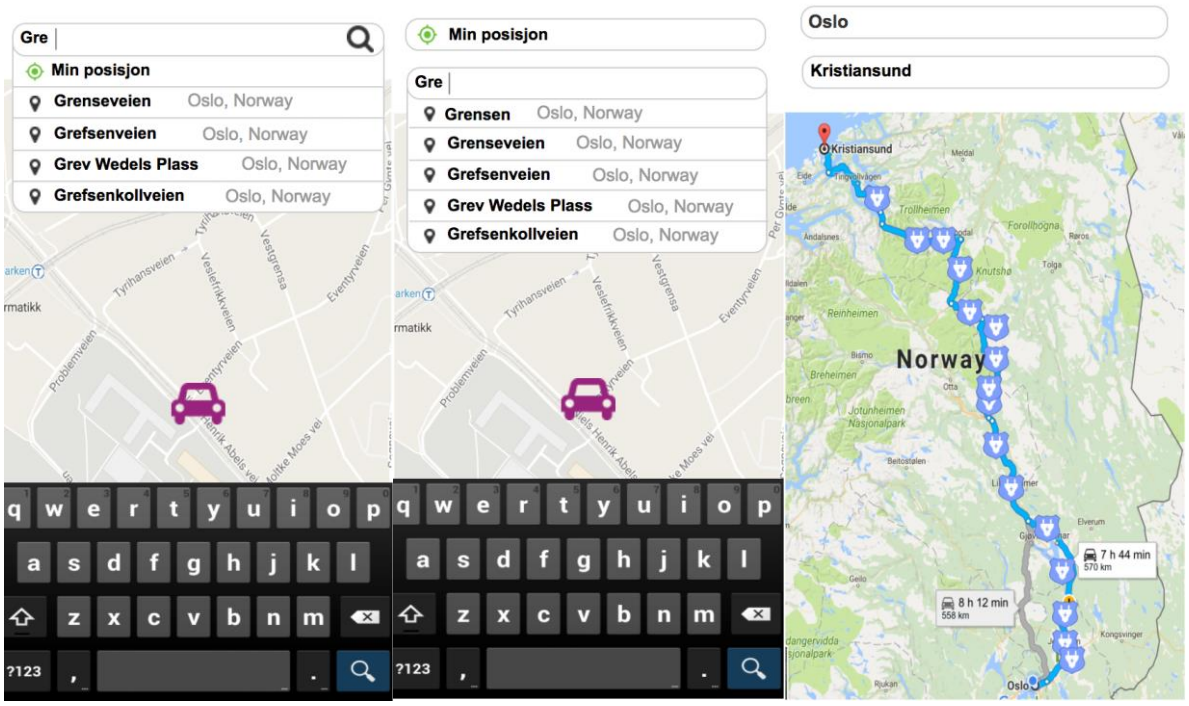

Figure 22: Prototypes for the functionalities of searching and generating routes.

In the first prototype (see section 4.3), we had not really included much information about the charging stations themselves, as we were uncertain which data points were important to eCar owners. Showing them the list of attributes from Nobil was our idea of gauging which information was important to them, but their responses were far from unanimous. In our second prototype, we decided to display some of the information in order to further investigate this issue. We also decided to try to represent the same information in different ways, some with icons and others without, in order to examine whether icons coupled with values convey enough information to infer their meaning or if all the information should be represented textually.

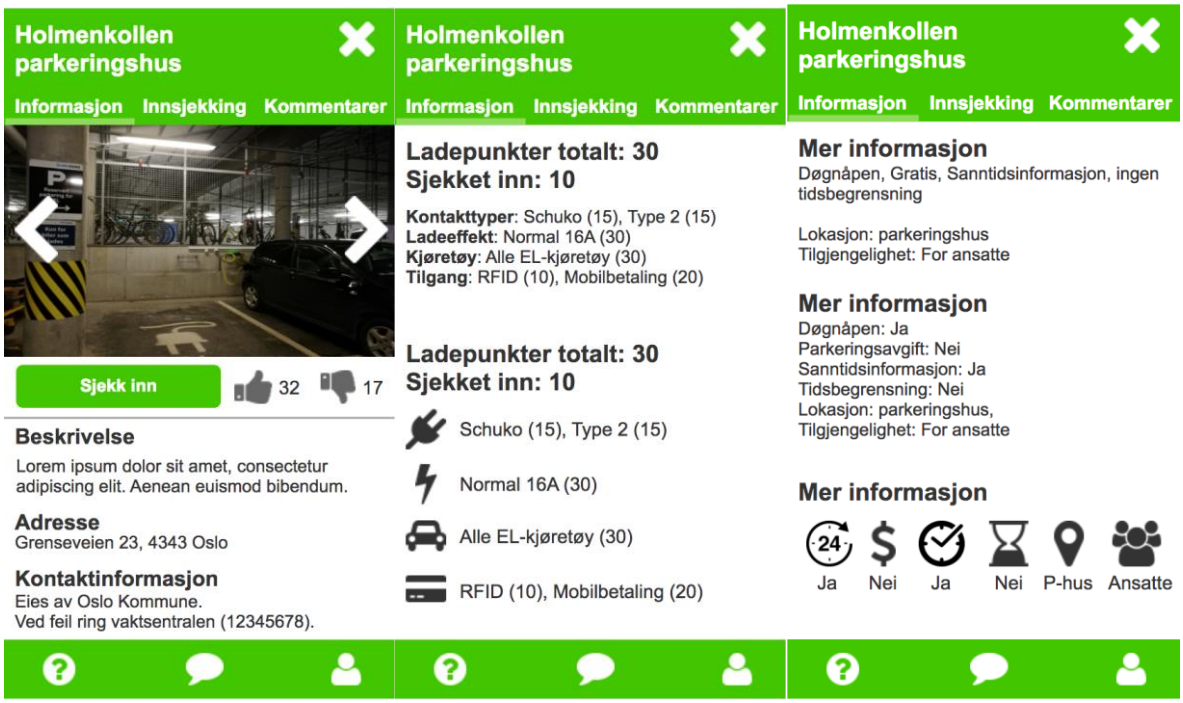

Figure 23: Prototypes to spawn discussions on what information is the most important and whether icons convey information appropriately.

We also knew based on the analysis of the initial interviews and the document analysis that there is a need to filter out certain charging stations from the map. Because of this, we made a prototype for a filtering function in which we included some of the attributes we thought the users might find it useful to filter on in order to ask them if these were actually useful or if some filtering options were still lacking. Another thing we were uncertain of during the prototyping session was whether the users' filter settings should be reset between sessions, or whether they should be saved. For some of the settings it would if they were saved between sessions, such as the compatible outlets. As two of the interviewees stated during the first interview round, this could or should be something you selected when you registered on the app, but other settings such as rapid charging could change depending on the users' immediate need. In order to investigate this issue further, we included questions about this on the interview guide.

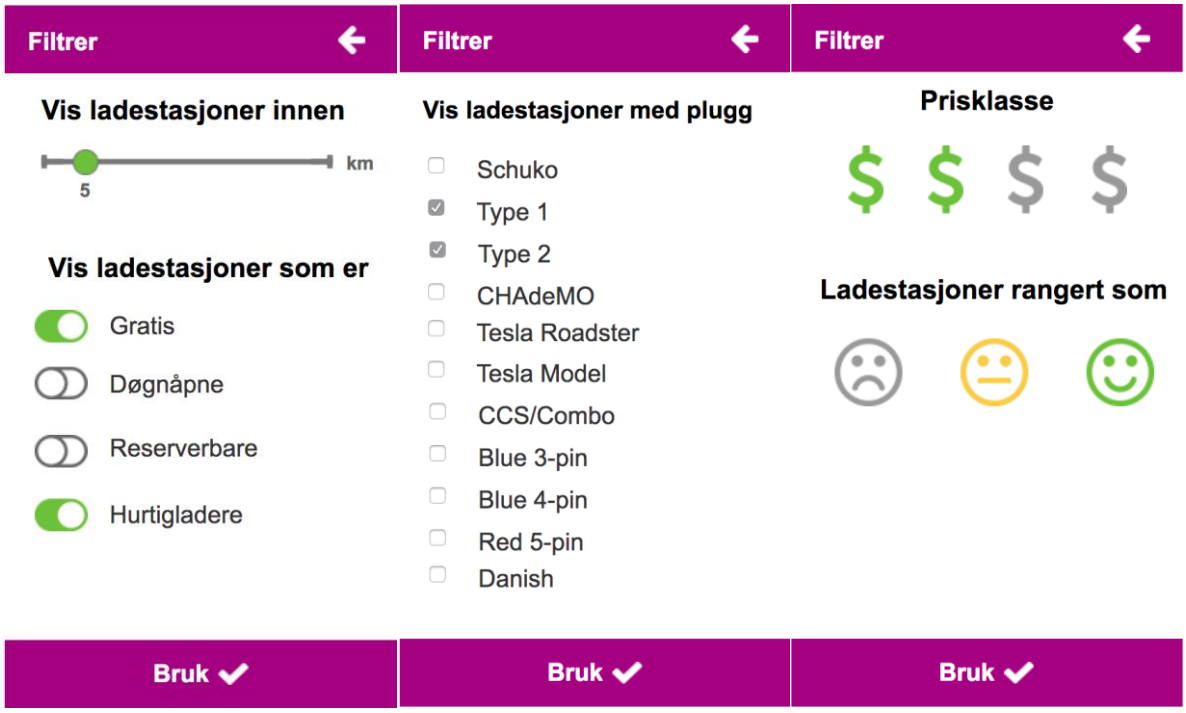

Figure 24: Prototypes designed to spark discussions on which attributes are the most important in terms of filter

Based on the results of the document analysis (see subsection 4.5.2), we also thought it might be a good idea to include comments and rating functionalities for users to quickly exchange experiences with one another in relation to specific charging stations. Since Nobil doesn't provide information on how much charging costs (only whether or not it costs anything), we thought it could be an idea for the users to be able to rate how expensive they thought different charging stations were. Additionally, as we had noticed a number of people asking other members on the forums of their experiences with certain charging stations, we decided we would like to implement some sort of overall rating system, although we were open to feedback on how to best do this. For the purposes of investigating this, we implemented different types of ratings, including smileys, likes and dislikes, and ratings for queue and pricing as a part of the comment section.

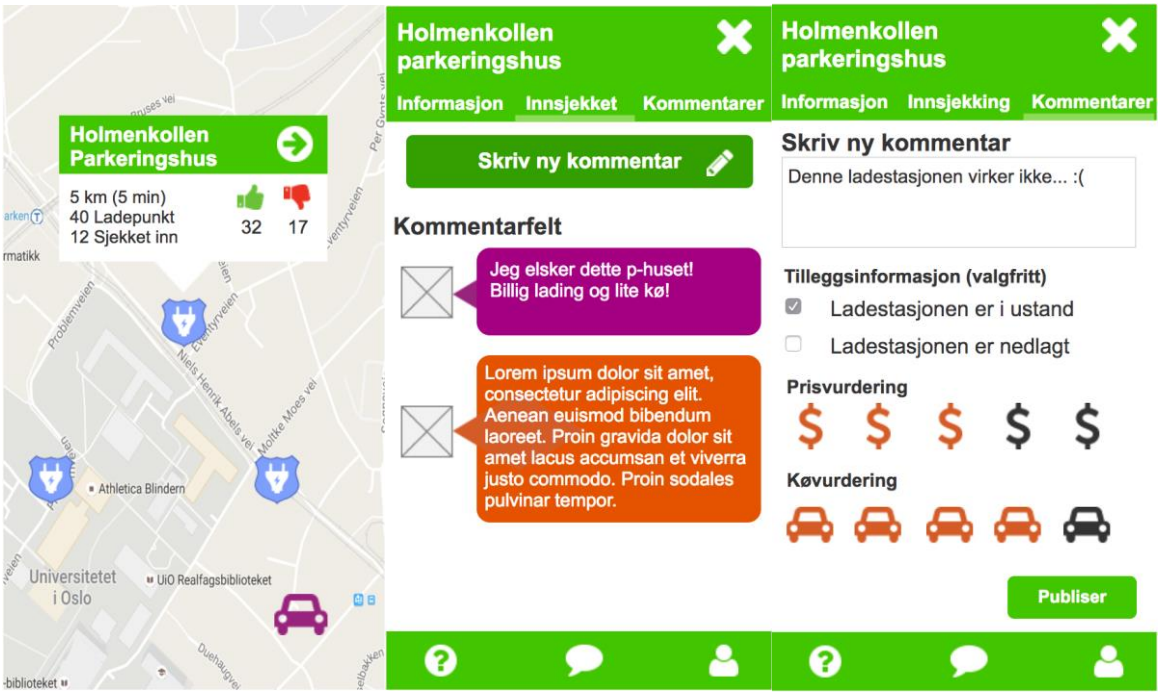

Figure 25: Prototypes for comments and different rating functionalities

We also designed prototypes for a user profile page within the app, in order to try to explore with the users what they should register as a part of their profile and to try to discuss the concept of gamification and their thought on, for example, receiving badges or rising in rank as rewards for doing various things within the app.

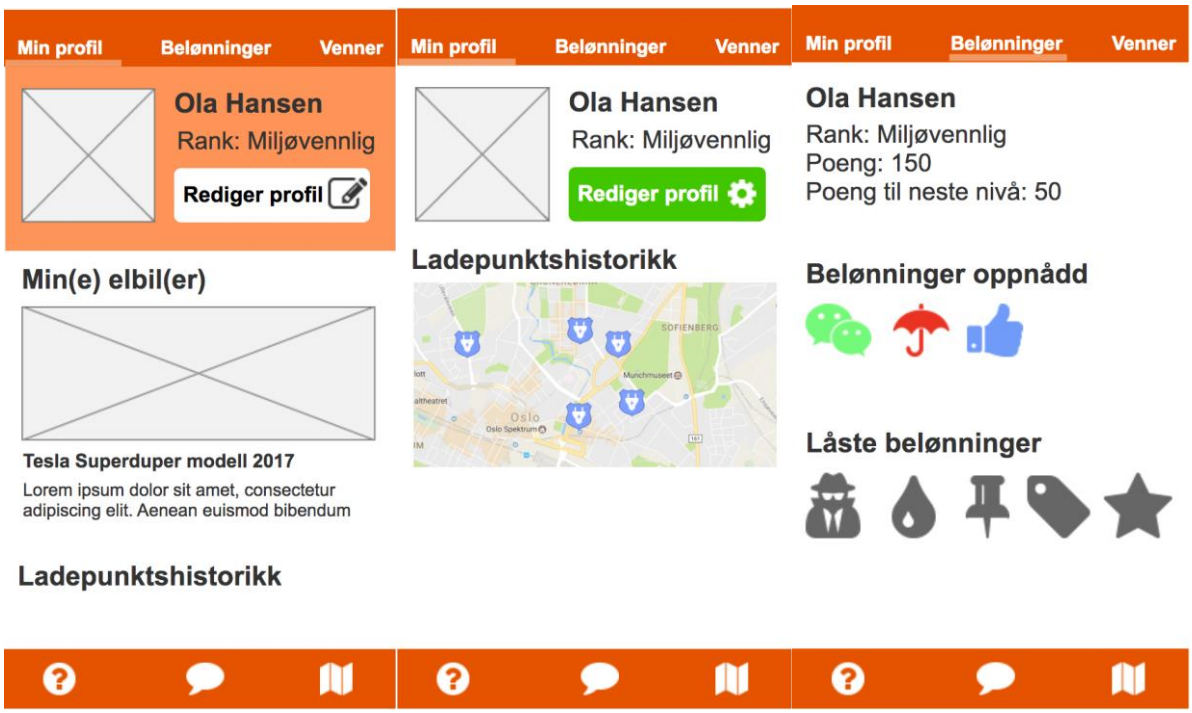

Figure 26: Prototypes for user profile, including gamification elements

The main purpose of the app is to encourage eCar drivers to move their eCars from a charging point to a regular parking spot when they no longer need the charging point for charging purposes. The proposed solution to achieve this is through a function in which users parked at a charging station manually checks into that charging station in the app, and that eCar drivers in need of charging can send a “charging request” to users checked into a charging station to alert them that someone else needs charging.

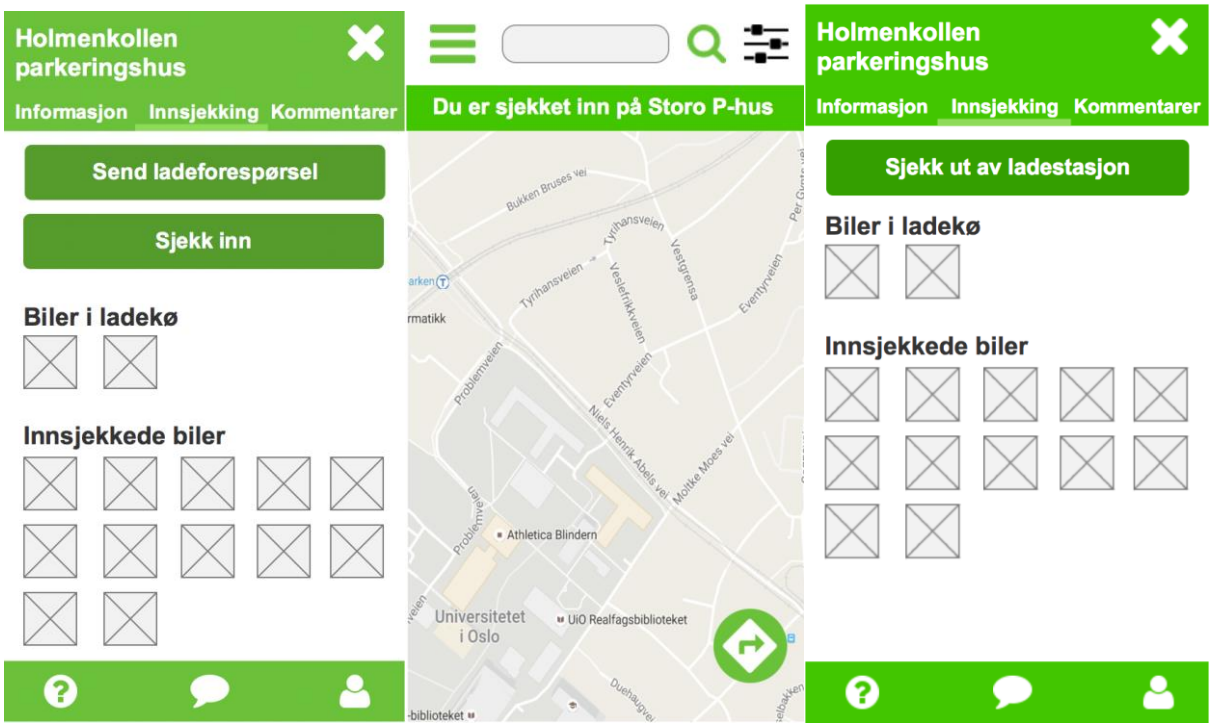

Figure 27: Prototypes demonstrating the proposed checking in and -out functionality.

Our great worry in terms of the checking in and -out functionality was that this was too complex a solution for the problem, so that people wouldn't bother using it. However, we thought this might be a good starting point for discussing alternative solutions to the challenge.

In preparation of the second round of interviews, we thought it would be good to revise some of our other interviewing strategies as well. Although Houde & Hill (1997) suggest higher fidelity prototypes might work better with users outside of the sphere of IT development and design (p. 379), we found that during the first interview round the participants showed a certain reluctance to interact with our clickable prototypes. Instead of making the new prototypes clickable, we chose to print them out on paper and explain the different functionalities to the users during the course of the interviews. We thought this would also make it easier for the interviewees to compare different prototypes, as it would alleviate the necessity to switch back and forth between different screens.

4.8 Analysis of the Second Interview Round

During the second round of interviews we interviewed a total of seven eCar drivers, ranging in age from their early thirties to mid-sixties. As mentioned in chapter 4.7, we had revised our interview guide to ask more specific questions relating to the design of the various prototypes and the different functionalities. The interview guide for the second interview may be found in appendix E

It bears mentioning that the interviewees for this second round were not recruited in the same manner as the interviewees in the first round. Rather, we utilized our personal connections and managed to get in touch with someone who works at a large organization that deals specifically with environmental research. This person helped us write and distribute an invitation to participate in interviews to the eCar owners working at the organization on our behalf. Because of this, the sample interviewed during this round were perhaps more likely to be environmentally conscious than the interviewees recruited by chance during the first interview round. This is for instance illustrated by one interviewee stating that it would be "embarrassing" for her to be seen driving to work in a fossil fueled automobile, given that her job specifically deals with sustainability. Indeed, of the seven interviewed, four stated that their primary motivation behind getting an eCar was environmental considerations. This finding is in contrast to the finding from the first interview, where environmental benefits were considered more as a bonus feature whilst the economic incentives were highlighted as the interviewees' primary motivation for getting an eCar (see section 4.5.1).

Our approach to both interviewing and analysis during the first round of interviews was rather loose, because the primary objective was to gain a better understanding of the target population and explore the utility of various proposed functionalities. During this interview round we had more refined prototypes, had created multiple design alternatives for the different functionalities, and the interviews were more focused on getting feedback on the design elements. We were also more consistent in the questions asked, with less revision of the interview guide between interviews, which allowed for the transcripts to be more easily compared and contrasted. For this round of interviews we employed a more structured analysis approach, similar to the process described by Walsham (2006) as a "looser approach" to grounded theory in which one note down impressions throughout the interview process, generate more organized sets of themes and issues after a group of interviews, and then reflect

on what has been learned (p. 325). For the purposes of summarizing our findings, we find it logical to break up this chapter into subchapters based on the major codes unveiled through the process and feedback from the users on the different design elements and functionalities presented to them in the prototypes.

4.8.1 Relation Between Make and Model of eCar and the Users's Needs

During this round we spoke to a few interviewees who drove specific types of eCars and the things they told further cemented to us how the make and model of an eCar is connected to the owner's needs. For instance, the Tesla owner reported that she only needed to charge her car once every week and that she only once had experienced a Tesla charging station being completely full, but reported worry that this might become a bigger problem in the future what with Teslas gaining popularity. Another interviewee drove an eCar that required a combination of a very specific charging effect and outlet, and what with Type 2 compatible cars becoming the standard was experiencing increasing difficulty finding charging points compatible with her eCar.

4.8.2 Other Apps and Services

We asked the interviewees what apps and services they currently used in conjunction with their eCar usage. Four of the respondents referred to the GPSes inside their eCars, but the various interviewees made multiple complaints about these. These complaints included that the map was outdated because it included charging stations that were defunct while not including recently constructed charging stations, that the map provided by the GPS also included private charging stations that the user could not access, and that it was impossible to filter out charging stations based on for instance the charging effect (rapid charging) and their operators.

One of the interviewees stated he used a website called "Lade i Norge", which we had never heard about before. The interviewee stated confidently that it included real-time information about all charging stations in Norway, but upon further research it seems that the only charging stations provided by Lade i Norge are those that actually transmit real-time information, which is a minority of the charging stations in Norway.

4.8.3 An Ideal eCar App

One question we asked each of the interviewees prior to showing them our prototypes was for them to describe what they would like from an ideal eCar app. The following is a list summarizing the responses.

- Real-time information of charging station status (i.e. occupied or unoccupied)
- Be able to pay through app if payment is required
- Get an overview of all rapid charging stations
- See your position relative to nearby charging stations on a map
- See all charging stations maintained by operators you subscribe to
- See up to date information about charging stations
- Clearly be able to see if charging stations are public or private
- See the distance from your position to the charging station in kilometers
- The app integrated with the car's GPS
- See map with information of connector type and charging capacity for charging stations
- Be able to plan for trips
- Be able to easily inform others that you're leaving and freeing up a charging point
- See all compatible charging stations
- Queuing system for rapid chargers and ability to see nearby charging stations with shorter ueue

Some of the “ideal” functionalities mentioned by the users we had already planned and designed prototypes for, for instance getting an overview of all rapid charging stations or seeing compatible charging stations (available through the proposed filtering functionality), seeing your position relative to nearby charging stations and their distance in kilometers, and ability to plan trips. Other requests fell outside the scope of what the app is meant for. For instance, handling payments would likely require us to partner u. Sop with different charging station operators and implement logic to handle secure payments. Similarly, while it would make sense for the app to be on GPS rather than on smartphone, different makes and models of cars have different GPS systems and we lack the technical know-how for GPS app development.

The app we envisioned responded to two attributes mentioned by our users in particular, namely the need for real-time information and the wish to be easily able to inform others that a charging point has been freed up. As far as we can tell, no current app provide real-time information of all charging stations, as only the minority of charging stations seemed to be equipped with technology that enables them to broadcast their status. As such, our proposed checking in and out functionality is a rather crude solution to this demand. Through checking in and out of charging stations, you would also be able to communicate to other eCar owners that a charging point has been freed up.

4.8.4 Games and Gamification

While the eCar drivers interviewed during the first round of interviews seemed nearly unanimous in their disregard for games, we nevertheless chose to ask some of the interviewees about games and gamification during this round of interviews. Of the four people asked whether they played games, three of them responded no. The reasons specified by those who chose to elaborate on their answers was that they “didn’t have time”, thought games were “boring”, and one reported being a “sore loser”. Further on, when we asked them about gamification, one interviewee was very vocal and stated that she was “wholly uninterested in such things” and that she “would not let herself be influenced by such things”. However, the fourth interviewee asked about this reported playing numerous games and was very positive to the idea of gamification, stating that from his own experience competitions was a powerful motivator and that he really “believed” in it. Another one of the interviewees

was not wholly negative to the idea, stating about gamification: “Hmm… Maybe more fun than useful”.

However, playing and enjoying games is not a prerequisite for enjoying gamified systems. As noted in noted in section 2.3, gamification is the application of game elements or lessons from the gaming domain in non-gaming contexts. Even though the majority of interviewees reported not being interested in neither games nor the idea of gamification as presented verbally by us, they might be influenced by it through the actual use of the technology. However, this is hard to assess a priori, without a finished app with functioning gamification elements that the users can test for themselves.

4.8.5 Menus

As illustrated by figure 20, we designed two main alternatives to the user menus for the application. The vast majority of the interviewees preferred the menu that slid in from the side, as opposed to the menu embedded at the bottom of the screen. The reasons for this, as reported by the users, was that they would like for the map to be as large as possible, and that they were familiar with slide-in menus from other apps. One interviewee, however, showed a clear preference for the menu affixed at the bottom of the screen, stating that it was “even easier” if the menu was there as opposed to hidden behind a menu button in the top left of the screen.

Another reason for choosing the slide-in menu as opposed to the menu embedded at the bottom of the screen was that a majority of the interviewees stated that they would prefer for the icons to be labeled. The slide-in menu provides plenty of space for the icons to have labels, while the menu at the bottom of the screen would have to be expanded if labels of a legible font size were to be included, which would further decrease the size of the map.

4.8.6 Directions

When designing the prototypes, we thought it would be useful to integrate our app with Google Maps and provide the users with the ability to plan a trip between point A and B, and see all charging stations along the route. The majority of the users liked the proposed solution from the prototype (see section 4.7). One user specifically requested that a route should be generated when she clicked on a charging station on the map, rather than having to click the

“directions” button for the route to appear. Another user noted that she would like to add “waypoints” to the route, i.e. stops along the way that may deviate from the fastest route. Yet another user would like to be able to adjust the radius around the route, noting that he didn’t mind departing from the route to charge, and would additionally like to see alternative routes.

4.8.7 Filter

One thing we debated heavily among ourselves during the prototyping phase was whether the filter should remember previous settings or be reset between uses. For some of the search criteria it made sense to us that it wouldn’t change between uses, for instance the outlet type compatible with your car. One interviewee during the previous round specifically requested that you should register plug type when you registered your profile. However, the users during this interview round seemed split on the question, some responding that they would prefer for the filter to remember previous settings, whilst others preferred for the filter to be reset between sessions. A few of the users noted that they utilized one cable for rapid charging and another for regular charging, and as such it wouldn’t make sense to register your type of plug when registering for the service because the type of plug would depend on your charging needs at that time. An alternative solution to this would be for the user to be able to add multiple plugs and specify which charging effect they were capable with so that they could easily switch in the filter.

4.8.8 Deciding Factors When Choosing a Charging Station

During the first interview round we showed the participant a list of the charging station attributes we were able to retrieve from Nobil’s database (see section 4.3 and appendix E). As noted previously, the responses we received then varied widely, making it difficult for us to deduce which information actually was the most crucial and thus should be presented first. In another effort to elicit this, we included a question on the interview guide about what was important to the interviewees when choosing which charging station to utilize (see appendix E).

Their responses were as follows:

- Should be easily accessible
- Should be free of charge
- Should be compatible
- Should be close by
- Should have desired charging capacity

This significantly narrowed down the original list of charging station attributes, and told us that the most important data points were accessibility, compatibility, price, proximity, and charging effect.

4.8.9 Charging Station Presentation

We showed the interviewees the proposed design alternatives for how charging station data should be presented within the app (see figure 23). One interviewee stated that there was "too much information" on each charging station, but this might have been an optical illusion as we had chosen to present the same information in three different ways within the same prototype screen.

There seemed to be some consensus among most of the users that pictures of charging stations were not really necessary, although one interviewee said liked it as she felt it would allow her to recognize the charging station when she got there. Another user stated that the most crucial information for the charging station was how its proximity to his location and how many available charging points. The users seemed to agree that the least important information was the charging station's description and contact information, and thus that this should be presented last.

When asked about the alternative ways of presenting the same information, the majority seemed to prefer the information to be represented by icons rather than pure text. This seemed to be the case even though, when probed, the interviewees admitted that some of the icons (particularly those chosen to represent "real-time information" and "time limit") did not

effectively convey their meaning. One user said that the use of icons made the information much easier to read as opposed to the purely textual information.

4.8.10 Rating and Comments

In the prototypes we included a comment section and several different suggestions for how to implement a rating functionality (refer to section 4.7 for a more thorough description). The majority of the interviewees liked the idea of having a comment section for each charging stations, but they seemed split on the proposed functionality for rating charging stations. Some reported liking it and said they believed that others' opinions would influence their choice of charging station. Some of these also requested that additional information should be attached to the comments and ratings to make them more useful, such as which make and model of eCar the rater was driving and at what time and date the ratings were posted in terms of queue rating and the possibility that the reported problems may have been fixed. We also heard that we should be consistent with which rating system we used, as the prototypes reflect both smileys, likes, price and queue ratings, with one user proposing instead that we used a star rating similar to that used by hotels. Another user really liked the like and dislike functionality, but would like for the information to be presented in percentages rather than the number of likes and dislikes as this would be more easily processed information. We were also made aware of an issue that we hadn't thought of, namely that people are likely to rate a charging station that is out of order poorly, but charging stations that are out of order may be fixed. As one interviewee put it: "It either works or it doesn't, but what happens if it gets fixed?".

Other users didn't see any need for a rating system whatsoever, with one user noting that "if people need charging, they will use the charging stations that are there regardless of other users' opinions of them". Another was even more straightforward in her criticism, stating that "if I find a parking garage I really love, that is free of charge and never crowded, I wouldn't want anyone else to know about it".

4.8.11 Checking In and Out of Charging Points

The by far most controversial functionality was, as expected, the functionality for checking in and out of charging points. While some users thought it was a "smart idea", and that being able to assess the risk of queue through the number of checked in users was "golden

information" others thought it was "too complicated". One of the interviewees was particularly sceptical to this idea, as she had previously participated in a similar project where the users were meant to rent and return bikes through the use of an app. She reported that even when the users were charged for forgetting to return the bike, this still didn't provide enough incentive for the users to open the app and register that the bike had been returned. However, we are slightly inclined to disagree with this interviewee's assessment that our project is doomed to fail. As discussed in subsection 2.1.2, monetary deterrents may actually crowd out intrinsic motivation and rarely leads to long-term behavioural change, but by implementing rewards that are unexpected or perceived as more informational than controlling they won't necessarily crowd out intrinsic motivation.

Several users questioned whether people would remember or bother to check into a charging station, one interviewee noting that "parking and plugging in an eCar to charge it is already a prolonged and complicated process without adding having to check in via an app". Of course, as many of the interviewees pointed out, it would be ideal if the process of checking in and out was automatic. One user felt that it was only a matter of time before real-time information will be available for all charging stations, thus rendering our solution obsolete, but as far as we can tell no one knows when or if real-time information will be publicly available for all charging stations. Another way of making the process more or less "automatic" would be for the GPS in the smartphone to register a users' proximity to a charging station and sending a push notification to ask whether he or she was currently charging or not. This would negate the user's need to manually open the app, navigate to the check-in section of the charging station, and pressing a button there. One interviewee actually stated that he thought 85% of people would respond to a push notification by selecting either yes or no. The obvious drawback of doing it this way from our perspective, and which we discussed with our users, is that the app then runs the risk of becoming too "naggy" and thus prone for deletion. However, a majority of the interviewees seemed to think sending push notification was a better solution than having to manually open the app to check in because checking in and out "has to be easy".

With some of the interviewees we discussed the possibility of them contacting the checked in users directly through the app. This raised several concerns in the users, most prominently that other users might be rude in their messages. The proposed solution to this was that the users should contact others by choosing messages from a predefined list. Some of the users

were also sceptical of a function allowing them to contact and be contacted by other users nearby, stating that the users might become paranoid or otherwise feel they were under surveillance, though not all of the users seemed to be bothered by this.

4.9 Finalized List of User Requirements

Building on the requirements listed in section 4.6, these are the revised requirements based on the second interview round, in which we probed for further requirements and asked for feedback on the requirements we had already gotten from the first interview round. As in the previous list of user requirements, each requirement has a priority where the number "1" denotes top priority, as well as a source of origin (F1 for first interview round, DA for document analysis, and SI for second interview round).

Table 3: Finalized list of user requirements

Requirement	**Description**	**Pri.**	**Source**
Map	The users want the app to have a map that shows the location of charging stations	1	FI
Geolocation	The users want to get an overview of nearby charging stations based on their proximity to these	1	FI
"Directions"	The users want to be able to plan trips by searching for places and see charging stations along a route	1	FI, DA, SI
Filter	The users want to be able to filter out charging station based on some criteria, for instance charging effect (rapid charging) or operator (Fortrum, Grønn Kontakt, etc.)	1	FI, DA, SI
"Clean" design	The users do not want the app to be too "messy"	1	FI
Simple check-in & out	The users want the checking-in and -out functionality to be easier than the one presented in both the first and second prototypes (see figures 16 and 27)	1	FI, SI
Exchange experiences	The users want the app to make it easy for them exchanging their experiences with charging stations	1	DA, SI

Slide-in menu	The users want the menu to slide in from the side when they click on the menu button in the upper left corner	1	SI
Charging station information	On the charging station information page, the users want the charging station's proximity to the user and the number of charging points to be presented first and the contact information and description to be presented last	2	SI
Easy navigation	The users want navigation to be easy and not multi-tiered	2	FI
"Balanced" icons	The users want the icons to be balanced, i.e. one in each corner of the screen rather than on top of one another	2	FI
Up to date	The users want charging station data to be kept up to date and new charging stations should be added quickly	2	FI, DA, SI
Meaningful names	The users want charging station attributes with meaningful, unambiguous name	2	FI
Charging station information with icons	The users prefer for charging station information to be presented with icons, rather than purely textual information	2	SI
Notify others	The users want to be able to easily inform other users when a charging point has been freed up	2	SI
Distance in kilometers	The users want to be able to see the distance from their position to a charging station in kilometers	2	SI
Push notifications to check in	The users would prefer for the app to send push notifications to users nearby charging stations to ask if they are charging to negate the need to open app and manually checking in	2	SI
Unobtrusive push notifications	The users want any push notifications to be unobtrusive and not "naggy"	2	SI
Consistent rating system	The users want the rating system should be consistent (i.e. not a mix of smiley faces, stars, likes, dollar signs and cars)	3	SI
Pricing	The users want to have information about how much it	3	DA

	costs to charge at a charging station		
Leaderboard	The users want the app to have a leaderboard for who has most frequently shared charging points to facilitate this same sharing	3	FI
Distinct icons	The users do not want icons in the app to look too similar to one another	3	FI
Register plug	Some users want the option to register to the outlet types their cable is compatible with when signing up	3	FI
Waypoints	Users want the ability to add waypoints to a route	3	SI
Radius around route	The users want to be able to adjust the search radius around a route to be able to see more nearby charging stations	3	SI
Additional information comment/rating	The users want comments and rating to have additional information such as time and date, and include the make and model of commentator's/rater's car	3	SI
Likes in percentages	The users want likes and dislikes to be presented by percentages rather than number of likes and dislikes	3	SI
Facebook friends	The users want friends to be imported from Facebook rather than by searching for username (if friends are included)	4	FI
Multiple eCars	Some users come from households with two or more eCars and would like to be able to add more than one eCar to their profile on the app	4	FI
GPS based charging requests	The users want it to be possible to send charging requests to people nearby based on GPS location, not just one specific charging station	4	FI
Alternative routes	Some users want to be able to see several alternative routes from point A to point B	4	SI
Connector type and charging capacity	The user should be easily able to see which connector types and charging capacity the charging points at a charging station have by looking at the map	4	SI

Fixed charging station	The users want for ratings and comments to somehow account for problems with charging stations being resolved/charging stations out of order being fixed	4	SI
Contact other eCar drivers	The app should offer ability to contact other eCar drivers, in case they park without charging or otherwise violate the eCar etiquette	5	DA
Groups	The users want the app to facilitate the formation of groups, for instance colleagues sharing a parking garage	5	FI
Private charging station specifications	If functionality for lending/renting out private charging stations is included, it should be possible to specify price and whether it is for emergencies only, as per users' request	5	FI
On-click route generation	Some users want a route to be generated from their position to a charging station upon clicking the charging station	5	SI
Predefined messages	If communication between users on the app is implemented, a user should choose a message from a predefined list rather than being allowed to write whatever he wants	5	SI
Pictures of charging stations	A few of the users want charging stations to have pictures so that they easily recognize that they are in the right place	5	SI
Queuing system	One user wanted the app to implement a formal queuing system functionality for getting in line at a rapid charging station, or see nearby charging stations with less queue	5	SI

Even though the title of this chapter is "Finalized list of user requirements", future research may uncover further requirements or unveil that some of the requirements we have specified are not, in fact, what the users want or need but a result of us misinterpreting what they told us. If not for the time restraints of the thesis, we could have spent years refining the requirements by interviewing, prototyping, testing, and talking to eCar owners. However, due to the time constraints, we have chosen to end the data collection process with these requirements and start building the system based on the above list, starting with the requirements of the highest priority.

5 Development Process

The development process have been parallel to the design process, as mentioned in both section 1.6 and at the introduction to chapter 4, and thus the design and development processes have informed one another. In this chapter we will describe the different technologies we have reviewed and tested, what experiences we have from both the development frameworks we have work with, what features we have implemented and how this implementation has been done.

5.1 Choosing Technology

Before any user involvement had been done in this project, we decided that a mobile application, or app, would be the obvious technical solution to our problems. Firstly, we wanted solution that was portable; something the users could take with them on trips, on their way to work, and outside of their home. Secondly, we wanted a solution that had the capability to alert or communicate with our users wherever they were. Thirdly, we wanted a technological solution that would be easily available and not expensive or hard to obtain. Fourthly we want to develop a solution on our own, meaning it needs to be written in a framework or language at least one of us have some experience with.

Mobile devices are more or less ubiquitous in today's society and people increasingly use them in all aspects of their lives (Rogers, Sharp & Preece, 2011, p. 188). As driving an eCar is a mobile activity in and of itself, it would make the most sense to implement our product as an app. Stark (2010) and Budiu (2013), divides mobile applications in three different categories; native apps, hybrid apps and web apps.

5.1.1 Native Apps

Native apps are built in the mobile phone platform's language (for instance, Java for Android and Swift for iOS), and have access to the phone's hardware and the platform's existing libraries. This makes it possible for the developer to integrate functionalities such as the camera, the phone's folders or storage, and the notification system when building native apps (Budiu, 2013; Stark, 2010).

Other benefits of native apps include that they can operate offline since they are installed on the phone and that they can utilize the phone's storage instead of a database. The drawback of developing native apps is that you need to develop separate sets of code in the respective platforms' programming languages. This would have been too time-consuming, and one of our goals was that the app should be available for everyone, we need to develop for both for the Android and iOS platform.

5.1.2 Web Apps

Web apps are apps designed to look and feel like native applications, but actually run in a browser. The main benefit of web apps is that the code can be written in any language which can be executed from a web server, making the apps platform independent.

Before the introduction of HTML5, web apps had little to no access to the hardware of the mobile phone. However, with the introduction of HTML5, information can now be stored in the browser's web storage, making it possible to also have offline web apps running (Heilmann, 2010). In addition to this, HTML5 now have access to the phone's geolocation (Budiu, 2013), and some browsers also have access to media capture and an ever growing library of APIs (Mobile HTML5, n.d). Even the highly missed push notification feature is now available for web apps (Medley, 2017). One of the negative sides of web apps is that they miss out on the different platforms' "store systems", like PlayStore for Android or App Store for iOS, where users can simply download the app and save the shortcut to their home screen (Stark, 2010, p. 1).

5.1.3 Hybrid Apps

Hybrid apps are a hybrid of the web app and native app described above. They are often built with HTML5 and Javascript, but is compiled into a native application. After deployment the app can be downloaded from the platform's store system. One solution is to develop the site as a web app and build an additional native app which simply render the website in the phone's browser whilst hiding the browser border. Another solution, which is growing more popular, is to build the web app using frameworks like Apache Cordova, Appcelerator Titanium, or Sencha Touch, which include JavaScript libraries that can be used to access the phone's hardware (Stark, 2010, p.2).

The Apache Cordova framework compiles the HTML, Javascript and CSS code into native applications. It does so by executing the web page within native application wrappers called WebView. This makes it possible to distribute the application to the different app stores.

As already mentioned, web apps have many new features such as hardware feature access, geolocation, media screen capture and push-notification that has been possible due to the introduction of HTML5. However, Apache Cordova plugins also gives access to a more extensive list of the phone's APIs, including, but not limited to, its battery status, contacts, media, media capture and status bar through the use of plugins (Wargo, 2015 p. 6-7).

Apache Cordova also supports many platforms in addition to the typical Android and iOS, like Windows Phone, Blackberry and Ubuntu Phones, however, not all plugins are supported by all platforms (Apache Cordova, n.d).

5.1.4 Our Choice

As mentioned at the onset of this chapter, one of our goals was to use technology that would allow us to develop this solution on our own. Taking this in consideration we need to exclude native apps as this would require two separate sets of code in order for it to work on the two most widely used operating systems for applications (Android and iOS). As our third goal in the list is that the solution should be easily available for our users, and excluding one or more mobile platforms would not be ideal.

Developing a web app and giving it app-like features and design would then have been a better solution. However, with a web app the users can't access the application from the store services, and when they run the app they would need to open a web url, instead of clicking on an icon saved to the phone's desktop.

The final solution we then landed upon was to develop a hybrid application where we write the code as if it is a web app, but then use Apache Cordova, to build the web app into a both an Android and iOS application.

5.2 Hybrid App Framework Alternatives

Having decided to go for a hybrid application gave us the opportunity to choose between a few different development frameworks that supports Apache Cordova. We found Drupal with

DrupalGap and AngularJS with Firebase as two viable solutions we wanted to consider. Both have their pros and cons, and are very different in terms of development and maintenance.

In the first stage of our thesis work we used Drupal with DrupalGap, but in February, 2017, we changed our development framework to AngularJS with Firebase. However, as we spent significant time and effort developing the app in Drupal with DrupalGap, we which to talk about both processes and outline why we considered starting the development from scratch again in February in a different development framework was absolutely necessary.

5.2.1 Drupal and DrupalGap

Drupal is an open-source Content Management System (CMS) with more than one million community members. Hannemyr (2017) defines a CMS as "some system (software tool) that allows an organisation or a group of collaborating authors to create, edit, manage, and publish contents in a consistent and organised fashion" (Hannemyr, n.d.). There are now 8 releases of Drupal, however we will only focus on version 7, and henceforth Drupal will refer to Drupal 7.

One of the benefits of working with a content management framework like Drupal is that it comes out of the box with features and services for building a website both with and without code. Another benefit of working with Drupal is its modularity by its use of "modules". Modules in Drupal gives different kinds of functionality to the Drupal sites. There are three types of modules: "core" modules that ships with the Drupal core installation; "contributed" modules, which are modules that are developed and contributed to Drupal by the Drupal community; and "custom" modules which are typically written for very specific functionalities by the developers of each respective site (Drupal.org, 2005a). Custom modules are usually developed in order to extend or customize Drupal outside of what is possible through the administrative menus and the installment of contributed models,. Custom modules utilize hooks in Drupal in order to extend and enhance functionalities that ships with core Drupal or with other modules (Drupal.org, 2001).

A piece of content in Drupal is called a node, and each node is of a specific content type (Drupal.org, 2005b). Each content type can have different fields connected to them, for instance one of the default content types that come with the Drupal core installation is "Article" which has two fields: body and a title (Drupal.org, 2009). New content types can be

defined through the administrative interface, in order to accommodate for different types of content. When a new node is created it is saved in Drupal's database, it is then automatically displayed at the frontpage if no other customization have been done to the site. This makes it easy for Drupal administrators to do very much with Drupal without having to code.

Views is a contributed module that can be installed on the site to give administrators the ability to customize how content is displayed. The view can then be saved as either a "block" that can be positioned in any available block region or be saved as a page which will be displayed after following a set path within the site's domain (Drupal.org, 2014).

DrupalGap

DrupalGap (http://drupalgap.org) is an open source development kit for Drupal that combines Drupal with Apache Cordova (Apache Cordova is described subsection 5.1.3, and will henceforth be referred to as "Cordova"). DrupalGap is developed and maintained by one person, that goes by the username Tyler Frankenstein. In order to work with DrupalGap, the DrupalGap module needs to be installed on the Drupal site and the DrupalGap application development kit needs to be downloaded and placed inside Drupals file system.

After successfully setting up and installing DrupalGap, Cordova's build tools can be used to compile the HTML, CSS and Javascript files contained within the DrupalGap application development kit into a mobile application that can run on both Android and iOS. These files then serves as a basis for further implementation. Like with Drupal, contributed modules can be installed on top of a DrupalGap instance to integrate different functionalities developed by other community members. In addition, as in Drupal, custom modules can be written to customize the DrupalGap app's functionality.

DrupalGap is also highly integrated with jQuery Mobile (https://jquerymobile.com/), a mobile HTML based user interface system designed for responsive web sites and apps. In order to customize DrupalGap, custom modules that implement DrupalGap hooks (similar to Drupal hooks) can be used to enhance and further extend DrupalGap's functionalities. In addition to enhancing and extending functionalities, DrupalGap hooks are used to create custom pages where different content can be displayed through jQuery Mobile's different widgets, such as a list (DrupalGap 7 Docs, n.d. b).

Back end and front end are terms typically used to describe different parts of a CMS. The front end is related to the part that is visible in the browser, and is typically written in HTML, CSS and JavaScript. The back end relates to the part of the CMS that is running on a server (Hannemyr, n.d).

DrupalGap utilizes a decoupled architecture where the front end and back end works independently and communicates with each other by sending and receiving Javascript Oriented Object Notation (JSON) API requests between them by the use of the Service and View Datasource module (DrupalGap 7 Docs, n.d. a). According to the DrupalGap documentation (n.d. c), "[t]he Services module provides URLs that can be used by a mobile application to C.R.U.D. [create, retrieve, update, delete] entities on a Drupal website". This makes it possible for the DrupalGap part of the website to handle basic Drupal requests that are offered by the Services API.

Figure 28: DrupalGap architecture. Reprinted from DrupalGap 7 Docs (n.d. a).

To summarize, when using DrupalGap, Drupal acts as a CMS and back-end solution, while the front-end part of the app is built by customizing the DrupalGap instance by the use of custom modules that implements DrupalGap hooks. Additionaly, UI elements are included by the use of widgets which utilizes the jQuery Mobile framework.

5.2.2 AngularJS and Firebase

AngularJS is a JavaScript framework developed by Google that follows some of the Model-View-Controller (MVC) architecture (Ramos, Valente, Terra & Santos, 2016).

The MVC architecture was first implemented by Reenskaug in 1978 and conceived as a solution to the challenge of the users "controlling a large and complex data set" (Reenskaug, n.d.). Reenskaug (n.d.) further states that: "[t]he ideal MVC solution supports the user illusion of seeing and manipulating the domain information directly".

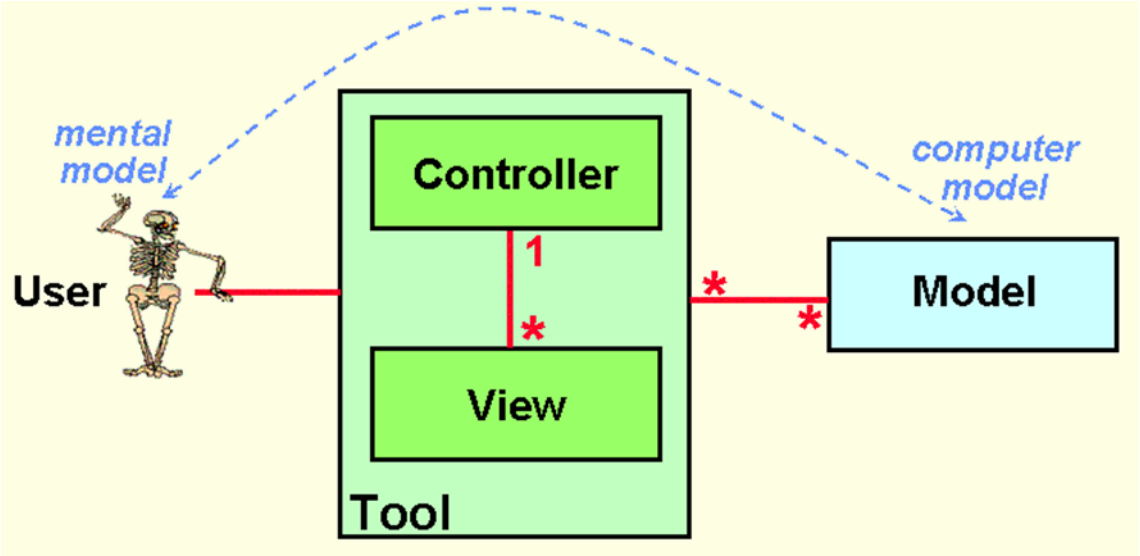

Figure 29: MVC model. Reprinted from Reenskaug (n.d.)

AngularJS Features

In this chapter we will provide a short description about the different features found in AngularJS, and how they can be be utilized to make the coding process much simpler.

When building AngularJS applications it is typical to split the different "pages" or places in the application into States. States are introduced by the Stateprovider in the AngularUI (https://angular-ui.github.io/) library, which is a companion suite to AngularJS. One state in the application can then be connected to a controller and a template. Each state can also have one or more sub-states, which then inherit the parents' controller and template (Chan et al., 2016).

The *scope* object in AngularJS detects and listens to changes in the live compiled webpage or application, and broadcasts these changes to its state (Jain, Mangal & Mehta, 2014, p.21-22).

This features removes the need to write boilerplate code that traverses, manipulates and listens to the DOM, which in typical web applications can contain up to 80% of the code (Jain, Mangal & Mehta, 2014).

The *controller* handles all business logic, such as deciding what happens when a user clicks a button or types keywords in the searchfield (AngularJS docs, n.d. a). The controller initiates the scope object, and adds additional behaviour to it (AngularJS docs, n.d. b).

Templates should only be concerned with the User Interface (UI), by embedding objects, AngularJS directives and structuring the HTML (AngularJS docs, n.d. a).

Services are stateless objects typically used for server requests and asynchronous operations (Ramos, Valente, Terra & Santos, 2016, p.1). Services are not specifically connected to a state, but can be easily injected as a dependency to any controllers, so it can be reused by different parts of the application (AngularJS Docs, n.d. c).

Directives can be reused in the different templates to extends the HTML with custom markup that can be attached to html element, or that serves as new html elements. They can also have templates and controllers attached to them. They can both share and inherit the parent's scope or create a new scope (AngularJS Docs, n.d. a; Ramos, Valente, Terra & Santos, 2016, p.2).

AngularJS however, as opposed to to Drupal and DrupalGap does not have any integrated back end solution or database. Using AngularJS would then require that we either build our own back end solution, or that we find a pre-existing back end framework which can be integrated with Angular.

Firebase

Firebase (https://firebase.google.com/features/) is a mobile platform developed by Google that offers different features to assist developers. The most important features, it pertains to our development, have been the realtime database feature, the authentication feature and the cloud messaging feature.

The realtime database offered by Firebase is a NoSQL database. NoSQL databases does not adhere to the rules of a relational databases with primary keys, foreign keys and a more strict data structure. The database consists of some rules that can be written in Firebase’s console,

and the database itself consists of JSON formatted files (Firebase docs n.d. a; Firebase docs n.d. b).

Firebase authentication feature integrates well with Firebase's realtime database by providing backend services and libraries to authenticate users in the app. The libraries can also be used to check whether or not a user is logged in, and to give the user access to different parts of the app (Firebase docs n.d. c).

Firebase's Cloud messaging feature (https://firebase.google.com/docs/cloud-messaging/) is used to deliver cross platform notifications to mobile phones. This feature is fairly important for our application as notifying others about available charging stations is a highly requested feature.

Firebase is a fairly new mobile platform application, however we find that it has good documentation and provides many examples of how it can be integrated with Javascript based websites (see for instance https://firebase.google.com/docs/reference/js/).

5.3 Development Process

We started implementing the app through DrupalGap, but in February of 2017 we chose to switch to AngularJS. As this is not the framework we ended up using only a brief description of the implementation process for DrupalGap will be included to make room for AngularJS.

One of the reasons we chose to start the development process using Drupal as our development platform was that we both have experience working with this framework. DrupalGap, however, was uncharted territory for us, but we needed a tool to convert a Drupal website into a hybrid app.

5.3.1 Developing in Drupal and DrupalGap

In this chapter we will detail the development process in Drupal and DrupalGap, and the difficulties we found that led us to switch to AngularJS. The code used in this process can be found in appendix C. Note that the development process was never completed, so some of the functionalities represented as prototypes and presented as requirements of the system described in chapter 4 has not yet been implemented.

Nobil (stylized NOBIL) is a service established in 2010 with a mission statement of gathering all the available information on the various charging stations in Norway in one place (Nobil, n.d.). NOBIL API Version 3.0 is a comprehensive database licensed under Creative Commons (https://creativecommons.org/licenses/by/3.0/), which allows for the export of data about most of the charging stations in Norway in addition to some in the other Scandinavian countries.

As we wanted to use Nobil's database for getting information about different charging points and charging stations we needed to import this data into Drupal's database. We found a module called Feeds which could be set up by cron to import data on intervals into Drupals system. Cron is a Unix process that executes in the background and can be configured to run programs at specific times (Nemeth, Snyder & Seebass, 1989, p.412).

First we needed to define two content types with the appropriate fields. We defined Charging station and charging Point, where each charging station could be connected to one or more charging points.

At this time in the design process, we did not know what fields would be interesting for our users, but we knew what information we could get from Nobil by printing out and inspecting the JSON file. We decided to simply include all the information that was available from Nobil's database, and later hide or remove information that would seem too excessive for our users.

After all the appropriate field had been defined we needed to setup the feed importer so the data would be saved to the appropriate fields. Our first challenge here was that the importer did not take into consideration that we wanted to import data into two content types from the same file. The solution we came up with was to set up two different importers, one for charging station and one for charging points, but to then connect the correct point to the correct station needed some customization in a custom module (see section 5.2.1).

We created a custom module which uses a hook to give each of the charging stations a unique id (see function ecar_custom_feeds_presave() in ecar_custom.module).

After successfully importing the charging stations and charging points into Drupals database, we moved onto integrating DrupalGap.

To enable this we followed a tutorial from the creator of DrupalGap (Tyler Frankenstein n.d). By following this tutorial we generated a Drupal view with all our charging stations, and configured this to be displayed as a JSON view and to be sorted by distance from our incoming parameter. We could then request the JSON and send parameters with the method "views_datasource_get_view_result(path, options)" from the application.

After successfully generating a map over all the charging stations, we could see that there were large differences in loading time and number of charging stations generated based on the location we specified. One kilometer in radius in Oslo center generated hundreds of charging stations, while one kilometer in a more remote location generated none. Since we were in no control over the algorithm other than the range we provided as a parameter to the view, our only solution to this problem was to implement a function that waits for the generated view result, and if the number of results were less than 10, we increased the range by 10 kilometer. We chose 10 kilometers, as this usually would only require one iteration, making the process faster (see function "populate_map(path, range, counter)", in my_module.js).

Nobil offers real time information about the availability of some of the charging stations. This information is accessible through the use of websockets (Lie, 2014). In order for our users to immediately see the availability of the charging station we implemented another function that colors the charging station marker based on its availability; green if there were any available connector, red if all connectors are busy, and grey for the charging stations that do not provide real-time information (see function runWebsocketServer() in my_module.js).

Troubles and Difficulties

We found it repeatedly difficult to customize the templates and CSS in DrupalGap. Creating a page in the app to display content required that we defined a set of different content objects that could contain either a jQuery widget (DrupalGap 7 Docs, n.d. b), or a custom markup that would have to be written in its entirety in one line.

The different available widgets are listed on the DrupalGap documentation, and are not particularly customizeable. For instance, if we wanted a list of items with images we could not have the images aligned to the left without doing some extensive Javascript and CSS repositioning.

As designers we found it very frustrating to use jQuery Mobile with DrupalGap, as we felt we had very little control over the templates and the CSS (styling). This became increasingly important as our users had more and more specific requirements for the design.

DrupalGap seemed more and more as a framework that would better fit the purpose of transforming an already working Drupal site into an application, without much template and CSS customization.

Another big issue when working with DrupalGap was the lack of documentation. Some tutorials and documentation for DrupalGap exist, but attempting to implement any functionality not covered by these required many hours of guesswork and trying, without much payoff.

We also believe that Drupal shines best when it handles large volumes of content, and is used as a CMS and not an hybrid application back end. For our case, most of our data will be loaded from an already existing database. We found that when the progress halted in late January due to the different issues outlined above, we decided the best solution was to scrap the progress made in DrupalGap and start over from scratch in a different framework.

5.3.2 Switching to AngularJS

In mid-February we decided to switch framework, from Drupal and DrupalGap to AngularJS and Cordova with Firebase as a back-end, database solution. In this chapter we will describe the implementation process step by step.

We found that developing the app in AngularJS was a much better solution for us. The code has grown to a substantial larger number of lines, however the separation between the presentation logic and business logic afforded by AngularJS gave us a much cleaner code, which in turn made the code much easier to write. In addition we found more libraries that supported the AngularJS framework than we found for DrupalGap. In addition we could now choose our own CSS framework, and were no longer restricted to jQuery Mobile. For our CSS we chose to use Twitter Bootstrap (http://getbootstrap.com/).

For AngularJS code and installation instructions, see appendix C.

Implementing the Back End

We followed a set of different tutorials and guides for how to setup a Cordova and AngularJS application, we also decided to use ngCordova (http://ngcordova.com/), which is an AngularJS-Cordova framework meant to bind these two together.

After having a working "Hello, world" app we started integrating the back end with our app. As mentioned in chapter 5.2.2, Firebase seemed like an appropriate back end solution when developing in AngularJS.

In our data collection we found that it was important for our users that the data in our application that was up to date, as one of the complaints leveraged at existing apps and services was that they contained outdated information (see subsection 4.8.2). In order to solve this we implemented a script that cron could run daily to compare our database with Nobil's database. If the script finds any changes it will upload this to our Firebase. In addition the script formats some of the data to better fit a noSQL data structure.. The script also translates most of the labels and values into Norwegian. (see www/cronjob.php and www/cronjob.js).

Implementing the Front End

In this stage of the design process we had now generated our final set of prototypes, in difference to when we started out with Drupal. We wanted to make the app as similar to the prototypes that the users preferred as possible. We also (as mentioned in chapter 4.8) wanted to start with the highest prioritized features.

As mentioned in chapter 5.2.2, a state in AngularJS corresponds to a "place" or "page" in the application. We decided that each of the screens in our prototype should be one state, and each of the tabs should be a sub-state. This in turns gave us six different parent states: login, register, profile, map, station and settings. The station and profile states both have three tabs or sub-states (see function app.config() in www/app.js).

The different states can be navigated between through a menu. The menu is opened from the top menu bar, and the top menu bar will change appearance depending on which state you are in. For instance the map have a search bar and a filter icon, and the station state displays the name of the station and its tabs (see figure 30). Instead of coding an individual top menu bar for each of the state views we made a directive that can be reused in each of the states. The

top menu directive also includes the slide in menu view and controller which is displayed when the menu button is clicked.

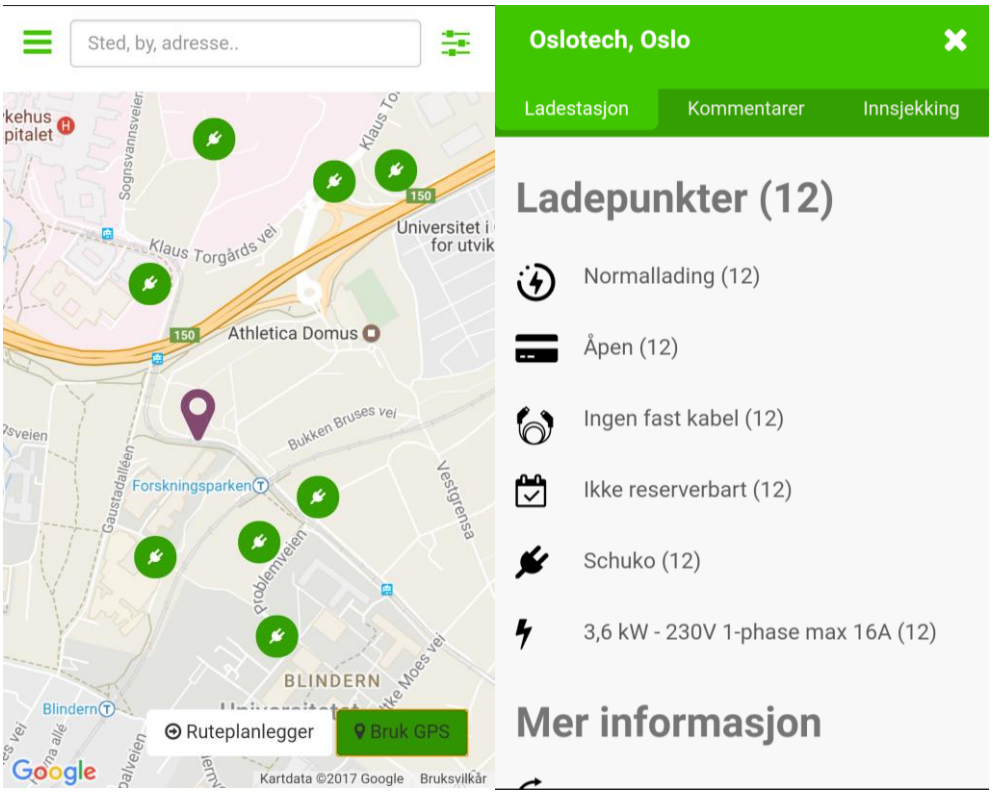

Figure 30: Screenshot of the station state and the map state, with two different top menu bars.

The directive can then be bound to different states, and their scope objects which the directive utilizes when compiling the page, see example below (from app/station/station.html). We believe that utilizing directives in this way makes the code more DRY (don't repeat yourself), since we do not need to implement several different menus for each of the states, but rather write one directive that is reused.

```
<top-menu name="{{cStation.name.value}}" themecolor="green" type="substate"
tabs="tabs"></top-menu>
```

The DRY principle was formulated by Hunt and Andrew (1999) as a principle aimed at making code better to understand and maintain. Martin (2008) argues that DRY "[c]oding becomes faster and less error prone because you have raised the abstraction level" (p.290).

All of the parent states are accessible from the slide in menu except from the station state, which is accessible by clicking on the different "pins" that represent charging station

locations on the map. We found a few different Google Maps frameworks that were available, and we tried both the core Google Maps API (https://developers.google.com/maps/) and an open source framework developed by Allen Kim called "GoogleMap AngularJS Directive" (https://github.com/allenhwkim/angularjs-google-maps). While integrating Google Maps API required us to set up controllers and services, and manually fed the map with the markers being loaded from a controller, Kim's AngularJS directive could be used directly in the template with minimum setup.

In order to make the app inaccessible for unregistered users we utilized Firebase authentication feature to check whether or not a user is logged in. When the app is loaded it checks whether or not the user is logged in, if the user is not logged in, the stateprovider will change that state by redirecting the user to the login state. From the login state the user have access to the register state if he or she is not already registered. When the user successfully logs in he or she is redirected to the map, and have access to all the other states from the menu.

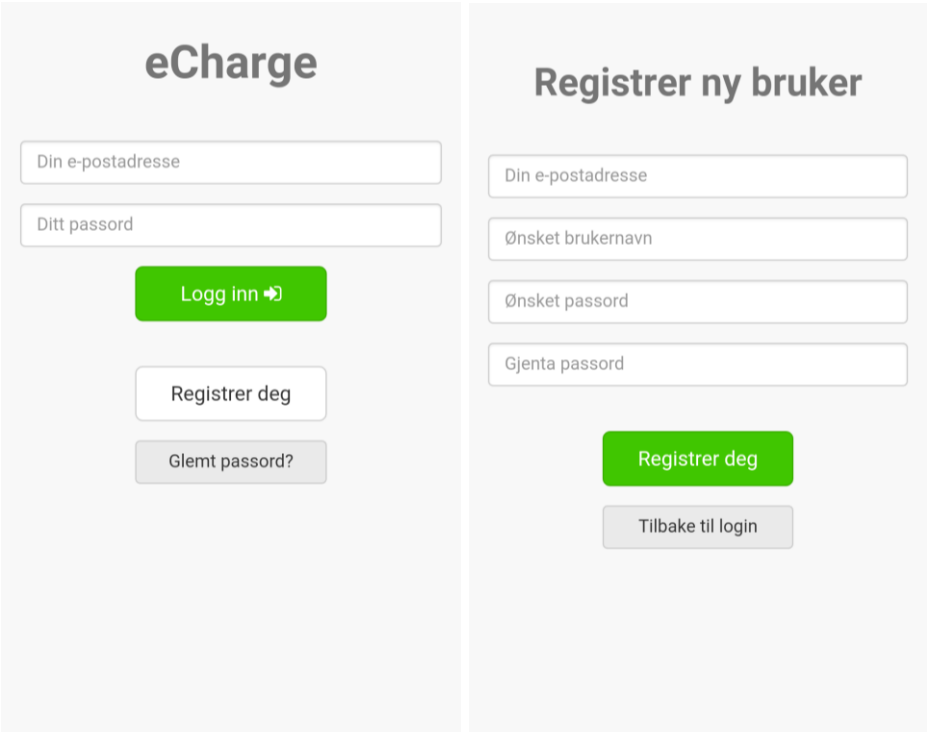

Figure 31: Screenshot of the login and register state.

When the map loads, the user is asked to permit the app to access geolocation from the phone (see figure 32). If the user accepts the geolocation request, the map will be centered around the users' location and will display charging points within one kilometer's radius from the user current position.. If the app is not permitted to access geolocation, the app will display a map of Norway, but with no charging point markers. A button at the bottom of the map titled "GPS" will also indicate by color (green or white) whether or not the phone's GPS is being used, and can be clicked to toggle this on and off.

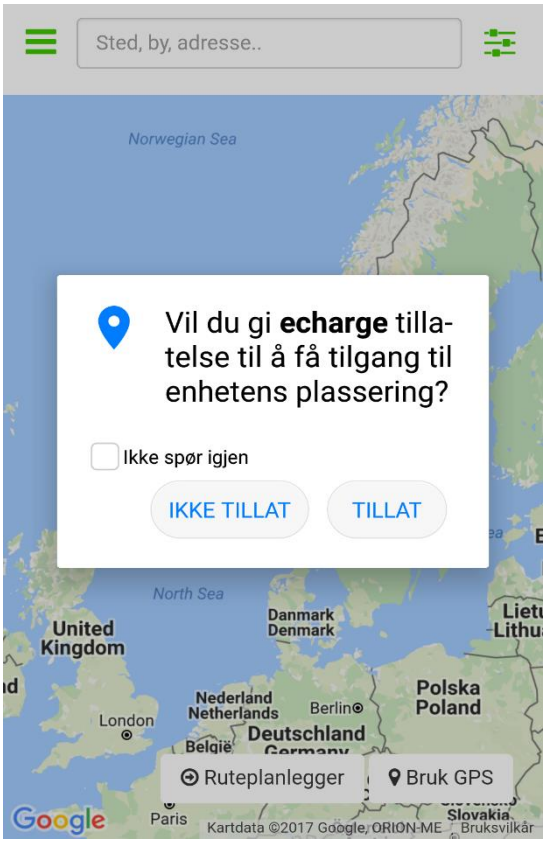

Figure 32: Screenshot of GPS permission request

The user can also search for a desired location in the search bar. The search bar implements Google Maps' Places Autocomplete API (https://developers.google.com/maps/documentation/javascript/examples/places-autocomplete), which gives the user suggestions to different locations while typing (see figure 33). After a location is chosen the map will center at that location, add a pin and load the nearby charging stations.

We also implemented the highly requested directions feature. Another button titled "Ruteplanlegger" or "Direction planner" is displayed next to the GPS button, and when clicked displays a new search field in the top menu, and the labels changes from "Search" to "Travel from.." and "Travel to.." (see figure 33). When two destinations have been selected a route will be displayed, and the app loads all charging stations in one km radius from the route. If the user want to increase the radius it is intended that this will be to changed from the filter settings, with a max limit of 5 km. The filter page has not yet been implemented at the time of delivery, due to time limitations.

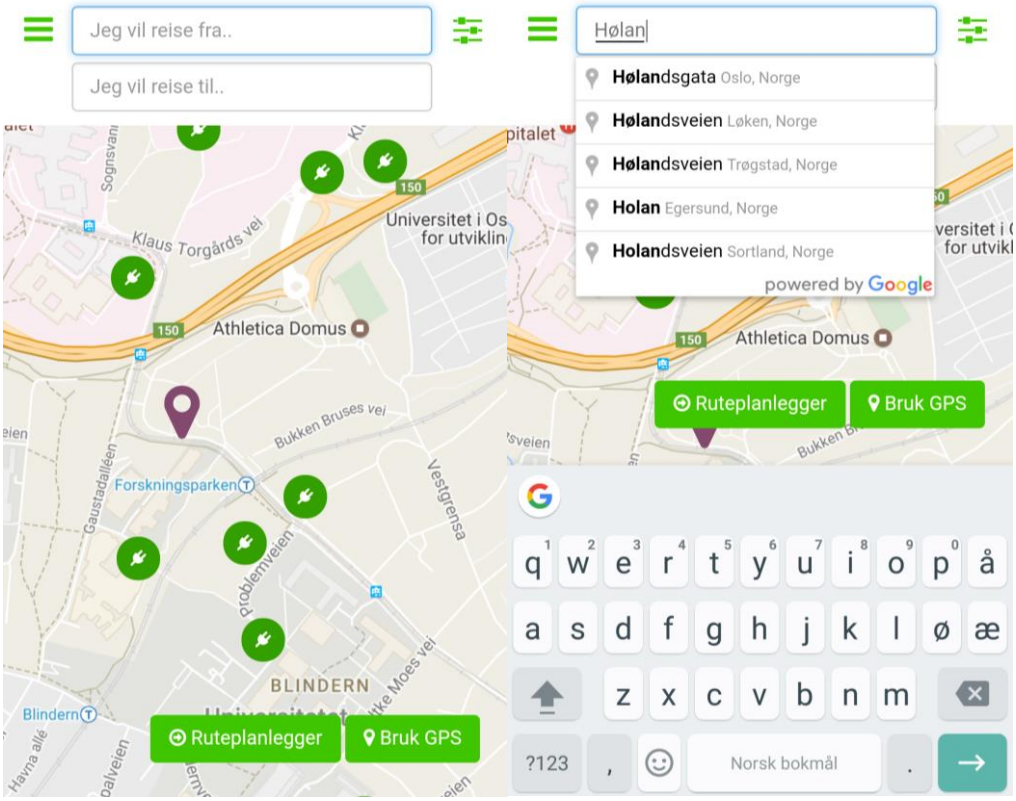

Figure 33: Screenshot of the direction feature to the left. Screenshot of search function with the implemented places autocomplete to the right.

Clicking on any of the displayed charging station loads the charging station information from the database. The first tab of the charging station displays information about the charging station, with the information considered the most important by our users displayed at the top (see chapter 4.8.9). The second tab displays a comment form and the different comments, and the third tab displays how many users are checked in, and in queue, in addition to some information about what it means to check in and out of the charging station. If there are no comments or no people are checked (i.e. if the state is “empty”), an informative message about how the user can write a comment and how he or she can check in is displayed.

Users can check into charging stations by pressing a button. When the user is checked in to the charging station, he or she will receive a push notification when another user clicks the “stand in queue” button, indicating that the charging station is full. As this is one of the more debated functions, we imagine further testing is required in order to assess whether or not this is a suitable solution easing to the charging station shortage described in section 1.3. In

addition, what our users experience as a maximum number of notifications should be explored so the app doesn't seem too bothersome.

5.3.3 Final State of the Code

Unfortunately there are a few features that is not yet implemented, such as friend requests, filter options, and notification that prompts the user to check in when he or she is close a charging point. In addition, the app is in need of bug and user testing for further improvements. However, we are pleased with what we managed to develop during the course of the months between February and May, and we hope some future master students wish to further work with this application.

6 Discussions and Reflections

In this penultimate chapter of this thesis, we will discuss our findings in terms of our three research questions, as well as reflect back on our research in terms of topics such as sampling, biases, ethics, future work and limitations.

6.1 User Wants and Unmet Needs

As mentioned in chapter 1.6, the first of our research questions read as follows “What do eCar drivers in Norway want from an eCar application?”, with a subquestion dealing with whether our users have any needs that are not currently not being met by existing eCar applications and services. In order to answer these questions we have triangulated different research methods in order to investigate the issue through a user-centered design process (detailed in chapter 4).

What a user want is highly subjective, and what one user might want from an app might sometimes conflict with what other users want. As we are working within the interpretive research paradigm (see chapter 3.1), a significant part of our research has dealt with interpreting what the users mean by their answers and converting their sometimes vague statements into user requirements that could lay the basis for our development of the technology. Because of the nature of interpretive research we have tried to be as transparent as possible in our data collection and analysis, and have included the raw data we have collected and interpreted into more concrete requirements in appendix F.

As discussed in section 3.3, the goal of a UCD process is to elicit a somewhat stable and unambiguous list of user requirements that can form the basis of the design and development of some product, in our case an app. As also noted in chapter 3.3, however, the search for user requirements is not a finite process with any clear endpoint. Due to time constraints, we had to stop user involvement after the second round of interviews in order to focus on writing and development, so the list of requirements presented in chapter 4.9 is subject to change if anyone wishes to continue the process we have started in the future. The finalized list of user requirements include a number of functionalities that are not present in other eCar apps. We feel like the design process as a whole has given us a comprehensive overview of eCar owners wants, needs, and requirements for an eCar app, and that the finalized list of user

requirements functions as an answer to the research question of what eCar owners want from an eCar app.

6.2 Challenges and Suggested Solutions

Our second research question reads as follows: "What are the main challenges of driving an eCar, and how can we design and develop technology to help our users overcome these challenges?".

We knew from the onset that the number of eCars in Norway heavily outweigh the number of public charging points, resulting in what we have referred to as a charging point shortage (see section 1.3). However, as a part of our research, we also wanted to research any other challenges eCar drivers face, discuss potential solutions to these with the users, and use this data to develop prototypes for said solutions.

As it turned, out, based on our research, the *problem of finding available charging points* is the main problem facing today's eCar drivers. Every single interviewee either reported having experienced problems finding available charging points themselves or being concerned with finding available charging points in the future, given that eCars are only growing in prevalence. Other challenges facing eCar owners are somewhat related to the challenge of finding charging points, namely "*range anxiety*", trips requiring careful planning when travelling to new locations, *finding compatible charging points*, and charging station data in existing apps and other services being *outdated* (see sections 4.5 and 4.8). In our opinion, these challenges are interconnected and relate to what fundamentally separates eCar drivers from the drivers of fossil fueled automobiles, namely that they are dependent on charging points rather than gas or diesel. While filling up a tank with gas rarely takes more than a minute, charging an eCar to an acceptable battery level may take anywhere from half an hour to a day, depending on which make and model of car you are driving, the distance to the next charging station on your route, and the effect of the charging point itself.

We have viewed these as the most important challenges facing modern eCar drivers that could potentially be resolved through designing and developing an app. In this chapter we will to describe how we have tried to solve the users challenges outlined above in the form of functionalities we have either prototyped or implemented in the app, and how and why we see these as solutions to the challenges.

6.2.1 Map and Planning

Although a map of charging stations seems to be a staple of eCar apps (see chapter 1.4), we felt from the very beginning that an eCar app without a map would be of relatively little use, given that an overview of the limited number of charging stations seems to be an absolute necessity. Our users seemed to be in agreement, and no one questioned the inclusion of a map, several even stating outright during the second interview round that they disliked the menu affixed to the bottom of the screen as it obscured some of the map (see subsection 4.8.5).

We also decided before speaking to the users that it might be useful for some functionality in the app that would allow the users to plan for trips. Surprisingly, a lot of eCar apps do not seem to include this functionality. In both Ladestasjoner.no and Fortum's Charge & Drive, as far as we can tell, the only route functionality is to generate a route between your current position to a given charging point through either opening a web browser or a separate map app such as Google Maps (i.e. the functionality is not implemented in the eCar app itself, but requires a secondary resource for generating the route, see figure 34).

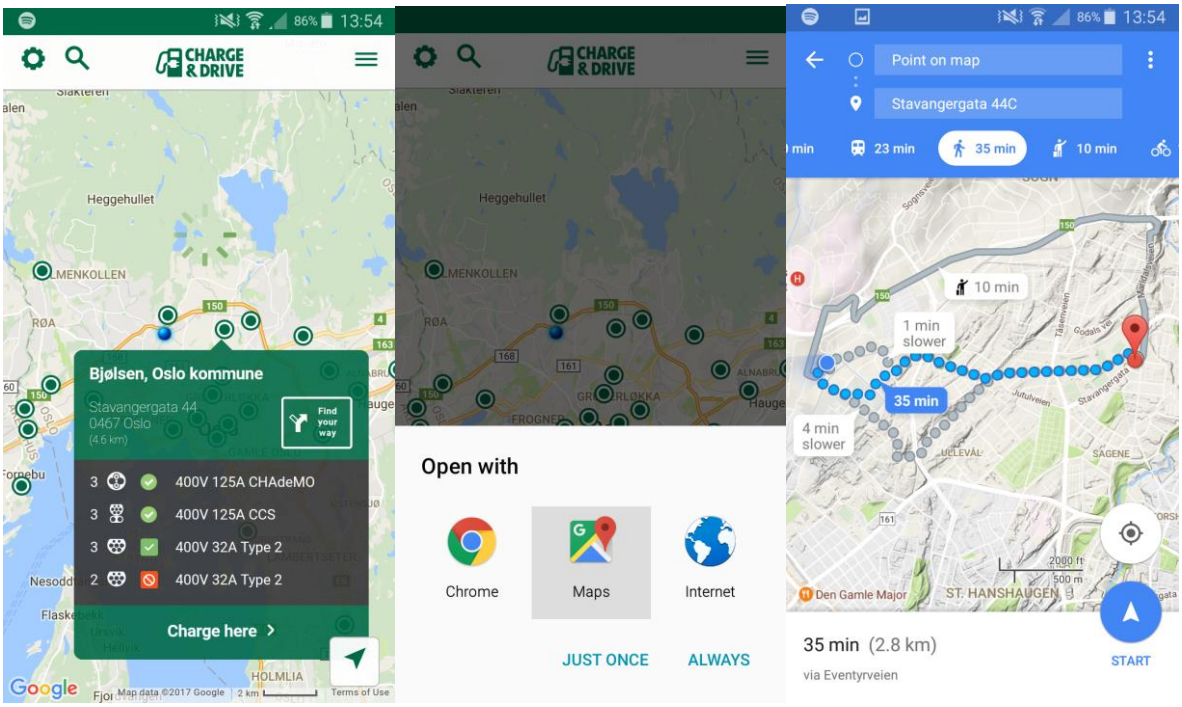

Figure 34: Navigation from current position to a charging station in Fortum's Charge & Drive app via Google Maps.

In our solution however, the users are able to see the route directly in the app without having to open up a separate application (see figure 35).

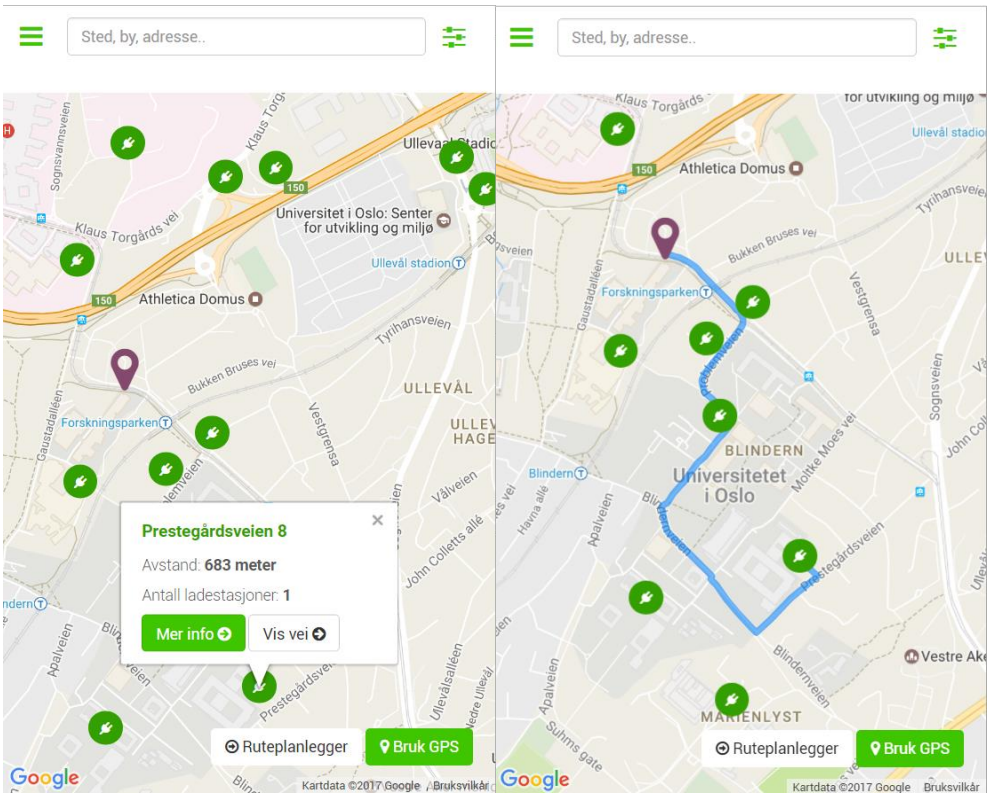

Figure 35: Screenshot of navigating from your current position to a charging station in our app.

The results from both the interview rounds, as well as the document analysis, indicated to us that the users need a way to navigate not only from their current position to a charging station, but also to see charging stations along a route in order to make travel plans. Neither Fortum's Charge & Drive nor Ladestasjoner.no seem to include any such functionality. One of the cited forum posts in subsection 4.5.2 provide an example of one of many users who explicitly used elbilforum.no to ask the other users for webpages or other services with for seeing charging stations along a specified route. The majority of these eCar owners received responses from other forum owners recommending various foreign webpages and services, perhaps the most cited being https://www.goingelectric.de/stromtankstellen/routenplaner/ which is a German website with no options for translation.

Because of this, one of the first functionalities we knew we had to have and implemented both when working with Drupal/DrupalGap and Angular/Firebase was "Directions".

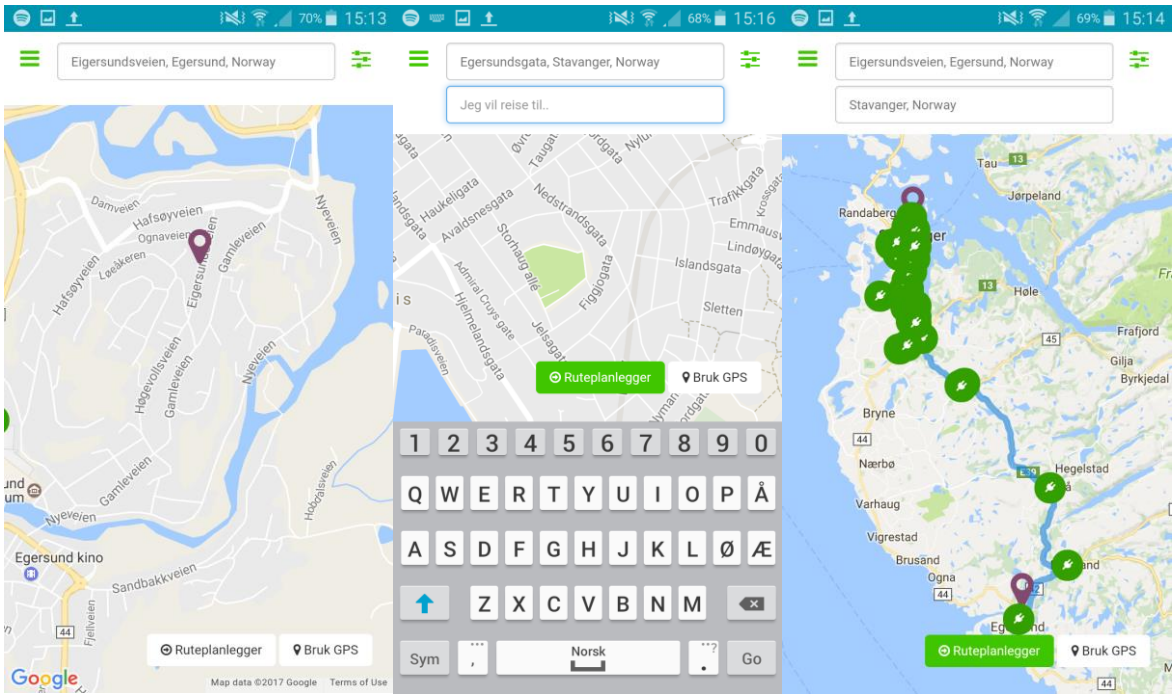

Figure 36: Demonstration of "Directions" functionality in finished app.

Figure 36 demonstrates the "Directions" functionality in the app we have developed. While it could stand some fine-tuning, it nevertheless provides the ability to see all charging stations along a specified route (in this case from Egersund to Stavanger) and negates need the for opening a secondary app or browser to generate the routes (although, as described in subsection 5.3.2, it still uses Google Maps' API) .

6.2.2 Filter

Another complaint the users leveraged against both GPSes and various other apps, websites, and services, was that the filtering function on these were insufficient. Some users have very specific needs when it comes to charging, as noted in sections 1.2 and 4.8.1. This means that users should be able to filter out charging stations from the map based on a number of criteria, rather than just a few. While most of the users agreed that rapid charging, price (i.e. free of charge or not), and public availability were important criteria to be able to filter on, several other factors were cited as important when choosing a charging station (see chapters 4.5.1 and 4.8.8). In our prototype we have therefore tried to be as inclusive as possible for the different data points we have for filtering, including the "most important" at the top of the filtering screen, but including added filters upon scrolling further down on the screen. An ongoing part

of our investigation has been whether the user should specify some filters upon registering (for instance compatible outlet types) and whether the filtering functionality should be able to remember your past settings or be reset between uses. As discussed in subsection 4.8.7, our users seemed split as to this question, and thus this never made it into the finalized list of requirements presented in section 4.9.

6.2.3 Up to Date Information

GPSes have traditionally been used as a means for planning trips, and indeed a number of the interviewees reported using the built-in GPS in their eCar when taking longer trips, but the downside reported by the majority of these was that the charging station data on their GPSes were seldomly up-to-date. New charging stations are being built all the time, while older, outdated charging stations are being closed, so up-to-date information is absolutely crucial for eCar drivers when planning for trips to avoid them ending up at a location without any remaining battery life in their eCar and without any place at which to charge.

As mentioned in subsection 5.2.2, we have used Nobil's database to import charging station data and have configured cron to check for updates daily. This means that if a charging station is added to or removed from, or in some other way altered in, Nobil's database, our app will reflect these changes within 24 hours. However, this solution depends on Nobil's database in itself being up-to-date, and during the document analysis we found a few forum users complaining that it wasn't.

Comments and rating have been a widely accepted feature during interviews with our users, and we believe these features can be designed to make up for lacking or unupdated information resulting from Nobil's database being outdated. But this would then require that we have users who want to utilize the comment features, and that their comments are written in a way such as it is helpful for the other users. So far the comments have been implemented without any rating since we did not find any consensus for how they should be implemented. We suggested likes, thumbs up and smileys, and one of the users suggested using star rating (see subsection 4.8.10). In addition we are not sure if they should be able to rate on the charging stations queue, and price. But all the users agreed that it would be very useful to know if there are any problems on the charging station.

6.3 Motivating People to Move

One of the most difficult and most important challenges throughout this project has been the attempt to investigate if and how a checking-in and out functionality can be designed and implemented to ease the challenge of the charging point shortage outlined in chapter 1.3. This speaks to our third and final research question, namely: "Can gamification and persuasive technology be used to motivate users into a more sustainable behaviour that focuses on sharing resources (in this case, charging points for eCars)?".

6.3.1 Gamification

SDT differentiates between intrinsic and extrinsic motivation, as discussed in subsections 2.1.2 and 2.1.3. Whether one of our users are intrinsically motivated to move his car because he values and enjoys the activity in and of itself or is experiencing a high degree of extrinsic motivation to move his car because he is aware of the charging point shortage and wants to help other eCar drivers is, for the purposes of our discussion, not relevant. As illustrated in figure 2, if a person experiences a high degree of extrinsic motivation he experiences it as emanating from within (i.e. as intrinsic motivation), even if it actually emanates from extrinsic factors that have been integrated into his sense of self and value system. As such, we will henceforth refrain from speculating in the users' degree of motivation and will thus not distinguish between intrinsic motivation and integrated extrinsic motivation in the following discussion, referring to their willingness to move their car simply as "motivation".

Based on the results from the interviews, we discovered that there is a large gap in the degree to which different eCar owners are motivated to move their cars. While some report walking as much as ten minutes from their place of work during their lunch break just to move their car, others simply stated that they "never" moved their car out of consideration for other eCar owners. Two of our interviewees had also found an alternate solution to moving their car unprompted, and gone through the trouble of making a sign containing their contact information to be placed in the windshield of their eCar to allow others to contact them when in need of charging.

Gamification holds that boring activities (such as moving your car) can be made more engaging and fun through applying lessons from the gaming domain into non-gaming systems and services (see section 2.3). In gamification, lessons from SDT are commonly used to

understand what makes players motivated to play, and the premise for much of the research process has been to investigate if and how our users can be more motivated to move their cars.

From PBLs to Informative Feedback

As mentioned in the analysis of both interview rounds (see subsections 4.5.1 and 4.8.4), the users we interviewed did, for the most part, not play games, nor did they seem to think that gamification would help motivate eCar owners to share charging points with one another.

None of our users had any deep knowledge of gamification. While some had heard of it and recognized some of its principles as we tried to describe it, others seemed to lose interest as soon as we mentioned the word "game". In describing gamification to our users, we perhaps focused too much on the aspect of getting virtual rewards (such as points and badges) for behaving sustainability, to which a majority of the interviewees responded that they neither believed they would influenced nor more motivated to move their cars if they received points, badges, or other virtual rewards for doing so.

PBLs, while commonly used in gamified systems to reward "correct" behaviour, have been criticised as not being a suitable means for achieving long-term user engagement in and of themselves (see chapter 2.3.1). The responses we got from our users during our interviews seemed to confirm this (see subsections 4.5.1 and 4.8.4). As we discussed in chapter 2.1.1, extrinsic motivators (such as points and badges) can also decrease a users' motivation. This is in part because if the rewards are expected the users are likely to start to perceive that they are acting to attain the reward, rather than because the behaviour in itself is enjoyable, and in part because rewarding users with external rewards may undermine their sense of autonomy if the reward is perceived as controlling rather than informative (see section 2.1.1 and 2.1.2). If extrinsic rewards are to be implemented successfully, that is without potentially decreasing the users' motivation, they therefore need to be designed to take the users by surprise and/or to be informative rather than controlling. The question then became whether or not PBLs, although a staple of most gamified systems and services, should be included in our app at all.

After having analyzed the interviews in light of the theories of gamification and SDT, we chose to completely remove PBLs from the prototype for our application, in exchange for providing the user with informative feedback.

Figure 37: Prototype with PBLs used in second interview round (left) and final prototype in which PBLs have been replaced by informative feedback (right).

As described in chapter 2.1.1, SDT postulates that humans have three fundamental psychological needs, namely the needs for competence, relatedness, and autonomy. We suggest, based on our research, that informative feedback better supports fulfilling these needs than PBLs do. In order to support these needs we have made design suggestions for a weekly "status report" within the app that informs the users about how many times they have moved their car for other people that week and in total since downloading the app in place of the badge collection previously included in the prototype (see figure 37), and additionally designed a suggestion for a weekly notification that conveys the same information in fewer words in the form of a notification (see figure 38). It should be noted that this feature have not been discussed or tested with our users, but is something we imagine would be more motivating to our users than PBLs and could feasibly be implemented in the future if someone wants to carry on the research effort we have started. The informative feedback might therefore need some finer adjustments in terms of timing, what information should be provided, and wording.

We have tried to design this feedback to be informative rather than controlling, so as not to undermine the users' motivation to move their car (see subsection 2.1.2). We imagine that, if implemented, the user should themselves be able to decide if they want to receive notifications about their sharing statistics, thus allowing users to decide for themselves if they want to use the app primarily to help others by sharing charging points or for some other purpose (such as making travel plans, etc.). By making the sharing voluntary rather than mandatory, the user should not perceive his autonomy to be undermined. The messages are worded so as to be perceived as encouraging and informative, rather than controlling. We believe that allowing the user to see how many other eCar drivers he has helped by moving his car both that week and previously can support his or her sense of competence and relatedness and thus make him or her more motivated to share, although, since we haven't had time to test this prototype with users, we cannot know this for sure.

Figure 38: Informative notification that is designed to support the user's need for competence and relatedness.

Designing for Sociability

Game elements are often considered elements that typically can be found in games, such as challenges, quests, and PBLs (see chapter 2.3.1). Literature suggest that these elements are often are implemented following a business-oriented approach, and thus constructed to support an organization's business goals rather than to support the users' needs (see chapter 3.3.1). In our research, however, we have followed a user-centered approach to gamification rather than a organization-oriented one. Thus, we have put our users' needs and wants ahead of our own agenda, and followed a more bottom up approach to gamification than the one that is typically done when implementing gamification elements (again, see chapter 3.3.1).

We started the data collection process with a questionnaire to investigate whether one of the player types in Kim's social action matrix was more dominant in our user group or if eCar owners were more evenly dispersed across the four quadrants (see subsections 2.3.2 and 4.2.1). As discussed in subsection 4.2.4, the questionnaire results suggested that the latter was the case in our user group, so when designing our first prototype we included features that corresponded to each of the quadrants in Kim's matrix (see section 4.3) and used this as a basis for our first discussions with our users. These features were later revised and refined in accordance with the users' feedback until we had our "final" list of user requirements (see section 4.9).

Through both the interviews and the document analysis, we got the sense that eCar owners view themselves as a united group. This is evidenced through statements from the interviews about the drivers of PHEVs in particular, in which various interviewees remarked that driving a PHEV is "cheating", that pure eCar owners tend to favor other pure eCar owners and like to tease the drivers of PHEVs, and that PHEVs need to look for alternative sources for fuel rather than occupy the scarce amount of charging points needed by pure eCar drivers. During our document analysis of elbilforum.no we also frequently found forum posts that suggested that eCar drivers view themselves as a united group. For instance, the following forum post was made by a new eCar owner wishing to share his reflections on the transition from a fossil fueled vehicle to an eCar:

> *What I have experienced so far, and that I want to mention, is:*
>
> a) *The drivers of fossil-fueled vehicles that don't give a f... whether they park at charging points reserved for eCars [...]*
> b) *People who complain that I, by driving an eCar, "mooch on the state". How can I respond to these?*
> c) *All the nice eCar drivers I meet at charging stations and by the roads :)*
>
> (Forum post on elbilforum.no, own translation.)

As mentioned in chapter 2.1.1, the need for relatedness in SDT refers a human's basic, psychological need to feel a sense of belongingness, both with other individuals and their community (Ryan & Deci, 2002, p. 7). Moving the car for the benefit of another, unknown person is in itself a highly helpful act which, and we believe that if technology is designed to support and facilitate this act of helpfulness, an eCar owner's sense of relatedness to the eCar

community as a whole can be increased. This belief is bolstered by the findings from our interviews. Firstly, as noted earlier in this chapter, two of our interviewees had actively placed notes in the windshields of their eCars in order for other eCar owners to contact them case they needed electricity. Secondly, when we asked what they thought about our app idea, several of our interviewees liked the concept, and when we asked them to elaborate on the reasons why they answered, among other things, that they felt the app could "encourage and foster solidarity", motivate people to "share the goods, and that it would be to "everyone's benefit if people shared".

As far as we can tell, no other eCar apps have any social features. Kim (2015), who is a renowned game designer and neuroscientist, states that the "most happiness boosting activity you can offer is to help people develop relationships that matter - which often involves coming together around a shared purpose". What we then label as the "gamification elements" in our application are the social features that can cultivate the sense of belonging to a community of eCar owners.

This need for the inclusion of social elements is also reflected in the finalized list of requirements (see chapter 4.9). Several of the features listed in the user requirement list, which is based on our data analysis, speak to the users' need for relatedness. For instance the comment and rating features of the app, which have been largely accepted by our users during the last interview round, enable our users to help each other find good charging stations and avoid charging points that are out of order. Similarly, the concept of the checking in and out functionality to facilitate the sharing of charging points seemed to be something the users liked, even though the proposed implementation was criticized for being too complex (see subsection 4.8.11).

What we take from these observations is that the users who are motivated to share charging stations, are motivated to do so because they want to help others. We believe our application could foster this feeling of relatedness by acting as a tool that enables the users who are motivated to move their cars to know when other eCar drivers need charging. As we have followed a user-centered design approach to gamification, rather than an organization-centered approach, we believe that listening to what our users say they need rather than imposing our own agendas on them is of crucial importance to designing effective and successful gamified systems.

6.3.2 Persuasive Technology

As described in section 2.2, FBM is a model for understanding human behaviour, which asserts that behaviour is the product of three concurrent factors, namely motivation, ability, and triggers. As stated in the introduction to chapter 4, our working theory at the onset of the design process was that a majority of the eCar drivers were currently amotivated to move their cars, and thus didn't bother moving them even if the drivers no longer had a need for electricity. However, as mentioned previously, our findings indicated that many eCar drivers actually are motivated to move their car to let others charge, but lack information on when and where other eCar drivers need charging. This fidning, in turn, suggested to us that we needed to focus more on the two other factors of the FBM, namely increasing the users' ability by making the check-in check-out functionality as simple and uncomplicated as possible and providing appropriate triggers when others need charging (particularly when the user's car has been charging for a while and is likely to be fully charged).

This was also backed up by our interviewees, who were concerned with the complexity of the checking in and out functionality as it was presented in both the first and the second prototypes (ability), and who repeatedly suggested that we use push notifications to alert parked eCar owners that other people needed electricity (triggers). The recurring theme when it pertains to the sharing of charging points in the second interview round, as discussed in subsection 4.8.11, was that the checking in and out functionality was too complex and time-consuming. This functionality, as presented in our prototypes, would require the user to manually open the app, locate the correct charging station and clicking it, navigating even further into the charging station through the tabs at the top of the screen, and then, finally, clicking on the button for checking in. As noted by one interviewee, the process of parking and plugging an

Figure 39: Informational notification asking user to move car

eCar into a charging outlet is already a more complicated process than just parking a fossil fueled car, and thus adding even more complexity to the task is a less than ideal solution.

We view this as a problem of ability, rather than motivation, and the solution suggested by the users was to employ push notifications (triggers) to simplify the process of checking in and out of charging stations and receiving charging requests. One user suggested that the app could detect when a user was in close proximity to a charging station and thus prompt the user with a push notification that asked whether he or she were currently parked at such-and-such charging station, and allow the user to check in through responding to the notification by pressing "yes" or "no". Similarly, after a number of hours had passed and the user's car was likely fully charged, or when a user sent a charging request to that charging station or other charging stations in the proximity, push notifications could be issued to checked in users to remind them to move their car or alert them that another eCar driver is in need. Our main concern about this idea, as also noted in subsection 4.8.11, was that the app would be considered "too naggy" by some users and thus be deleted within days, but the results of the interviews suggested that push notifications would increase the viability of the app. At the time of writing, notifications have been implemented in the app, but due to time constraints we have not yet been able to test whether these are appropriate in terms of frequency, wording, etc. with our users.

As noted the previous section, the users seemed very positive to the idea of the app facilitating the sharing of charging points, but questioned our proposed implementation. Several users noted that they wished for some sort of queuing system, some way of alerting others that a charging point has been freed up when they leave a charging station, or some way of creating a group within the app of the people who usually share a charging station so that the app could be used to facilitate sharing. The app could viably be refined to allow for all of these functionalities, but the interview data suggest that the most important aspects that will make the users actually use the checking in and out functionality are to keep it simple and provide appropriate triggers, rather than to reward users for moving their cars through virtual, extrinsic rewards such as points and badges (see the previous section).

Fogg also speaks of other factors of persuasion beyond motivation, ability, and triggers, namely so-called social clues (see section 2.2). In terms of physical attractiveness, we have strived to design the app to look clean and aesthetically appealing. When choosing colors, we used the online tool Paletton (Paletton.com) to generate a color scheme with complimentary

colors to the main shade of green that were used in the second prototype round and the app itself since the users did not seem to object to our choice of colors (see figure 40).

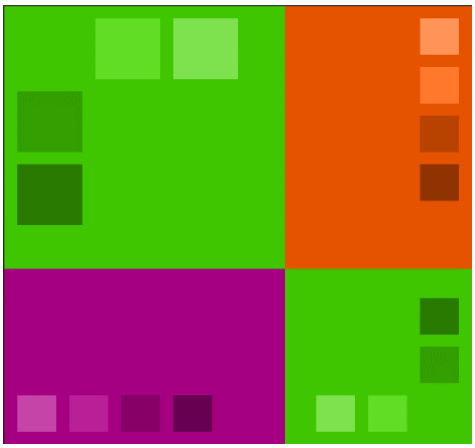

Figure 40: Color scheme generated by Paletton

Beyond just colors, different corporations that work within mobile app design today have their own detailed and publicly accessible design guidelines and principles for how different interface elements should be designed. For instance, Apple has their own guidelines for app design on Apple's iOS called the "iOS Human Interface Guidelines" (https://developer.apple.com/ios/human-interface-guidelines/overview/design-principles/), while Google offer their own guidelines for design and development on Android platforms (https://developer.android.com/design/material/index.html). In our design and development process, we have referred to the latter when we have been unsure of how to best implement various features of the app. For instance, the notifications we have discussed were designed building on Google's guidelines for notification design (see figure 41).

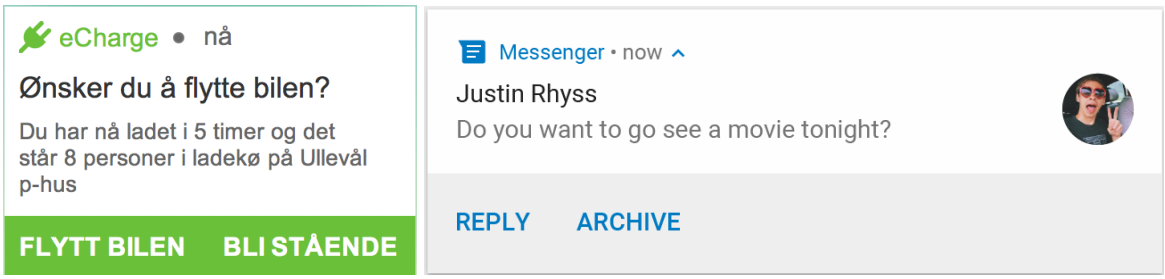

Figure 41: Proposed notification for our app (left) and suggested notification design from Google's guidelines for material design (right).

There seemed to be consensus amongst the users that the design of the second prototype was physically attractive, and thus the app should, according to Fogg's theory, be more persuasive.

Regarding psychological and social interactions, the notifications and other information in the app has been designed to be friendly and informational, rather than pushy or controlling.

Perhaps we could have played even more on this aspect of the app during the research process, and integrated more personalized interactions in our prototypes (e.g. “Do you wish to move your car, John?” instead of simply “Do you wish to move your car?”), but to research whether this would increase the persuasive aspect of the app can be subject for future research.

6.4 Sampling and Representativeness

As mentioned in section 3.4, a sample is a subset of the population under scrutiny, while sampling is the process whereby the sample is selected. For instance in our project, the population is all eCar drivers in Norway, while the sample are the eCar drivers who have either responded to our survey, posted on elbilforum.no, or the people who have volunteered to be interviewees, in other words the people we have collected data from.

In our project, we have used non-probabilistic sampling. Instead of drawing our participants from a well-defined list of every eCar driver in Norway, we have collected data from the people that uses the website elbilforum.no (see sections 4.2.3 and 4.4), eCar drivers we have bumped into in the Oslo area (see chapter 4.3), and eCar owners belonging to an organization that specifically deals with environmental research (see chapter 4.7). The people who participate on elbilform.no is a subset of the population, and based on what we have read during the document analysis we feel that it would be fair to say that the active forum users are more engaged in eCar challenges, politics, and trivia than the average eCar owner. The people we recruited by going to parking garages and asking eCar owners to participate in interviews constitutes the sample most close to the probabilistic approach to sampling. However, this method of recruiting interviewees was very time-consuming, requiring us to stand for hours on end in parking garages and scouting for eCars coming or going. In addition, the majority of the eCar owners who consented to give us their contact information did not reply to our attempts at contacting them, leaving us with a feeling that we had wasted valuable time. For the second interview round, we were lucky enough to find an “in”, when an organization actually distributed information about our project on our behalf and encouraged eCar drivers who were interested in participating to contact us. We rapidly received many responses, and at one point in time had to decide that we had enough information to process and as such had to decline further participants. While this was a much more efficient way of recruiting participants, leaving us more time to write this thesis and

develop the application, this meant that the sample was less random as all of the participants in the second round had one thing in common, namely that they were associated with an organization heavily focused environmental research.

The fact that we have collected data from the users of elbilforum.no, that all of the interviewees lived in Oslo or the surrounding areas, and that the participants in the second interview round were all affiliated with an organization that specialises in environmental research has no doubt affected the data we are left with. However, as noted in section 3.4, non-probabilistic sampling is considered a valid research approach in HCI projects. All participants have one thing in common, namely that they drive an eCar on a regular basis. When recruiting participants for both interview rounds, we were conscious of trying to recruit people of both genders and of all ages. Out of the twelve eCar drivers interviewed in this study, six were male and six were female, and they ranged in age from their early twenties to mid-sixties.

6.5 Bias

In section 3.4 we also briefly presented a couple of common biases that we believed are relevant for our research and discussed how biases in general can compromise a research effort by skewing the results. Throughout our research process, we have tried to remain sensitive to biases introduced by either us or our research participants. As Rogers, Sharp & Preece (2011) note, people sometimes choose to answer whatever they think will portray them in the best light when posed a question (p. 233). Particularly in the responses to our questionnaire (see subsection 4.2.4), we were astounded to see the amount of respondents who claimed that they always moved their car when it was fully charged. Either the respondents (who primarily were recruited through elbilforum.no) were uncharacteristically concerned with so-called “eCar etiquette”, or there is some form of social desirability bias involved (see section 3.4). During the interviewees, the majority of eCar owners also reported that they moved their car when they were done charging, although a few were bluntly honest and reported that they “never” moved their cars to allow others to charge. Others stated that they tried to move their cars, but that it was easy to forget. The premise of our app is to facilitate the sharing of charging points, and if it is true that the majority of the users already move their cars out of the way, our app is of limited utility. However, the informal review conducted by the Norwegian Electric Vehicle Association discussed in section 1.3 showed

that only one third of the eCars parked at charging points actually needed the electricity provided, and given that news articles from 2017 claim that the charging point shortage is worse than ever there seems to be a real need for some solution to facilitate better sharing despite that our research indicate that eCar owners for the most part are conscientious when it comes to sharing charging points.

As discussed in the previous section, we have tried to include users from both genders and all age groups. However, we cannot exclude the possibility that the eCar owners who agreed to participate in our research project shared some characteristics that separate them from those who chose not to respond when we contacted them to schedule interviews. However, this will be pure speculation on our part, and it is therefore hard for us to come up with a definitive answer to whether or not the study is subject to selection bias.

Although we have always stressed during the interviews that we are open to all kinds of feedback and criticism, it is possible that some of the research participants have felt uncomfortable when it came to critiquing the prototypes we had created and the functionalities we proposed. When it comes to confirmation bias, this is a somewhat complicated issue due to the way we have chosen to conduct our research. We have tried to avoid asking leading questions during the interviews, but the fact remains that we had an agenda besides just researching the users' challenges and unmet needs, namely trying to explore the utility of gamification to facilitate the sharing of charging points. As noted throughout chapter 4, we were largely met with scepticism and resistance towards the idea of gamification, and thus we have not tried to push the subject during the interviews when the interviewees were clearly uninterested in the concept.

6.6 Ethics

Throughout the survey and interviews we were very conscientious about the ethical aspect of data collection. All participants were promised confidentiality and that we would not disclose information that could be traced back to them in this thesis (see appendix E). In the interview transcriptions (appendix D), we have purposefully left out information such as place of work and place of residence (beyond vague descriptions such as "Oslo" or "Akershus", which have thousands of residents). We have also not stored any notes or documents describing the interviews that contain personal information that can be traced back to our interviewees,

because all interview notes were written down on paper in shorthand and later destroyed once a transcription had been made.

The document analysis we did of the webpage elbilforum.no constitutes so-called Internet research, as we have used the Internet to collect our data. The Association of Internet Researchers (AoIR) is an academic association for Internet studies that, amongst other things, publish ethical guides for researchers dabbling in Internet research (AoIR, n.d.). There is some precedent for online research quoting publicly accessible online content within AoIR's own publications For instance Niemi (2011) wrote a paper about deviant behaviour on online forums and included quotes and usernames to illustrate his points. Similarly, an article was published in a special issue of the journal Information, Communication, and Society (ICS) in collaboration with AoIR, in which the role of Twitter and Youtube in the Occupy Movement is explored through references to, quotes of, and screenshots of Twitter "tweets" and YouTube videos complete with dates and usernames (Thorson, et. al., 2013).

In the cited forum posts in sections 4.5.2 and 6.3.1, we have not included the username of the poster, have translated the text from Norwegian to English, and redacted specific words that are not crucial for the app under development, such as the posters' model of eCar or specific addresses. Nevertheless, it is feasible from the data included to find the original forum post and read it. Elbilforum.no is publicly available to everyone, including users that have not registered at the forum. Paragraph 9d of the Personal Data Act states that even the processing sensitive personal data is permitted, given that "the processing relates exclusively to data which the data subject has voluntarily and manifestly made public" (Datatilsynet, 2015). As far as we see it, the data included in the cited forum posts do not constitute sensitive personal data and is unproblematic to publish given that the forum users themselves have posted them on a publicly available forum.

6.7 Other Limitations

Students typically choose their master thesis towards the end of their first semester of the master degree. We, also, chose our master thesis at this point (December, 2015), but due to various circumstances we felt we needed to change our master thesis and our supervisor at the beginning of our third semester (August, 2016). Due to this, we have had several months less to work on this thesis and collect data than the average master's student.

Another limitation of the thesis is that we started off by developing the application in Drupal/DrupalGap (see chapter 5), which proved to be very time-consuming and hard to work with due to the lack of documentation online. The development went much smoother after switching to AngularJS in February, 2017, and the app would have likely been finished by now if we hadn't chosen to first try developing it in Drupal/DrupalGap. The effort that went into understanding DrupalGap and trying to develop the app using a largely undocumented development framework took up an enormous amount of time that could otherwise have been spent writing or collecting more data from users.

We also had no prior knowledge of our user group or what it is like to drive an eCar. This required us to do quite a bit of research before commencing the data collection regarding the terminology frequently used when speaking about eCars and charging.

While we have extensive experience working with users through user-centered design processes and have previously worked with Fogg's behaviour model as a framework for understanding how technology can be designed to be more persuasive and encourage behavioural change, this was our first attempt at working with gamification, and it was challenging to use gamification as our main theoretical background when we met with so much resistance from the majority of the users when we broached the subject during the interviews. The resistance we met to the concept of gamification, we believe, is a result of us focusing too much on the PBL aspect of gamification when explaining the concept to our users, and as noted earlier PBLs are rarely experienced as motivating or engaging in themselves within a gaming context.

6.8 Future Work

If time would have allowed it, we would have liked to finish the development of the app and proceeded with user testing. This would also have allowed us to assess whether the gamification aspect of the app would have encouraged eCar owners to share charging points to a larger extent than they seem to do today. The research we have done and the charging station app we have developed can lay the groundwork for future students to further investigate the design and development of the app to encourage charging point sharing between eCar owners, and we hope someone will be interested in continuing the design and development processes we have started.

7 Conclusion

Through the research we have done we have learned that the shortage of charging points due to the explosive sales of eCars is a real problem eCar drivers face, at least those residing within Oslo and its surrounding areas. The premise of our thesis has been to encourage eCar drivers to share charging stations, by moving their eCars when they no longer are in need of charging. Our motivation for choosing this thesis has been to contribute to sustainable development. Electric vehicles are less detrimental to the environment than fossil-fueled cars, because they do not emit carbon dioxide and other pollutants.

What fundamentally separates eCar drivers from the drivers of fossil-fueled vehicles is their reliance on electricity, and our research indicates that most of the challenges our users experience leads back to this dependency and the shortage of charging points (e.g. trips require more planning, it is difficult to find compatible charging points for some makes and models of eCars, and existing eCar applications and other services have outdated charging station data). The results from the first round of interviews and our findings through the document analysis, suggested to us that many eCar drivers do not drive eCars primarily out of environmental conscientiousness, but rather for the incentives offered by the Norwegian government. While eCar drivers at this point in time have a number of incentives, there is much talk in the media about these incentives being removed a few years down the line. If and when the eCar incentives are removed, current and prospective eCar drivers will be left with no incentives for driving an eCar beyond it being a more environmentally viable choice of vehicle, and a number of deterrents or challenges that fossil-fueled drivers do not have to deal with.

Through our research effort we have learned about eCar owners needs and the challenges they face, and proposed technical solutions through the use of prototypes in the hopes that the app, if implementation is finalized sometime in the future, can make the challenges eCar drivers face less deterring for future eCar drivers. As far as we can tell, existing eCar apps and services only correspond to eCar owners base need to locate charging stations and see information about them. These apps and services are not in any way designed or developed to encourage their users to move their eCars, and thus lessen the severity of the charging point shortage that leads back to the challenges today’s eCar drivers face.

In trying to understand user behaviour, we have used persuasive technology and Fogg's behaviour model, which states that behaviour is the result of three concurrent factors: motivation, ability, and triggers. Early in the research process, we assumed that it was a lack of motivation that caused eCar drivers not to move their cars to allow others access to charging. The results of our research, however, suggested that many eCar owners are motivated to move their car and thus reducing the charging point shortage, but they lack a means of knowing when other eCar owners need charging. We believe the most important feature of our app, and that which fundamentally separates our app from all the other technological solutions aimed at the same user group, is that it facilitates the sharing of charging points by providing a way for eCar drivers in need of charging to notify other eCar owners of their need for electricity, thereby triggering the recipient(s) to move their car(s). Our research also suggests that, for our users to be interested in using this feature, it needs to be designed to be as simple as possible, so as to heighten the users' ability to behave sustainably rather than to add yet another burden to eCar drivers' everyday life.

Through our research we have also gained a better understanding of how gamification can be used in a user centered-design approach to increase the users' motivation. Much of the literature describes gamification approaches from an organization-centered rather than a user-centered perspective. In an organization-centered approach to gamification, the designers and developers typically try to gamify some system to motivate either an organization's customers or employees in order to reach some business goals that derives from the management of said organization. We believe that imposing our agenda on our users is inherently in conflict with the user-centered approach, and we have instead listened to our users and revised our prototypes based on their feedback.

Through our user-centered approach to gamification, we learned that, while game elements and mechanics are simple tools to include, designing and developing a successful gamified system relies more on understanding how motivation can be leveraged through supporting the users' fundamental, psychological needs for competence, relatedness, and autonomy. Through working with our users we learned the hard way that typical game elements used in gamified systems such as points badges and leaderboards (PBLs) were not perceived as motivating, but instead were viewed as "simple tricks" to get the them to behave a certain way. This finding is in line with what several game designers have stated about PBLs, namely that they don't create long-term engagement and are not motivating in and of themselves. We believe the

reason why PBLs don't work on their own is because they are used to reward some behaviour the designers and developers have imposed upon the gamified system, which the user then perceives as a form of control that undermines his sense autonomy. Due to this, we believe it is important when designing and developing gamified systems that any feedback from the gamified system is perceived as informational rather than controlling, and that the information it conveys supports the users' need to feel competent, related to others, and autonomous. The results of our research suggest that eCar drivers identify with each other and tend to view themselves as a group. While our users did not find PBLs motivating, they were much more positive towards the various social aspects proposed such as comments, ratings, and the aforementioned feature that encouraged sharing and allowed a user to notify others when in need of charging. Because of this sense of community, we believe the app can be used to motivate eCar drivers by being a tool that cultivates their sense of relatedness by providing them with information on when they can help another eCar driver in need by moving their car.

As mentioned in section 6.7, one of our biggest limitations has been that we were not able to complete the development of the application in time to test it out on our users. We learned that even though we did not need to build any back end with DrupalGap, it can be very time consuming to develop a hybrid app in a new framework maintained by only one developer, since this also mean that the framework did not have many code examples and limited documentation to assist us through the process. We also found jQuery Mobile to be very difficult to work with, because it was hard to customize without writing large amounts of code to transverse the DOM. We did found AngularJS to be a much more suitable development framework for us as designers and front end developers, as it separates the business logic from the user interface by way of controllers and templates. We also found that every question that propped up about AngularJS was already answered online, unlike when we sought answers relating to DrupalGap. In addition most of the libraries we needed in AngularJS, such as Google Maps, were easy to integrate and customize.

While we have previously worked within the field of user-centered design, this is by far the largest UCD project we have participated in. As the premise of the research effort has been to research how elements from gamification can be incorporated into a way that can motivate users to move their cars, it was at times frustrating to be met by resistance from the users. However, the process has further cemented to us the importance of keeping the user at the

core in user-centered design, and highlighted the importance of listening to what the users say and letting that be the guiding force for the design process rather than relentlessly pursuing one's own agenda as a designer. Personally, we both play games and find game elements motivating, but upon realizing that users didn't we had to redefine how we thought of gamification and its utility in this project.

Litteraturliste

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Appendix A: Project description

Sharing charging points for e-cars

In this master thesis *gamification* and *persuasive techology* shall be used to facilitate and motivate e-car owners to hand over a charging point to some other e-car owner when it is no longer needed for charging purposes.

For owners of e-cars, finding an available charging point is always a challenge. There already exists a native app to inform you about available charging points hear your location, but there is AFAIK no way to make better use of charging points.

Many e-cars are connected to a charging point for much longer than the time required to fully charge the car. The problem at hand is to motivate the owners of e-cars to free up the charging spot when their vehicle is fully charged, so that someone else may use it.

This master thesis aims at providing a native app (or a location aware responsive web page) to facilitate and motivate e-car owners to hand over a charging point to some other e-car owner when it is no longer needed for charging purposes.

For the pilot of the app/page, the parking basement of the Informatics building will be used. With a growing number of e-cars in use, charging points are already in short supply. For many of the charging points there, it is occupied by a single vehicle for a full working day. There exists no simple way to "swap" a charging point parking spot for a non-charging one when the vehicle is fully charged.

Research in gamification indicates that social behaviour is intrinsically motivating to many people. Research on persuasive technologies indicates that people are more likely to be nudged into desired behaviour when the threshold for doing so is low.

This master thesis shall build on this research (gamification and persuasive technology) to create an app or a page that make the threshold for sharing charging points low and that leverages on the intrinsic motivation people have for social behaviour to make e-car owners do so.

Acknowledgement: I got the idea for this app from Kai Atle Rosenlund in Eiendomsavdelingen who got it from someone in USIT (if you know who, please tell us).

Last retrieved April 11, 2017, from:
http://www.mn.uio.no/ifi/studier/masteroppgaver/design/sharing-charging-points-for-e-cars.html

Appendix B: Technology

In this appendix we will briefly mention the technology we have used in our project.

AngularJS (https://angularjs.org/):

AngularUI (https://angular-ui.github.io/):

Apache Cordova (https://cordova.apache.org/): Formerly known as PhoneGap. An open-source mobile development framework that allows for cross-platform development using standard web technologies such as HTML5, CSS3, and JavaScript.

Axure RP 8 Enterprise Edition (https://www.axure.com): A prototyping tool used to generate clickable prototype. Also offers cloud services through Axure Share, which makes it easy for two or more people to collaborate on prototypes.

Twitter Bootstrap (http://getbootstrap.com/):

Drupal (https://www.drupal.org/): An open-source content management system (CMS) with more than a million community members.

DrupalGap (http://drupalgap.org/): An open-source application development kit for Drupal websites.

Firebase (https://developers.google.com/maps/):

GoogleMap AngularJS Directive (https://github.com/allenhwkim/angularjs-google-map**):**

jQuery Mobile (https://jquerymobile.com/):

PhoneGap (http://phonegap.com/): Adobe's distribution of Apache Cordova, with some extra capabilities (such as PhoneGap Build's remote build functionality) added by Adobe.

Appendix C: Code

C.1 AngularJS application code

The code for the angular/firebase/cordova application can be found on this github repository:
https://github.com/RonjaKnudtsen/ECharge
There are many libraries that needs to be installed, but the main part of the apps logic which is written by us is put inside the "www/app/" folder. The cronjob and index file however, is located in the www folder. Installment instructions can be found in the readme.

C.2 Drupal and DrupalGap custom modules

The code used in the drupal module can be found here:
https://github.com/RonjaKnudtsen/eCharge-Masterfiles
Installment instructions are not provided, as this code is not sufficient to set up a full drupal application.

Appendix D: Interview transcriptions

D.1 Transcripts from the first interview round

Interviewee 1

The first informant we interviewed commutes to and from work for forty kilometers every weekday. She got her first eCar in august, so had only been driving it for a couple of months at the time of our interview. She has never experienced problems with her vehicle running out of battery power, but believes this might become more of a problem come winter, as the cold negatively impacts the car's battery. In case of emergency, she knows about a fast charging point on her way to work.

On questions regarding what she sees as the most positive highlights of driving an eCar, she immediately jumps to the economic incentives also cited in international press as the reason why Norway has been so successful in terms of eCar sales. In addition to this, she has two children attending school in Oslo, so by having them aboard the car on her way to work she qualifies to drive in the carpool lane, which makes her commute to work much faster. As an added benefit, she reports that driving an eCar gives her a "good feeling", whereas driving her old diesel fueled vehicle made her uncomfortable because it made her think about how she was contributing to pollution.

She says that she has never personally had problems finding empty charging points at the car park at work where she usually parks, and attributes this to the fact that she is always early. Her car has to be plugged into the power outlet at work for five and a half hours in order to be fully charged, and once she returns home after work she usually has 54 kilometers to spare. Even though she knows that her car only requires five and a half hour to be fully charged, she doesn't usually move her car because charging points she utilizes is located in a different building and moving it would require a somewhat lengthy walk. However, in consideration of her fellow eCar owners, she has put up a note in her car window with her contact information on it so that people in need of a charging point can contact her and request that she moves her car.

We gave her a list over the attributes that we are able to extract from Nobil's database, and asked her which of these would be the most important to her in choosing a charging station. She responded that the by far most important attribute was the connector type, as this would determine whether she would be able to actually use the charging station. Further, she stated that whether or not the charging points had fast charging would be relevant, and she also requested real-time information about the status of the charging points.

She stated that she doesn't use any apps, whether for gaming or otherwise, but when pressed on the question she admitted that she used Google Maps and similar applications to make her everyday life more efficient, but that she doesn't have the time to play games on her phone. This is also the reason why knowing about fast charging stations are important to her, but she did state that it would be interested if an application rewarded sustainable behaviour in the form of points.

She strongly felt that an app such as the one we envision should be used to encourage and foster solidarity, and motivate its users to "share the goods" (in this case charging points). She would be very interested if this app could be used as a messaging app between eCar owners, because she doesn't always know if the unknown numbers calling her are telemarketers or eCar owners calling to request that she moves her car, which frequently results in her not picking up her phone when unknown numbers call her. Furthermore, she stated that she and the other eCar drivers in the building in which she works have discussed making a "group of eCar owners" to ensure that everyone at work in need of charging points

have access once charging points are installed at their workplace. She felt our application would support this plan.

Interviewee 2

The second informant we interviewed also travels to and from Oslo for work, for approximately 25 kilometers each way. She told us that her household has both a pure electric car, which is mostly driven by her, and a plug-in hybrid vehicle which is mainly driven by her partner. We asked her what she found challenging about driving an eCar, and she told us that new legislation meant that she is no longer eligible for utilizing the carpool lane when driving her eCar, which means she has to get up much earlier in order to make work because of the morning traffic rush. Being able to utilize this lane was her main motivation for getting an eCar in the first place, because taking the train or driving in the conventional lanes was not an acceptable solution due to time constraints. She is unhappy that incentives are now being taken away from eCar owners.

The interviewee's workplace is connected to a larger parking garage in Oslo. She explained that previously the parking garage offered free parking and charging for eCars, and at this time she often took the elevator down into the parking garage at lunchtime to move her car to allow others to charge there because it was often challenging to find a free charging point if arriving late. She told us that at her workplace there was a "culture that encouraged sharing", and said that people who didn't move their vehicles after they were fully charged were "lazy" or "forgetful", confessing that she also sometimes forgot to move her car during lunch.

However, because of some recent developments this summer eCars are now required to pay 20 kroner an hour to utilize the charging points, and in addition the charging points themselves have been changed so that she now needs a separate "adapter" to be able to charge there. She explained that this "adapter" was very expensive, and that she did not consider it economically viable to pay for the adapter in addition to parking fees every day of the workweek. Because of this, she now parks at the conventional parking spots in the garage. As a part of our research we visited the garage, and noted that the majority of eCars there were parked at the conventional parking spots, rather than utilizing the charging points, a fact also noted by the interviewee when she stated "almost nobody at this building charge at work anymore due to the changes this summer".

Further on in the interview, she told us that she has just bought a new eCar which will be handed over to her shortly and which can be driven for greater distances without requiring charging. Like the first informant, she told us that cold temperatures have a significant bad impact on eCar's battery capacity and that she will likely be nervous about her car running out of battery before reaching home now that winter is approaching. She makes a point of stating the importance of staying vigilant about the battery levels at all times.

When asked whether she uses any applications or other services in conjunction with her eCar usage, she responded that she doesn't, but that she does use Google to find information about "rapid chargers" in preparation for longer trips.

We introduced the concept of gamification for her briefly, upon which she responded that she wasn't interested in games, but that she does use a lot of apps to make her day more efficient. In addition to social media apps such as Facebook, SnapChat, Twitter, and Instagram, she highlighted that she travels a lot and uses apps for airlines and various other travel related apps. On further probing with questions based on Kim's social action matrix, she placed herself somewhere in between a socializer and an explorer.

In an effort to elicit some requirements she would have of an app designed to help her in her everyday life as an eCar driver, she answered that she wouldn't need much, but that it

would be nice if an app would allow her to find unoccupied charging points nearby because "the charging stations are almost always full".

At this point, we explained some of the functionalities we had considered for the application. She thought that being able to send request for charging points and getting notifications when other people sent these request for charging points nearby were "smart" and "interesting". She had "no immediate need" to communicate with others through the app, and she would not be willing to lend her private charging points at home to others when not utilizing it. However, in accordance with the answers from the first interview, she thought it would be "helpful" to be able to filter the displayed charging points so that they only showed charging points compatible with her vehicle.

Afterwards, we presented our prototype to her. At this point, we had made the prototype clickable to be able to simulate a real app, but the interviewee was reluctant to use it on her own, requesting instead that we guided her through the screens by clicking the various elements. She thought the prototype looked nice, but requested, amongst other things, the ability to add more than one eCar to the user's profile as her own household had two. When probed about the design alternatives we had made for the various functions, she told us that it looked more "balanced" to her when the filtration icon was placed in the top left corner opposite the menu icon but that she disliked the drop-down list in that same screen, articulating a preference for the "boxes" in the remaining prototypes. She also questioned whether people would understand the purpose of the filtering function if placed inside the search bar.

With regard to the proposed method of "checking into" charging stations and "requesting" charging points she was concerned that this would require too much work on the part of the user, a challenge which we were aware of. However, without real-time information about all charging stations this is currently the best solution we have been able to think of.

Interviewee 3 & 4

For our third interview, we managed to recruit two interviewees that we interviewed simultaneously. Both of them were in their early thirties and worked for a construction management firm in Oslo. As a part of their work in construction management they have, amongst other things, overseen the building and maintenance of a parking garages with charging points for eCar, and reported that eCar owners in recent years have become more demanding of charging points in buildings. This interview was conducted in a meeting room with both participants. Henceforth, we will refer to them as interviewee A and interviewee B.

Interviewee A drives a plug-in hybrid vehicle and lives in Oslo. Interviewee B drives a pure eCar and lives outside of Oslo, in Bærum. Interviewee A states the primary reason for him choosing this kind of car were economic, as he doesn't have to pay as much for gas and have access to free charging points while at work. Interviewee B says that he has always been fascinated by eCars, and although the first eCar he drove didn't have a good range (in terms of battery capacity), he has continued to drive eCars ever since. He further elaborated that driving an eCar makes it easier for him to get to and from work, that it takes less time, and that it cost less because he lives outside the toll plaza and eCars are exempt from these fees at the time being. When asked what they believed the biggest motivator for Norwegians buying eCars, Interviewee B stated that he believed it has more to do with economy than "the green transition", at the same time noting that the removal of economic incentives for eCars might influence the sales in a negative way. However, he noted that now that he had driven an eCar for years, he had become fond of driving an eCar and prefers driving that to an exhaust vehicle despite the possible loss of incentives. Interviewee A agreed.

Both participants stated that they drive their eCars more or less every day. Interviewee A said that he charges his car mostly at home and at work, and more seldomly at communal charging stations. Interviewee B stated that he rarely charges or parks other places than at home and at work, because his Tesla has a large battery which requires less frequent charging than older models. He also noted that the GPS in his Tesla provides him with an overview of all the "Tesla super stations" in addition to all the charging stations he has previously utilized. He recounts a story of when he went to a wedding in a rural place in Norway where he had to leave the event to charge his car, and that he believed that the fear of not getting to charge your car, or "range anxiety", could be one reason for people to choose fossil-fueled cars over eCars.

Interviewee B also explained to us how the effect of home charging depends on the type of charging point you set up, and that it take his eCar 22 hours to get fully charged at home. When asked questions about knowing other eCar owners, Interviewee B stated that pure eCar owners tended to favor other pure eCar owners and liked to tease the owners of PHEVs and fossil-fueled cars. Interviewee A agreed with this assessment, stating in a joking way that he felt like an outsider because of his choice of vehicle. Interviewee B also stated that a lot of people living in Bærum owned Teslas, and that they acted like "tech nerds" when comparing their cars and car-related accessories.

We then asked them to imagine a scenario where they found hundreds of charging points nearby, and they would be able to filter out the charging points based on some data. We then asked the interviewees to look over a sheet of attributes from Nobil's data points and highlight which data points would influence their choice of charging stations. Both participants agreed that whether or not the charging station was available 24 hours a day, whether or not it required a parking fee and whether or not there was a time limit on utilizing the charging points were important factors for eCar owners to know when trying to locate suitable charging stations. Further on, they both deemed real-time information about availability to be a big bonus feature of a charging station, in addition to information about which vehicles could be parked there and the availability in terms of payment methods. Additionally, Interviewee B noted that he thought it might be useful to know whether the charging points had a fixed cable and was reservable. They both seemed confused by the attributes listed in Nobil's list as "charging capacity" and "connector". Interviewee A also said that he often felt confused by the signs at charging stations in regards to whether or not he was allowed to park there with his PHEV, so he liked the attribute "vehicle type" that explicitly stated which types of vehicles were allowed to park at the various charging stations.

We tried asking them what kind of apps they used on their smartphones, and each noted that they used "social applications", with participant A clarifying that he also used TV apps such as Netflix and NRK. In terms of their eCars, they spoke about how many eCar manufacturers release their own apps with the cars, where you amongst other things can check how much battery you have left. Interviewee B conceded, and told us that the car his mother drives (Nissan Leaf) has an app that shows her all the charging stations in Oslo when she visits, and that the huge amount of charging stations can be overwhelming on a relatively small screen.

We briefly outlined the concept of gamification, and when given examples they responded that they vaguely knew about it. Interviewee B described himself as a conscientious eCar owner who didn't need incentives provided through gamification in order to move his car to allow others to charge, but noted that others might because there are many people who don't move their cars when they are fully charged. He also told us about how Tesla had started charging eCar owners who left their cars at the Tesla chargers for longer than necessary. Although they didn't seem particularly excited or interested in the idea of earning points within the app, they quickly became more engaged when we described the

concept of a leaderboard. They seemed to view this as a sort of competition, where nobody wanted to be publicly outed as "selfish" by not moving their cars to allow other eCar owners to park there.

At this point, we started to discuss some of ideas we had about possible functionalities of the finished app. Both seemed to agree that it was a good idea to give eCar owners a message through the app when their car was fully charged (thus when they not needed the charging point any more), and jokingly discussed the possibility of excommunicating people from the app if they never shared charging points with others.

When probed about the concept of taking and sharing pictures of the charging station, they commented that some people would probably think this was fun, although they did not seem to consider themselves as such people. When asked about a possible chat functionality within the app, they asked how this would work. Interviewee B suggested that it would make sense for it to be linked to specific charging stations or GPS locations so that you could ask nearby users of the app to move their car, rather than our original idea of allowing the users to add their friends and colleagues.

We asked them what they thought about the idea of sharing their own, private charging stations through the app when they did not use them themselves. Interviewee A stated that it could be smart and feasible, but Interviewee B stated that he was "not keen" on the idea, but that he might share his private charging point with fellow eCar owners in emergency situations.

When asked whether they believed you should only see charging stations that were compatible with your car, they responded that should be a standard than you register the make and model of your car when registering on the app so that you didn't get overwhelmed by charging points that weren't compatible with your car. We asked them if they thought people would be interested in posting pictures of their own eCars as a part of their profile, whereupon Interviewee B stated that he would not do it himself, but that he has seen many people in social medias such as Facebook who do it to brag, so that it would probably be a useful feature.

When asked if they would feel motivated by the idea of gaining privileges by gaining points in the app, they asked for clarification and joked whether one such privilege could be free charging. When we explained further, they said they didn't know, but seemed disinterested. They liked the idea of having an overview of all the charging stations you had used, and additionally thought it would be good if the application could provide statistics on how much electricity the car had consumed and others figures from the eCar usage.

Finally in the interview, we showed them our prototype. We went through the different design alternatives for the different functionalities we had discussed, and asked them for their feedback. Interviewee A noted that the filter icon we had chosen for the application looked too similar to the menu icon, and that they were confusing when they were on top of each other. Interviewee B disagreed, stating that he understood which was the menu icon and which was the filtering icon. They both agreed that it was important that the app did not look messy and that there were not too many navigational menus. As a new design alternative, they proposed putting the filtering functionality in the main menu. When asked which of the design alternatives they preferred, between checkboxes for features we believed would be relevant for choosing charging station (free of charge, fast chargers, etc.) or a navigational menu that allowed them to specify more specifically what they were looking for, they both seemed to agree that they preferred the checkboxes. Interviewee B also suggested a functionality we could incorporate in order to ask the users for further help, by allowing them to submit feedback to us through the app. This feedback could be both design suggestions or complaints, as well as factual issues with the app (for instance if a certain charging point was not working). When shown the prototype for the "share your private charging point",

Interviewee B once more reiterated the idea of being able to share his own charging point only if the one wanting to lend it was in an emergency. When shown the functionality for adding friends, they were critical and asked if it would be difficult to retrieve the friend list from Facebook instead, as this would be much simpler and alleviate the problem of having to know the usernames of all your friends on the app. They were also confused by one of our design alternatives for the abbreviated information about the charging station, in which we had two different arrow symbols (one to see more information about the station, and the other an icon inspired by Google Maps' "Get directions" icon). They said they believed people would understand it eventually, but that it would be smart to design for the app to be as intuitive as possible and avoid similar icons.

Interviewees 5

The subject of our fourth interview was a Oslo-based student in his twenties who does not own his own eCar, but burrows his parents' eCar approximately four times a month. This informant is a friend of a friend of ours, and had a vague knowledge of our project beforehand, so this might have influenced his answers. With that said, we had explained to most of the interviewees what our project entailed during the recruitment process, as well as stated it on the consent form provided to each of the informants ahead of the interviews.

According to himself, the only positive thing about driving an eCar is that they are better for the environment. When we asked him follow-up questions regarding this statement, he responded that he believed the range of eCars to be poor compared to conventional vehicles, stating that the eCar he lends from his parents can drive a maximum of 180 kilometers when fully charged. He then added that the range is significantly worse in the winter, mainly because of the amount of electricity required to power the car's heater. Sometimes during the winter he drives the car with his outerwear on and with the heater turned off in order to preserve electricity. Unlike the previous four eCar owners we had interviewed, he did not mention economy in relation to his eCar usage, and when questioned about it he answered that he did not have much knowledge about the economic benefits of driving an eCar as his parents were responsible for the fees.

We asked him how he usually charges the eCar, whereupon he confessed that he lives next to a company that has charging points that are not used outside of business hours, and that he then "steals" power from them. Upon further questioning, he told us that the nearest communal charging station he was aware of lay approximately fifteen minutes on foot away from his apartment, and that he considered it too much of a hassle to walk back and forth for this duration on a daily basis. Fully charging the car at this charging point, which he described as a medium capacity charging point, would take six to seven hours. He also told us that his apartment complex had tried to put up charging points in the parking garage attached to it over a year ago, but that due to a installation error none of the residents were able to charge their eCars with these

Sometimes when he borrows the eCar he uses it to visit relatives outside of Oslo, because it is faster to travel that way than by utilizing public transportation, and otherwise he uses it to run small errands during the days he has it.

We asked him if he had experienced almost running out of electricity, upon which he responded that he had on many occasions because he often had problems finding unoccupied charging points. We asked him to elaborate upon this, and he told us that it is usually hard to find free charging points during daytime. When he began driving the eCar three years ago he almost always found free charging points, but nowadays it's not that easy anymore. He stated that finding an unoccupied charging point in the city centre of Oslo is about as hard as finding a free parking spot for a conventional car.

He told us about a gas station that he often charged at when the eCar was almost out of electricity, where he can pay 50 kroner to charge for half an hour at a "hurtiglader" which results in his car being almost fully charged.

We asked him if he, when parked at a communal charging point, usually physically moves the vehicle in order to allow others access to power, whereupon he answered "No, I usually just let it stay there like an asshole". He elaborated that at the charging point he usually uses when not stealing power from the firm next door allowed his car to be park he is allowed to leave his car for sixteen hours, and that he has never moved his car to give other people access to the outlet.

As with the previous interviewees, we decided to show him the list of attributes from Nobil and ask him which he thought were the most important to him when choosing one charging station above another. He emphasised that he preferred free charging stations, but if none were available he would like to know the prices for the different charging stations (something Nobil does not provide at the time of writing). He also noted that if real-time information was available it would be "perfect" (again, something Nobil only provides for a minority of charging stations). Furthermore, he said that if you needed something (like an RFID "brikke") to access the charging point, this would influence his choice. When questioned about the cable, he said that he believed one type of cable was beginning to become the "standard" and that he had one of these in addition to the one that came with the car. He stated that he was "pretty sure he could charge anywhere" with the two cables he keeps in the car. He also would like to see the "hurtigladere", but was less interested in the payment method, stating that "it always works itself out in the end".

He told us that the GPS in the car he borrows has a map over charging points, but that the map is incomplete and outdated. In order to update the map so as to remove defunct charging stations and add recently established ones, the eCar needs to go in for service, and that the map provides no additional information about the charging stations beyond their location.

He also said that he disliked parking garages, claiming that these charged eCar owners double: for both paying and charging.

We asked which apps he uses, whereupon he opened his smartphone to check. The apps he reported using were his bank, Ruter (public transportation), Post, apps for vegan food recipes, and for discounts at the various grocery stores. As the first of our interviewees, he reported also playing video games, naming a few such as "Witcher" and "Rimworld".

In response to a question on what he would like in an ideal eCar app, he said that it should provide a clickable map that gave him more information about the charging stations such as their availability (real-time) and price.

We asked him some questions relating to the gamification aspect of our project. He said that the best thing would be if eCar owners could just move each others' cars out of the way, but the second best solution was to contact someone through the app. He also said he understood the point of gamification, stating that people need incentives in order to move. In addition he said that he would use the app if it existed because it would be to everyone's benefit if people shared. He did not seem to believe that he himself would be motivated by earning points or climbing leaderboards, but commented that there's probably some people who are and that we might implement incentives and punishments for those who don't share. He would also like the app to be colorful when you do something good, stating that the colorful Las Vegas slot machines.

We then went through the list of discussed functionalities. He called the idea of people uploading pictures of charging stations "clever", but also wonder if we would be able to retrieve images of the charging stations through Google Maps, an idea we

ur informants, he was very positive towards the idea of letting other eCar owners lend his charging point, although through discussion it emerged that he was excited by the idea because his apartment complex were working on providing the residents with charging stations and that he saw the chance to let others use his private charging point in exchange for money given that he only uses it a few times a month. For this functionality, he would like to be able to add which price he would charge for renting it out to others. He also reminded us of the firm next door at which he frequently charged, stating that a lot of companies have charging points that go unused for much of the day and night. He would also like to be able to combine the app with social medias.

We then presented our prototype. Of the filtering options he preferred the one that had the filtering option in the upper left corner, because it felt the most "natural". He thought the idea of using an eye as a filter icon was "weird" and stated that he "didn't like it". He said that the menu was okay, but he would prefer it if it filled the entire screen, as you wouldn't need to see the map while looking at the menu. Also, it would reduce the risk of clicking the wrong option. He thought the profile page was okay, and preferred the first option (with bigger pictured) for adding friends as this again would reduce the chances of clicking the wrong icon. As the first out of the interviewees, he preferred the second option of the "more information" screen.

D.2 Transcripts from the second interview round

Interviewee 6

This interviewee lives in Oslo, but studies approximately 30 kilometers outside of the city and uses her pure eCar to commute. She says she mostly always charges her eCar at home because she only drives "short distances", but she knows there are charging stations at her place of work. We asked some follow-up questions with regards to this, and learned that her workplace is at a hospital in which she knows it is "very difficult" for those who need them to find available chargers because there is a shortage of charging points. According to her, the only times you are guaranteed a charging point is during the night shifts.

It takes her car four to five hours to be fully charged, which she describes as a "long time". But despite reporting that it takes virtually no time at all to move her car when she charges it at her workplace, she says she never moves it to give it to more needy eCar owners. We asked her how she would go about finding an empty charging station in case she ever needed to use one outside of home and work, and she stated that her GPS had an overview of the charging stations, but that she never uses it because she knows "they exist", so presumably she would drive around until she located one.

We asked if she used any other apps in accordance with her eCar usage, to which she replied "no". When asked which other applications she frequently uses, she listed "Ruter", "Finn", "Felleskatalogen", "NRK TV", "Snapchat", translations applications from Norwegian to English, "Facebook", "Messenger", TripAdvisor", "Elixia", "Google Earth", and "Vipps". She does not play any games.

We then asked her what as the most important for her in terms of choosing a charging station. She stated that it was that it was "easy to access", so that she didn't have to "lukeparkere", and that it had to be free of charge. When asked what she would want out of a potential eCar application, she said she would like to have an overview of charging points that were occupied or free as an ideal, and that she would be able to pay through the app in case usage required payment.

On the front page, various menu items were illustrated with icons. We asked her if she understood what they meant, to which she answered no and stated a preference for the icons

that had a small informational text underneath them. She also said that she preferred the menu that slid in from the side rather than the one embedded in the bottom, possibly because the slide-in menu also had textual information about the different options.

We showed her the prototype for how to calculate a travel route and how to find charging stations along that route. When told about this feature, she got excited, and told us about one time she had driven her eCar to Sweden and had problems finding charging points along the route, stating that she ended up running into one on pure accident but that this one didn't work. But, again, she felt that the icon or button we had chosen to access the direction functionality was not intuitive, and would have preferred an informational text, suggesting "rutevalg" rather than our proposed "veiviser". We also showed us the proposed solution to navigating from your position inside of the search bar, to which she responded that it would have been better with a separate button with an informational text.

She felt the most useful attributes to filter on were the ones we had placed on the top of the screen, namely setting the distance from her current location to the displayed charging points, and the toggle buttons for functionalities that only has to values (yes and no) such as fast charger, free parking, etc. As far as others' ratings were concerned, she said that she wasn't interested in this aspect of filtering, and stated that "if people need charging, they will use the one that's there regardless of other users' opinions". She also expressed surprise at the number of different charging plugs, stating that she had no idea which one she used herself. We also asked her whether she would like the filter options to apply each time she used the app, or whether they should be reset between uses, to which she expressed a preference for the latter.

She seemed confused by the proposed "number of people in line" part of the info window, stating "10 i kø, herlighet!" She also said she would have liked a route to be drawn on the map between her position and the charging station when she clicked on one.

On the actual information screen, she felt it was way too much information at once, and that it was too much text. When we tried to explain the idea of people "checking into" charging stations, she said that it was too complicated and that she had problems following our explanation, but added that it was maybe more suited for young people who are used to utilizing their cellphones.

In response to the additional information, she preferred the design alternative with the icons to the textual information, even though she didn't quite understand the icon for "real time information". She also felt that the information conveyed through the icons should come ahead of the information we currently had placed there (i.e. description, address, contact information, images, and likes). On the topic of likes and dislikes, she said she wasn't sure what she thought about it, but when we elaborated on our idea of letting people easily see if a charging station had many dislikes for instance because of being out of order, she said it was "smart".

We tried to ask her about the choice of colors in the tentative design for the comment section, but she didn't really have any input due to her saying she wouldn't have used it either way. Her reasoning was "If I find a parking garage I really loved, that was free and never crowded, I wouldn't want anyone else to know about it". She thought the idea of letting other people know a charging station was out of order was maybe smart, but also added that she would never venture so far into an application as to end up in the comment section.

At this point, the interviewee seemed to lose a bit of interest, because it seemed the ideas had gotten too complicated. As such, we decided not to show her and ask her questions about the gamification screen, but limited ourselves to showing her the idea of seeing your history of previously utilized charging stations, which she seemed to find convenient, stating that "It would help you find and better remember the charging stations you had previously used".

In conclusion, she seemed unsure of the utility of our application, as most eCar GPSs already have an overview of existing charging points, but reiterated that she liked the filtering idea as well as the directional service. We chose not to show her the color palettes, as she was in a hurry to get to another meeting and seemed distracted throughout the last stretch of the interview, presumably due to this.

Interviewee 7

The second interviewee during this iteration was a male in his forties. He lives about 40 kilometers from his place of work and commutes back and forth in his eCar. He stated that he charges the car where he sees fit, and elaborated that during the summer months he mostly charges at work, whilst in winter he charges at home because he likes "waking up to a warm car". He said that it wouldn't take him long if he were to physically move his car while charging at work, but that he rarely did so. Like the first interviewee we had, he also has a note in the back window of his car with contact information in case anyone needs a charging point. He stated that used to feel that his place of work had a good amount of charging stations, but that the steady increase of colleagues also driving eCars made them tougher to come by.

When asked about his main motivation for driving an eCar, he immediately jumped to money and economy. When probed about potential negative sides of driving an eCar, he responded that the range of it was a drawback, particularly because he owns dogs and likes to drive to the "wilderness" where charging points are in short supply. He says that his car (which he describes as old) was advertised to have a range of 200 kilometers, but that it in actuality had a range of about 150-160 kilometers.

We asked him about which applications he used in connection with his eCar usage, and he pointed to the app built into the GPS of his eCar, stating that it works "okay" but that it is rarely up to date. He complained that this application showed other users' private charging stations on the map, and also stated that it had a "huge potential for improvement". When asked which other applications he used, he said "Google maps, Google calendar, a lot of Google in general, Facebook, audiobooks, car parking…".

We asked him if he played any games, whereupon he named Pokémon Go, which he stated that he liked because it encouraged activity and was fun to play while walking his dogs, in addition to a game called "Mobile Strike", which he described as a "war game" in which multiple players formed alliances and chatted. He also mentioned sometimes playing chess.

When asked what was important to him in choosing a charging station, he answered that availability was the first and foremost, but noted that the correct outlet was also important, in addition to pricing (showing a preference for charging points that were free of charge). He also named that being able to see rapid charging stations when you needed them, and being able to see the charging stations maintained by specific companies that he had subscriptions with. We probed further, asking him what he would like from an ideal eCar app, he said that it should have a map that showed where he was in relation to the charging stations, that it should have updated information, and that it should clearly show whether charging stations were were public or private.

We then showed him the design alternatives for the app's front page. He showed a preference for the menu that slid in from the site rather than the one embedded on the bottom of the page, because he wanted "more map". Because we had chosen to have this menu in purple, we asked him whether the choice of colors would dissuade him from using the app, he said that it didn't matter as long as it wasn't bright pink, and also added that the most important thing was that it had a "simple interface".

When probed about the use of icons, for instance in the case of directions and GPS locations, he said that it was understandable and that people learn quickly by experimenting. He emphasized the importance of searching not only at the place you were at, but the places you were planning to go.

He liked to idea to filter on rapid charging stations, stating that the GPS in his car only showed rapid chargers. He also liked the ability to filter on charging stations that were free of charge. He said that it would make most sense to choose which contact types the first time you used the app, and also stated a preference for the filtering options to be remembered between uses. When asked about the inclusion of rating and whether he believed this would influence his choice of charging station, he responded "yes, I actually think so", and said that he would rate charging stations poorly if they were out of order or turned out to be private. He also said that the app should allow you to filter according to which operator maintained the charging stations, because he was subscribed to two of these operators and said that he wouldn't consider using charging stations maintained by others because they were "too pricey".

When presented the info window, he said he liked the "like" functionality, because it would allow him to quickly make up his mind about whether to use a charging station. He elaborated on this point, saying that from a safety perspective it was important to be able to quickly learn the relevant information as you most likely would be using the app while in your car. The proposed prototype had the number of likes and dislikes beneath the icons, and he stated that it would be quicker to process if they were represented by percentage rather than numbers.

He was really excited about the idea of being able to "check in" and "check out" of charging stations, and stated that the ability to see the risk of queue was "golden information". We discussed the practicalities of the idea, whether it would be too time consuming for people to have to manually check in and out, whereupon he suggested sending notifications to people based on their GPS locations, asking them whether they were "in line" or "charging". He did not see the need of pictures of the charging stations. He also said that in order to read text as quickly as possible, a study conducted by "Vegvesenet" had suggested that black text on a bright yellow background was the best, and that we might consider presenting information in this way.

He liked the information presented with icons the best out of the different design alternatives and said that he found them "understandable". In one of our prototypes we suggested for the user to be able to see a list over the people checked into and waiting in line at a charging stations. He objected to this idea, saying it was better if you could just see numbers rather than who was there, stating that "accurate information is more important than knowing exactly who is there", and also said that displaying user information to the other users might dissuade people from using the app and that people had a need to be "inkognito".

When asked about the potential dialogue with other users in terms of charging requests, he said that writing your own texts would be too time consuming, but that the user should rather be presented with a list of options such as "5 minutes", "10 minutes", and so on to indicate when they would be able to move their car. He also thought the idea was smart, as it would alleviate his need to have the note in the car and giving out his contact information. He also pointed out that it was important that the app was not too "naggy" with its notification.

With the proposed comment section, he said that the queue rating was not interesting unless it told him how much queue it was at that time. He had no need to post pictures of his own car.

Lastly, we told him about gamification, and he was very positive to the idea, saying that from his own experience competitions was a powerful motivator and that he really

"believed" in it. He was however sceptical to the proposition of limiting the functionality for new users, although he acknowledge the need for incentives to check into charging stations.

Interviewee 8

The third interviewee in this iteration was a woman in her late thirties. She commutes about 10 kilometers back and forth between her place of work and her job, and she mostly charges her eCar while at work because she has recently moved and the garage is not yet set up with a charging point.

The eCar she drives is a Tesla, and said that the battery in it was such that she only needed to charge about once a week. She felt a guide if you needed charging would be good, because it can be difficult to find charging stations if you arrive late and need electricity. She informed us that her workplace had recently set up a number of new charging points, but that these were a longer walk away from the actual place of employment. She did not have too much experience driving in Oslo, but said that she had only once experienced that a Tesla charging station was full, and that going on longer trips was worse now that there are so many Teslas.

When asked about her motivation behind driving an eCar in the first place, she said that she had always been very concerned with the environment and that she got her first eCar more than ten years ago. She said that her boyfriend (whom she shared the car with) is also concerned with the environment, in addition to being fascinated with the technology behind eCars. She said she was surprised by all the economic incentives, because this had not been her main motivation. When asked what, if anything, was negative about driving an eCar, she said that it required a bit of planning, but quickly added that this quickly becomes a habit.

When asked which apps she uses, she pulled up her phone and went through them. "Train times, cinema, grocery stores, renovation, Filmgrail, Instagram, TripAdvisor, Get, NRK, Ruter, DNB". We also asked her if she played any games, whereupon she answered "No, that's boring", adding that she was a "sore loser".

We asked what was the most important for her in relation to her choice of a charging station, and she answered that it should be free of charge and easily accessible, and preferably information about whether or not it is a rapid charger for longer drives. Ideally she would like to use the app not on her smartphone, but rather on the GPS screen inside of her Tesla. In an optimal app, she would like to have a map that gave her information about the type of charger and speed of charging, and she would also like to be able to plan trips by plotting in travel route and locate charging points along it that were compatible with her car and cables. She gave an example of being able to find the hotels that offer charging points to their guests so that she wouldn't have to call the hotels in advance when planning her trips and would like an option in the app in order to filter on hotels with overnight charging.

We asked her about the icons we had used, and she recognized the directions-button from Google, but guessed that the icons we had chosen for profile and notifications meant people connected and comments, respectively. Nevertheless, she said she wouldn't need labels on the icons, but stated that "everyone is different", and that some people might find it helpful. She preferred the menu that came in from the side of the screen to the fixed one on the bottom, because that is what she is used to in other apps, but also stated that it would depend somewhat on the importance of accessing your profile and notifications in the finalized product.

Regarding the directional services, she requested that we add what is known as "Waypoints" in Google, i.e. functionality that allows the user to add additional points along a route.

Regarding the filter, she said that the most important thing was the connector so this should be the first thing asked. We asked if she would like to do this upon registering in the app instead, but she responded that it would depend on her needs because she has different cables for different speeds of charging, so if she needed to for instance "rapid charge" she would use a different connector than with slow charging. She also came back to the hotels from earlier, saying that she thought people would be very interested if the app allowed you to filter on hotels with overnight charging. She thought other people's opinions were the least important, and would prefer them on the very bottom of the screen.

About the info window, she said that the distance and the number of unoccupied charging points were the most important factors. She thought having pictures of the charging stations were okay, but pointed out the inconsistency in the proposed design with regards to the filtering prototype using faces and the information screen using likes to display customer satisfaction. She proposed using a star rating system instead, "like hotels do", and that the average star rating would be calculated to a number. She further elaborated on this idea when we showed her the prototypes for the comment functionality, stating that she felt a charging station's "value" should be calculated based on the average of the price and queue rating from the users, but emphasized that it should have a minimum of reviews for this because "one person's review is not reliable". She further thought that letting people write comments was "smart", because it would allow people to see what they are reacting to in order to surmise if this would also affect you.

She did not think the icons in the "additional information on charging stations" were clear enough, and preferred the list of attributes in the middle. She also took issue with the design proposal having the description, address, and contact information above the additional information, stating, "Description and contact information are less important and should be at the bottom of the screen".

Regarding the checking in and out of charging stations functionality, she was highly sceptical. She stated that "I don't need it because I know I will never use it". She had previously been involved with a somewhat similar project to ours, in which the users were required to use an app in order for the business idea to work, and she told us that even though the users of this app were charged if they forgot to use it this was still not a good enough incentive to get them to use it. She said that she believes charging points will be "live" after a while, and "communicate with the world around them", which we took to mean as real-time information. When probed further on her thoughts around our project, she said that for her checking in and out of charging station had no value. We tried to tell her about gamification and how we believe that might work as a motivator, but she did not believe it would, stating that she was "wholly uninterested in such things" and that she "would not let herself be influenced by such". We also told her about the idea to require the users to check in and out a few times in order to access the remaining functionalities in the app, to which she responded "I would not bother to use it if it required me to do something so-and-so many times".

We asked her then about the idea of sending requests to people at charging stations, which she liked better than "checking in", but she was concerned that people could become rude if they were allowed to compose their own request, suggesting that people could choose from a predefined list. When we told her about a previous interviewee's idea of sending these requests based on GPS locations she expressed that people might become unsettled or paranoid, and feel like we were surveilling them.

Interviewee 9

The fourth informant we met with both lives and works in Oslo, and uses her eCar to commute. She says that her place of work has charging points, but much fewer than there are

employees with eCars, and that she herself has only charged at work two or three times. She said she wished it would be easier for eCar owners to communicate with each other and alert each other of charging points being available, stating that people working there have different schedules so that if someone for instance leaves at one o'clock the colleagues would not know that a charging points had been freed up. We asked her what motivated her to get an eCar in the first place, to which she responded that it was a combination of economic and environmental factors. On questions of possible drawbacks to eCars, she stated range in addition to limited space in the car.

She said she uses Fortum's webpage in order to check routes for rapid chargers ahead of longer trips, stating that the GPS in her car shows her all rapid chargers regardless of their operator. She says Fortum provides live information about the statuses of charging points, for instance if they are out of order.

Other apps she uses are "Finn" (which she states she is dissatisfied with the design of), "Ruter", "Yr", "Vipps" (which she thinks is "fantastic"), "Facebook", and mail.

She said the factor that mostly influenced her choice of a charging station would be its location (the distance from her work), but other factors of importance were the pricing (preferring free of charge) and effect (preferring rapid charging). When asked what she would like in an ideal eCar application, she said that it would need a map so she could see where she was in relation to the charging stations, and she would be able to filter on the connector type, whether the charging station was rapid or not, and to see the distance from it in kilometers.

We then showed her out prototypes. She didn't like the menu embedded on the bottom of the screen, saying that it was better when it was "open" and had a larger map. About the search and directions functionality, she stated that it was "absolutely interesting", but reiterated that she would like to see if the charging stations are fast chargers or not along a route as no one has time to charge for ten hours while on a roadtrip. Otherwise she believed it would be very useful, and felt that the choice of hiding the "my position" within the search field was "intuitive".

As far as the filtering functionality goes, she felt that connector type should be a part of the profile, because it is not something that changes. She also stated that there is a difference between normal charging and rapid charging, because she uses different plugs for the different modes, and as such would like to add to her profile which connector type she uses for each speed of charging. She would also like the app to remember her filtering settings between uses, and she would like for it to be efficient to switch between rapid and normal charging.

We asked her about the charging station prototypes, and she stated immediately that she liked that our prototypes had pictures of the charging stations because if she was going to use a charging station for the first time she had previously used Google maps to find pictures of it in order to recognize it. She also said that the number of charging points was essential information, in terms of planning and factoring in the potential for queues. She also questioned the rating system, stating "It either works or it doesn't, and what happens if it gets fixed?".

She thought it was "much easier to read" the information when it was presented with icons, but then took issue with the prototype we had made because we had arbitrarily chosen "for employees" as the availability. She said that if some charging stations were only accessible for employees they were completely uninteresting to her and should as a standard be filtered out.

On the topic of checking in and out of charging stations, she said that "it would be nice if it would be automatic". She questioned how people would remember to go into the app to check in or out, but noted that it would be nice if there was a way for people to notify

others if they moved their car. She felt that to get a notification about someone wishing to charge (request) was okay as long as it was simple (only pushing one button), but also noted that she would ignore notifications if they came while she was at work and only receive them once it was possible for her to move her car.

Interviewee 10

The fifth informant was a woman in her sixties, who lives in Oslo and commutes to her place of work about 30 kilometers outside of the city using her eCar. She stated that she didn't feel the the commute was too lengthy, but that she sometimes felt "range anxiety", particularly during the winters because of the cold's negative impact on the eCar's battery.

She told us that she drives a relatively rare eCar and often experience problems finding charging stations compatible with her vehicle. She said "both the outlets and the electricity network need to correspond". None of the other interviewees up until this point had mentioned "electricity networks", so we probed in order to understand what she meant by it. It seemed she was referring to what Nobil calls "charging capacity" in their attribute list, i.e. what we have come to refer to as the effect of the charging point.

She would like to know which charging points are unoccupied and whether they are compatible with her car. She stated that she had only managed to charge once on a communal charging point with an adapter, because she "rarely has time to drive around looking for free charging stations when they're mostly all full". She cannot use the charging points at her work because they are not compatible with her car. She actually requested permission to be allowed to pay for the installation of a compatible charging point at her workplace, but was denied. She felt it would a huge relief to her if she could charge at work, and also stated that having an eCar was a lot more complicated than she at first anticipated. She said she knew nothing about the different charging modes before she came to own an eCar.

If she needs to find a charging station she will use websites, but also added that she rarely has a need to because she is familiar with the area in which she lives and "mostly knows" where the charging stations are at. She also stated that the charging points are good, but that there are far too few compared to the demand, and also added that "PHEV drivers should find another solution than to take up the charging points needed by pure electric car owners".

When questioned on her motivation for getting an eCar, she says that it was primarily due to environmental factors. As her job deals with the environment, she also added that it would be "embarrassing" to be seen driving to work in a fossil fueled automobile. In addition, she added that the economic incentives were a nice bonus.Travelling to and from work on public transit was also out of the question, as it by her estimation would result in three hours of each workday being spent commuting, as opposed to one hour with the eCar.

She tells us a story of a cabin trip that she had taken together with her partner, where they had both suffered extreme anxiety with regard to the potential of not finding any charging points compatible with the car and had ended up cancelling the entire trip and going back home. She said that after this experience they realized they could not take the eCar for longer trips, but noted that she would like to if she would be able to find charging stations.

On the topic of apps, she was uncertain if she was part of our target population. We ensured her that we were interested in speaking to eCar owners of all ages and experiences. She said that she doesn't really use much apps, but mentioned WhatsApp, Snapchat, and various apps related to travelling (Ruter and NSB).

She would like for there to be "an easier system" to understand where you can charge your eCar, and at the same time noting that everything would be easier if her eCar had been "standard" because more and more of the newly erected charging stations has Type 2 outlet.

We then began showing her our prototypes and explaining our ideas. She liked the menu that was affixed on the bottom, stating that it was "even easier" if the menu was there as opposed to hidden behind a menu button. She also preferred the menu items with labels.

She liked the possibility of filtering out the charging station based on their connector type, but requested that we also did the same for charging capacity.

When we showed her the our designs for the map, she said that it looked a lot like the maps she already has through various apps, and stated that "the point is to find the charging points that are compatible with your vehicle and that they are not out of order or anything".

We showed her the filtering functionality, which she liked, wanting to everything that was incompatible to "disappear" from the map. She highlighted that the most important thing was the correct combination of charging capacity and connector type, because she had one cable for rapid charging and another for normal charging, and she would like to easily switched between these two alternatives depending on her immediate needs. She also questioned our ability to filter on charging stations that were free of charge, stating "Free of charge for whom? We have an entire keychain of keys and cards from various organizations that allows us to charge for free, so whether it is free depends on which organizations you are a part of", also noting that "I don't think whether it is free of charge or not will be a deciding factor for most people". This is interesting, because most of the other interviewees had highlighted price as highly relevant in terms of which charging station to choose.

She seemed highly sceptical of the proposal of "checking in" and "checking out" of charging stations, saying that the idea was good, but she doubted that people would bother to use it as intended. She also said that the availability of charging station was very important, but that parking your eCar and plugging it into the charger was already a prolonged and complicated process without adding the burden of having to "check in" via an app. She liked the idea of sending push notifications to ask users whether they were charging or not better, as they wouldn't have to open the app and check in on their own initiative. She thought that if we could somehow obtain real time information from the charging stations that it would be great, and suggested that we could use an institution such as the University of Oslo to pilot the project.

As far as the different design options we presented to her, she showed a clear preference for the ones illustrated with icons. She liked the idea of users being able to rate and write comments about the charging stations, but felt it would be more useful if information about which vehicles they were driving were included. She said contact information was a nice inclusion, but didn't much care if we provided pictures of the charging station or not. She also questioned the utility of showing people their charging history, stating "Everyone has an app for that on their phones, don't they?", showing us her own app.

Interviewee 11

The sixth person we interviewed on this iteration of the design process was a man in his late fifties or early sixties. He lives and works in Oslo, but as he has extended family living approximately 125 kilometers away he often drives there on the weekends. He mainly charges his car at home and at work, but he used to have an older car that he sometimes needed to charge along the way on longer routes. When asked if he sometimes finds it challenging to find unoccupied charging points, he responded that it was more difficult with the old car, and that he believed it depended on which part of the country you are in.

He presented to us three challenges he believed had no real solution in terms of eCars: namely updated information about their status in terms whether they are operational or not, whether they are occupied, and whether there is a "charging line". He stated there was no

good source of information of these things, because the services available were “rarely updated”. He also told us that eCars at rapid charging stations usually switch over to more time-consuming charging once their batteries were 80% full, and that there was a need for people to move their cars when they reached this point.

In terms of his motivation for getting an eCar, he stated he was fascinated by the technology behind it, but that he also appreciated the economic and environmental benefits, in addition to the car being very silent. He also listed some negative aspects, namely the limited range, the difficulty in finding charging points now that eCars are becoming more numerous, the fact that he can’t bring a “tilhenger”, and he also lamented that he couldn’t “open it” to actually observe how the motor works in action.

In terms of an ideal application for his eCar needs, he would like to have a good overview of the “status” of the charging points, to see how long the lines were, and also a “system for knowing where you can charge”. He stated that he would like to see charging stations in a bigger radius around the suggested route when planning trips, because he didn’t mind driving off the road in order to get charging, he just needed to know about the charging stations. He would also like to be able to see alternative routes.

In terms of apps, he said he didn’t use many, but upon probing he said he had travel apps (Ruter, NSB, Flytoget, and Google Maps), productive apps (Windows Excel, Windows Word, calendars), social apps (Facebook and email), and also an app that communicated with his eCar to let him see the battery levels of said car.

Because the informant had an upcoming meeting, we decided to only show him the prototypes very quickly. He preferred the menu screen with the labels, stating that many “computer programs” use the same icons for different functionalities. He did however not have any problems recognizing the menu and filtering icons, because “they are standard in most applications”. He also suggested that we might implement a “newbie” version of the app for first-time users in order to get them familiar with the functions in our app. In terms of the charging stations he said he was interested in three things: if they were in order, if they were occupied, and if there was a queue.

He stated that the “hovedveisnettet” outside of Oslo was particularly bad, and even though there are many charging stations, there are long lines on all of them. He would like to have a queue-system to see how many are waiting, and also be able to see alternative charging stations nearby with shorter lines. We told him about our idea of “checking in and out” of charging points and the challenges we were facing, and he agreed that people were unlikely to use this, stating that “when they first get there, they couldn’t care less about everyone else”. He then proposed that we might perhaps be able to utilize the technology in the AutoPASS tag that he says all eCars have, despite being exempt from toll fees. His idea was to somehow use this to compute the status of charging stations, by retrieving the distance from the AutoPASS tag to the phone with the app. The idea was that eCars in line to charge often park in close proximity to the charging stations, but in order to verify whether people are actually in line he agreed that sending simple notifications to users in close proximity was a better idea than requiring them to open the app and manually “check into” the charging station in question. He believed that 85% would answer if they were prompted by the app, because it would play on their conscience.

Interviewee 12

This was a male student in his early thirties. He lives in Oslo, but studies at an institution 30 kilometers outside of the city and commutes there “when he has to”, preferring to utilize local libraries in the capital. He drives a pure eCar, stating that “driving a PHEV is cheating”. He mainly uses his eCar to drive to and from school, and reports seldomly taking his eCar on

longer rides. When probed if he had ever taken the eCar on a lenghty drive, he told us he and his friends occasionally use it to drive over to Sweden on "harrytur" and uses rapid chargers there while shopping. However, he stated he only uses rapid chargers when he "has to".

When asked whether he felt it was difficult to find free charging stations, he responded that it was very hard and frequently required "circling around and looking" for a lengthy period of time. He has driven his eCar for two and a half years and said that he has noticed an increase in charging stations over this time period, but notes that there has also been an increase in the number of eCars, so the problem of finding available charging stations persists. Additionally, he said that the problem is exacerbated because "those stupid PHEVs" also utilize the charging points. He says that recently twelve new charging points were erected less than a hundred meters away from where he lives, so now he mainly charges there, but before these charging points were established he frequently had to park one or even two kilometers away from his residence. He told us that he sometimes also charges at school, especially when it is cold, but that the majority of these charging points had recently been reserved for employees only and that is was extremely difficult for the students there to get available charging.

Even though he knows about the challenges facing eCar owners in terms of charging points, he confessed that he sometimes he leaves his car at a charging point overnight even if he knows it is fully charged by the evening, but added that he "tries to be good" at moving his car and noted that "it is easy to forget to move your car".

When asked what was his motivation for getting an eCar in the first place, he said it was split fifty-fifty between environmental and economic factors. He explained that public transportation was a less than ideal option since he is over 30 and no longer qualifies for the student discount on public transportation, in addition to public transportation to and from his school being much more time-consuming than commuting by eCar. When asked what, if anything, he considered to negative about driving an eCar, he said "everything that has to do with charging unless you have your own private charging point".

We asked which applications or services he used in relation to his eCar usage, to which he responded that he used the app Ladestasjoner.no and the website "Lade i Norge", which he claimed provided an overview of the status all the charging points in Norway (in actuality it only shows the charging stations that have real-time information, as far as we can tell). When asked about any additional apps he used, he said he had many, but used most of them infrequently. The apps he used the most, he told us, were Twitter and Ruter. When asked if he played any games on his phone or otherwise, he responded "no, I don't have time for that".

When asked what he would like in an ideal eCar app, he responded that he would like to be able to reserve charging points ahead of time.

We then showed him our prototypes. He preferred the one that had the menu sliding in from the side, noting that the menu reminded him of Fortum's Charge & Drive's menu. He had no problems understanding the "filtering" icon. We asked him whether he thought user rating of charging stations would influence his choice of which to utilize, whereupon he responded "maybe, because a lot of them are out of order or not working correctly". He liked the idea of being able to filter which charging stations appeared on the map by their connector type, but questioned the number of options and whether anyone used the latter ones included, stating that his car is compatible with "Type 2" connectors and that it is "less hassle" to have a standardized plug. He was unsure of the utility of filtering according to the company responsible for maintaining even though he himself subscribe to both Fortum and Grønn Kontakt. He stated "everyone has their own RFID or whatever its called", and noted "Yes, I guess that is a thing some might want". On the topic of operators, he said "some are not as good, you have your favorites".

When we showed him the likes-functionality, he suggested having comments. We then told him we had prototypes for a comment functionality and showed him these. He thought the idea of being able to rate charging stations in terms of queue and price, and said he would like for the comments to be dated so that he could tell whether the problems described within the comments were recent.

When shown the prototypes for the charging stations themselves we explained the idea of "checking into" charging stations, to which he responded "that's a pretty smart idea, being able to see who are there and if they are charging". We explained the idea of getting notification on your phone based on your GPS location as an alternative to having to check in through opening the app, which he also thought was a good idea, but warned us against letting the app "nag" too much as this would increase the risk of the users just deleting it. As far as privacy, he wasn't concerned, and stated "I just let apps have access to whatever they want".

When shown the prototypes for more information, he said that the information about the number of different plugs, their effect, etc. was the most relevant for him, followed by the information about pricing and such. He also showed a clear preference for the prototypes with icons, stating "I'm very fond of icons", but he also pointed out that the icons for "real-time information" and "time restrictions" did not communicate clearly what they entailed.

On the topic of gamification, he said "Hmm… Maybe more fun than useful", and stated that it was "maybe a good idea". He suggested that we ally ourselves with one of the charging point operators so that we would be able to offer physical rather than virtual rewards, such as charging for free for a limited amount of time.

On the idea of being able to reserve charging points through the app, he admitted that it would not be feasible to do this for all charging stations countrywide, but suggested we might try it for a privately owned charging station such as the one at his school. He also suggested to add functionality for renting out your private charging stations, something we had stopped asking interviewees about after receiving almost solely negative feedback on earlier reviews. We told him about these interviewee's concerns in regard to letting strangers into their private garages, and he clarified that he meant those who had private "street parking" spots with charging capabilities.

Appendix E: Interview Material

Appendix E.1 Attributes from nobil

- **Fastmontert kabel**: Ja/Nei
- **Reserverbart**: Ja/Nei
- **Parkeringsavgift:** Ja/Nei
- **Tidsbegrensning:** Ja/Nei
- **Åpent 24t i døgnet:** Ja/Nei
- **Sanntidsinformasjon:** Ja/Nei
- **Hurtiglader:** Ja/Nei
- **Type lokalasjon:** F.eks Gate, Parkeringshus, Flyplass, Kjøpesenter, Transport-hub, Hotel og restauranter, bensinstasjon
- **Tilgjengelighet:** Offentlig, Besøkende, Ansatte, Ved avtale, Beboende
- **Offentlig finansiert**: Oslo kommune, Transnova, Andre, Ingen,
- **Tilgjengelighet:** Åpen, Standard nøkkel, andre, RFID, betaling, Mobilbetaling
- **Ladekapasitet:** i.e. (3.6kW-230V 1-phase max 16A)..(11kW - 400V 3-phase max 16A) 230V 3-phase max 16A, 230V 3-phase max 32A ..
- **Ladeplugg**: f.eks: Schuko, Type 1, Type 2, Blue industrial 3-pin, Blue industrial 4-pin,
- **Betalingsmetode:** F.eks Mobilbetaling, Visa og mastercard,american express, dinars, andre kort, abonnement, mynt, diverse kort, mobilbetaling og ladekort, visa, mastercard og ladekort.
- **Kjøretøy**: Alle kjøretøy, korte kjøretøy, mopeder, elektriske sykler.

Appendix E.2 First interview guide

Start med å forklar hva målet med intervjuet er og hva vi skal bruke dataen til. Snakk også litt om appen.

Generelle spørsmål:

- I hvilken bydel bor du?
- I hvilken bydel jobber du?

El-bil spørsmål:

- Kjører du hybrid eller ren elbil?

Indre motivasjon:

- Hvorfor kjører du elbil
    - Hva er positivt ved å kjøre elbil?
    - Hva er negativt ved å kjøre elbil?

Vaner:

- Hvor ofte kjører du elbil? (hvor mange dager i uken/hvor mange timer til dagen, også i helgene?)
- Hvor pleier du da å parkere din elbil? (Til hverdags?)
    - Om hybrideiere/elbileiere parkerer på ladepunkter
    - Spørsmål om ladesituasjonen hjemme
- Hvor lang tid tar det å gå til og fra ladestasjon på jobb (Hvis de lader på jobb).
- Hvordan opplever du det å finne ledige ladepunkter i Oslo?
- Opplever du noen gang at ingen ladepunkter er tilgjengelige når du kommer på jobb/eventuelt når du skal parkere andre plasser? (I såfall ja: Hvorfor tror du det er slik.)
- Utgjør det å potensielt ikke finne ledige ladepunkter et bekymringsmoment i din hverdag? (ikke like skummelt for hybridbiler)
- Har bilen din noensinne blitt helt utladet? (For el-biler er det katastrofe, for hybrider er det ikke krise - trenger ikke spørre om det til de.)
- Hvor lenge pleier du å la bilen stå parkert på et ladepunkt av gangen?
- Hvor lang tid tar det for din elbil å bli ferdig oppladet på en vanlig dag på den ladestasjonen du pleier å parkere på?
- Pleier du å flytte elbilen din etter noen timer/når den er ferdig oppladet?
    - Hvorfor/hvorfor ikke?
- Kjenner du andre elbileiere?
    - I såfall: Hvor godt kjenner du de (personlig eller bare gjennom facebook f.eks). Hvor mange (Om det er en gruppe, flere i familien eller bare en venn/kollega).
- Hva er avgjørende for deg når du skal velge ladestasjon?
- Vi har ulike data som vi har hentet ut for de ulike ladestasjonene. Hvilke av disse ville vært interessante for deg dersom du skulle funnet en ladestasjon i nærheten? (Vise metadataark).

Motivasjon/engasjement

- Bruker du noen apper eller andre tjenester i forbindelse med din elbilbruk?
    - Hva bruker du disse appene til?
- Hva slags apper har du ellers/hva slags apper bruker du mest?
    - Hvorfor velger du å bruke akkurat disse appene?
- Spiller du noen spill av noe slag (dataspill, brettspill, mobilspill)?
    - Hva syns du er engasjerende/morsomt å gjøre i spillet?

Spørsmål om appens funksjonalitet.

- Hvis en elbilapplikasjon skulle tilfredstille alle dine elbilbehov, hvilke funksjoner burde den da ha?
- Forklar litt om gamification.
    - Synes dere dette virker interessant?
    - Føler du deg motivert av å se at du er høyere oppe enn andre på poengtavler og lignende?
    - Få poeng
- Hva synes du om:
    - Innsjekking på ladestasjon
    - Sende ladeplassforespørsler dersom det er fullt
    - Å følge ladestasjoner du bruker ofte for å få notification
    - Laste opp bilder av ladestasjoner
    - Chatte-system med andre brukere
    - Kommentarer/diskusjoner om ladestasjonene
    - Vennesystem, hvor du f.eks. Kan legge til kolleger/naboer som også kjører elbil
    - Private meldinger hvor du kan spørre andre elbileiere om å flytte bilene
    - Forum
    - Roller, hvor de mest aktive brukerne kan laste opp nye ladestasjoner/moderere siden/redigere informasjon om ladestasjoner
    - Laste opp egne ladestasjoner når man f.eks. er på jobb slik at andre kan bruke dem
    - Legge inn egen biltype/kontakttype og bare få oversikt over de ladeplassene som er kompatible med din bil.
    - Laste opp bilde av egen bil
    - Mulighet til å koble inn andre sosiale medier (Facebook/Twitter) for å dele informasjon/invitere andre til å bruke appen, osv.
    - Oversikt over alle byene du har vært i/ladestasjonene du har brukt
    - Få achievements for å besøke ulike steder

Prototyping

I forbindelse med utviklingen av appen har vi laget en prototype av hvordan vi ser for oss at den vil se ut og fungere når den er ferdig utviklet.

- Hvilke av disse filtreringsmulighetene synes du er best? (Og hvorfor?)
- Hvilken av disse alternativene for å se mer info synes du er best (Og hvorfor)?
- Hvilken av disse måtene å søke etter andre brukere (venner/kolleger) synes du er best? (Og hvorfor?)
- Er det noe du savner i forhold til funksjonene, f.eks. i (hamburger)menyen?
- Er det noe du synes er overflødig, eller noe du ikke kunne tenkt deg å bruke selv?
- Hva synes du om fargevalgene?
- Hva tenker du om muligheten til å sende ladeforespørsler til andre elbilbrukere når du har behov for å lade bilen din?
- Hva tenker du om muligheten til å se om mange har sendt ladeforespørsler til en ladestasjon (dvs. Om det er lang kø for å få ladet på en stasjon)?
- Hva var bra?
- Hva kan gjøres bedre?

Appendix E.3 Second interview guide

Generelle spørsmål:

- Bosted?
- Hvor jobber du?

El-bil spørsmål:

- Kjører du hybrid eller ren elbil? - Hvorfor?
- Hvor lader du og parkerer elbilen?
- Hvor lang tid tar det for deg å lade bilen? (ikke hurtiglader)
- Hvor lang tid tar det for deg å gå til bilen fra der du pleier å lade?
- Pleier du å flytte bilen?
- Syns du det er vanskelig å finne ledige ladestasjoner?
- Hvorfor kjører du elbil?
    - Hva er positivt ved å kjøre elbil?
    - Hva er negativt ved å kjøre elbil?

Motivasjon/engasjement

- Bruker du noen apper eller andre tjenester i forbindelse med din elbilbruk?
    - Hva bruker du disse appene til?
- Hva slags apper har du ellers/hva slags apper bruker du mest?
    - Hvorfor velger du å bruke akkurat disse appene?
- Spiller du noen spill av noe slag (dataspill, brettspill, mobilspill)?
    - Hva syns du er engasjerende/morsomt å gjøre i spillet?

Finne ladestasjoner

- Hva er avgjørende for deg når du skal velge ladestasjon?
- Hva ønsker du fra en elbilapp?

Vise fram prototypene og stille spørsmål.
Understreke at vi ikke blir fornærmet hvis de ikke liker noe.

Søk og veivisning

- Har du et behov for å se alternative ruter
- Har du behov for å øke radiusen? (km). Med slider.
- Fargevalg? Burde alt være ulike nyanser av grønt, eller er farger spennende? - Prototype en i grønn og en lilla
- Andre innspill?

Filter

- Er filterikonet forståelig? Burde det vært tekst i tillegg?
- Er det noen av disse filtreringsmulighetene som er interessante/uinteressante?
- Er andres oppfatninger av en ladestasjon noe du tror kan påvirke deg til å bruke den/ikke bruke den?

    - Burde dette være i form av likes, thumbs up, eller en beregnet score.
- Burde valg av plugg gjøres i registreringen (i stedet for å velge i filter)?
- Burde ting du velger i filtreringen gjelde alltid (som innstillinger) eller justeres etter behov fra gang til gang?

Oversiktskart - info window

- Er det noe mer info du savner her?
    - Likes i infovindu, i stasjonssida eller ikke i det hele tatt?

Informasjon om ladestasjonen.

- Hva er viktigst av informasjonen om ladestasjonen?
- Ulike måter å presentere informasjon om: tekstlig eller ikoner?
    - Burde ikonene evt. ha forklaring/hjelpetekst?
- Legge til bilder/se bilder av ladestasjonene?

Kommentarer, ladeforespørsler og innsjekk

- Greit at det er bilde av de som er sjekket inn eller står i kø, eller best med bare antall?
- Tabs øverst - forståelige, eller ville en annen løsning vært bedre? (eks. Scrolle nedover)
- Innsjekk og utsjekk
    - Hva syns du om funksjonen.
    - Evt. andre forslag?
    - Hvordan burde notifiseringen fungere, før og etter eller kun før?
- Ville du skrevet kommentarer?
    - Ville du f.eks. skrevet inn om ladestasjonen var i ustand?
    - Hva med å rangere ladestasjoner på pris og kø
- Er andres kommentarer om en ladestasjon noe du tror kan påvirke deg til å bruke den/ikke bruke den?
    - Hva med å være i stand til å se andres rangeringer av pris og kø?

Profil

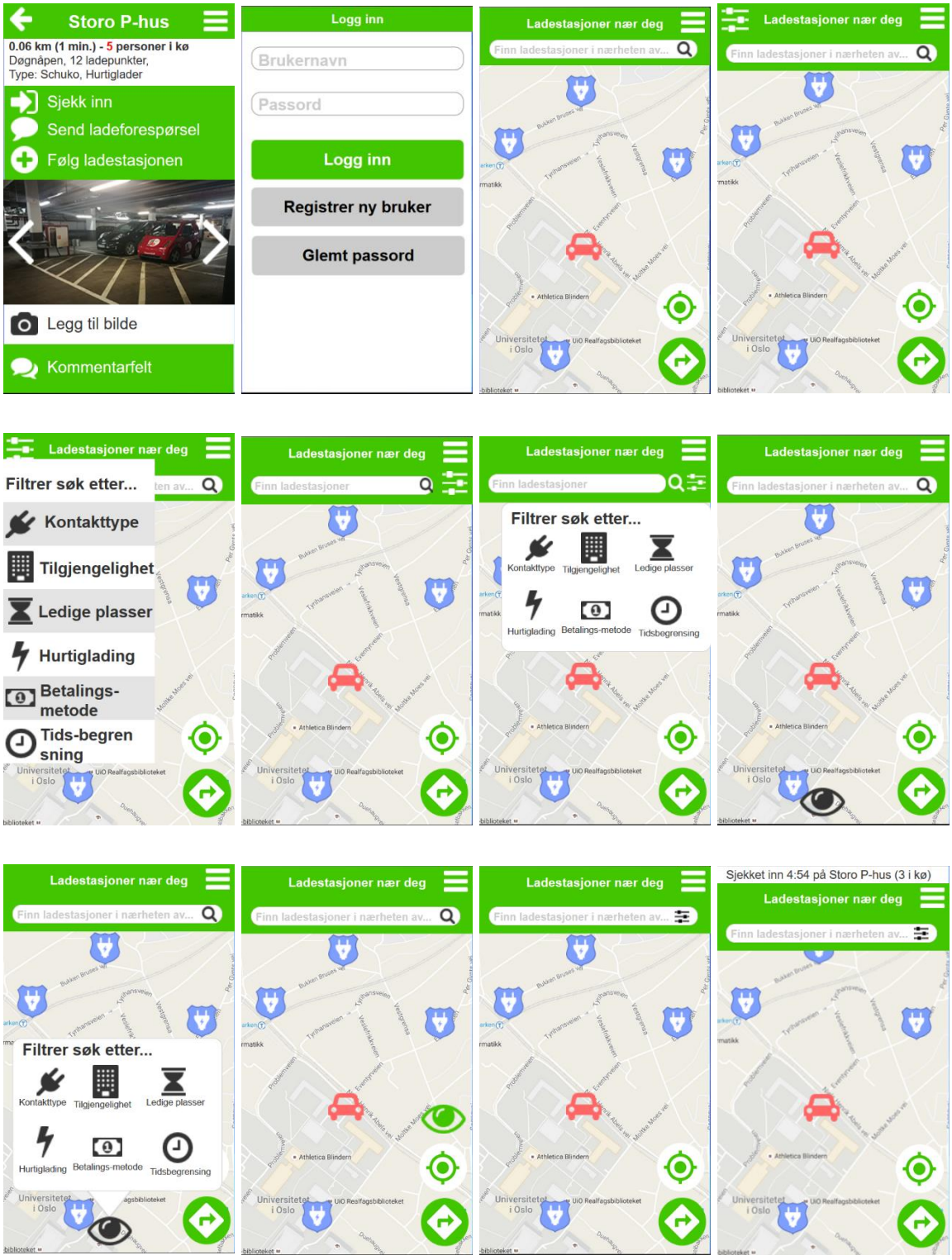
- Hva syns du om ranks?
- Ladepunktshistorikk - liste eller kart - interessant?
- Nødvendig å legge inn en eller flere elbiler, med informasjon?
- Offentlig eller lukket profil?
- Finne venner og kolleger gjennom appen eller importere fra Facebook?
- Noe annet som burde være med i en profil?
- Innstillinger gjemt i profilen eller bytte ut “hjelp”-knappen på nederste linje?
- Legge til egen ladestasjon?
- Gamification - belønninger for å gjøre ting i appen. Har du kommet over dette i andre apper og blitt engasjert?

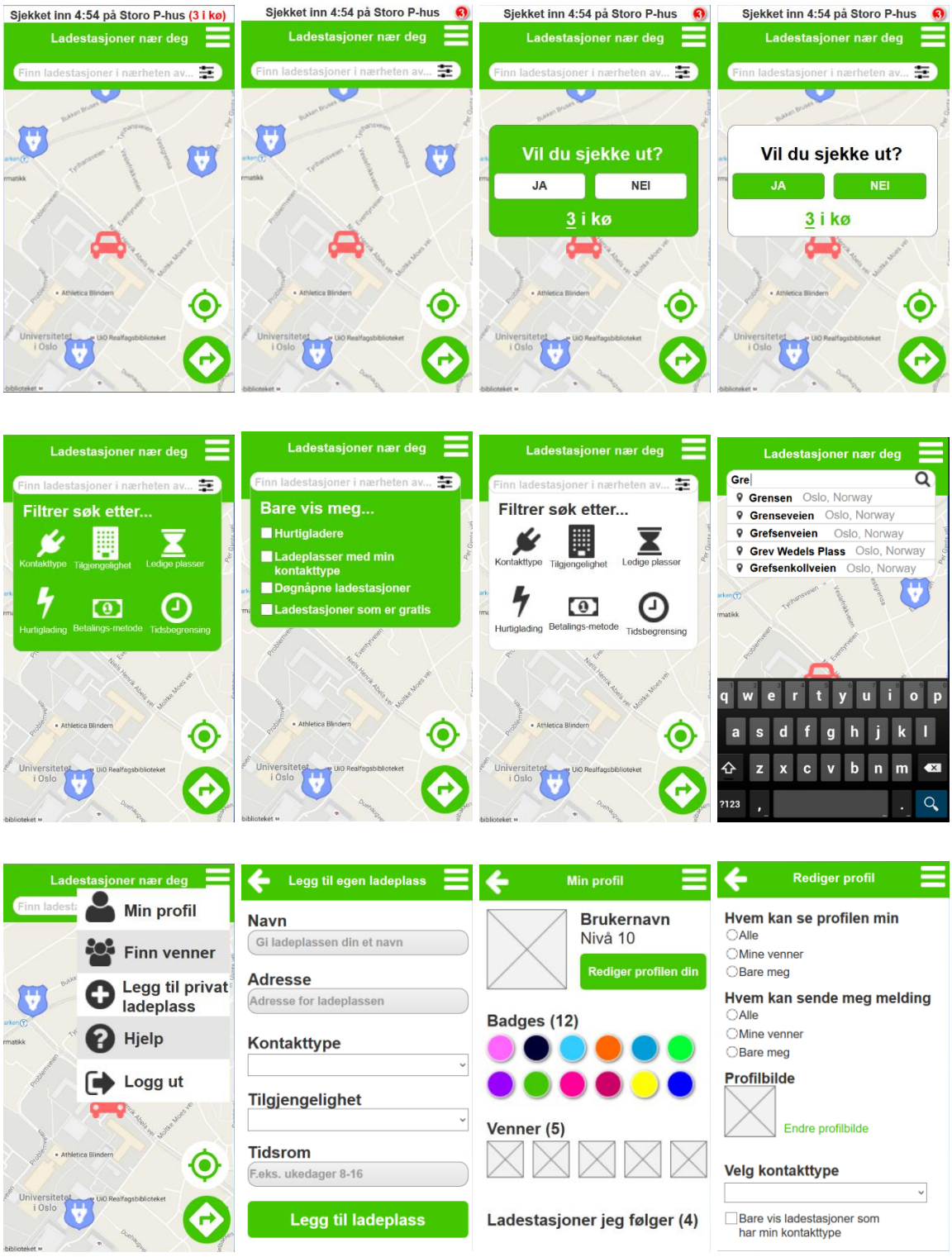
    - Belønninger for å hjelpe andre
    - Kvalitetssikring ved å kun la folk som har brukt appen litt (gått opp i level) får lov å legge inn kommentarer/rate/osv.
    - Begrensninger for lade forespørsler hvis du aldri sjekker inn og ut?

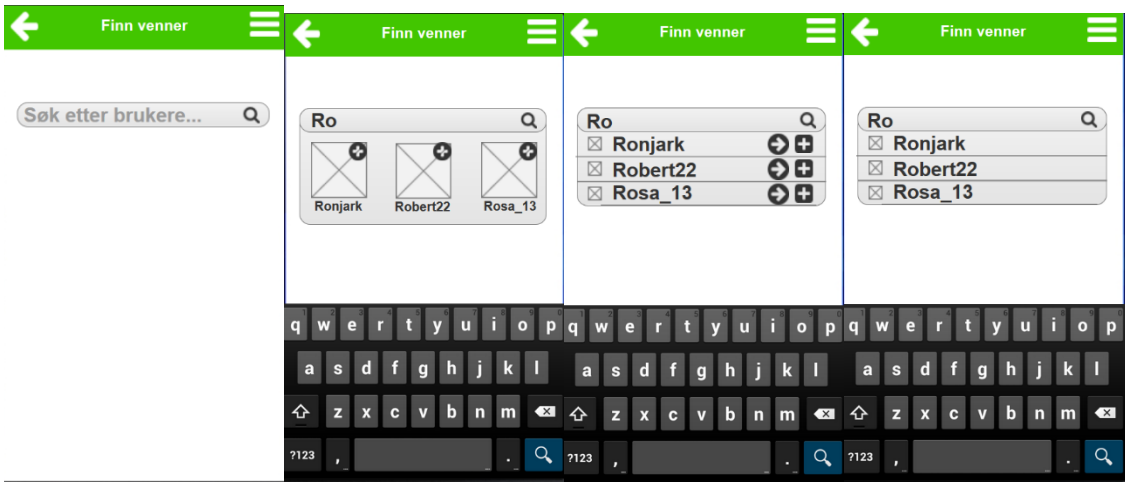
Generelt til slutt

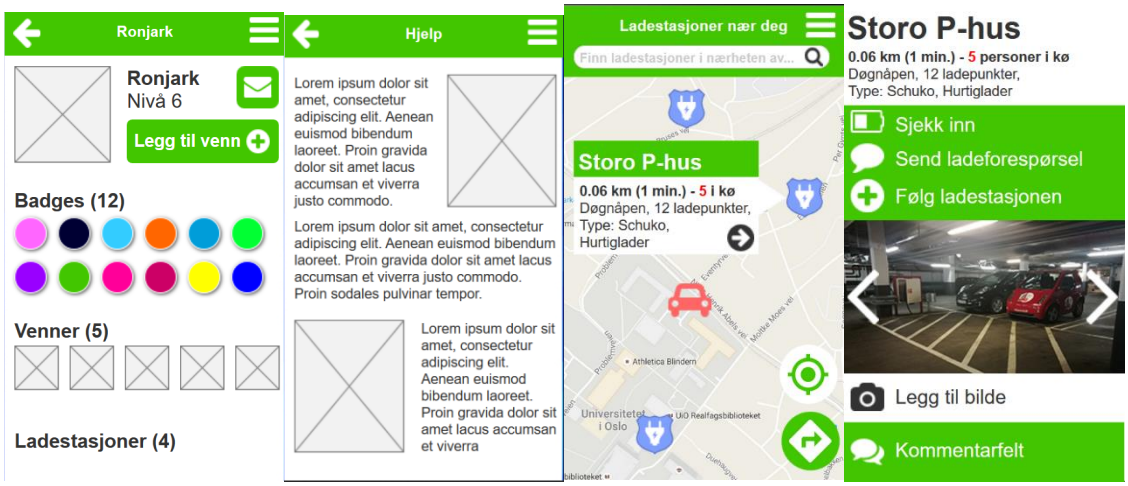
- Noe du ikke tror du ville brukt/ha bruk for?
- Helhetsinntrykket? Noe du ville brukt?
- Oversikt over alle byene du har vært i/ladestasjonene du har brukt
- Få achievements for å besøke ulike steder

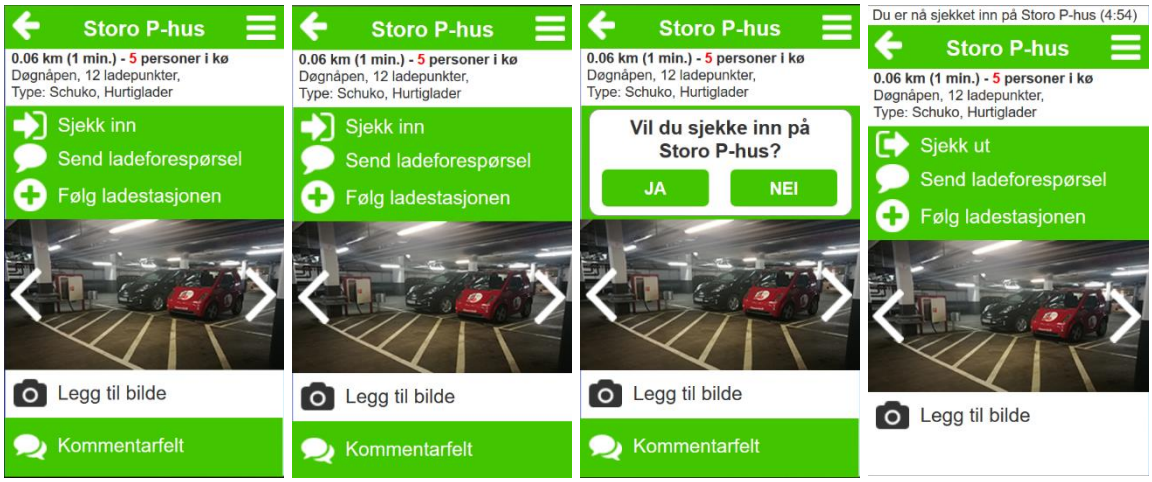
Appendix E.4 First prototype round

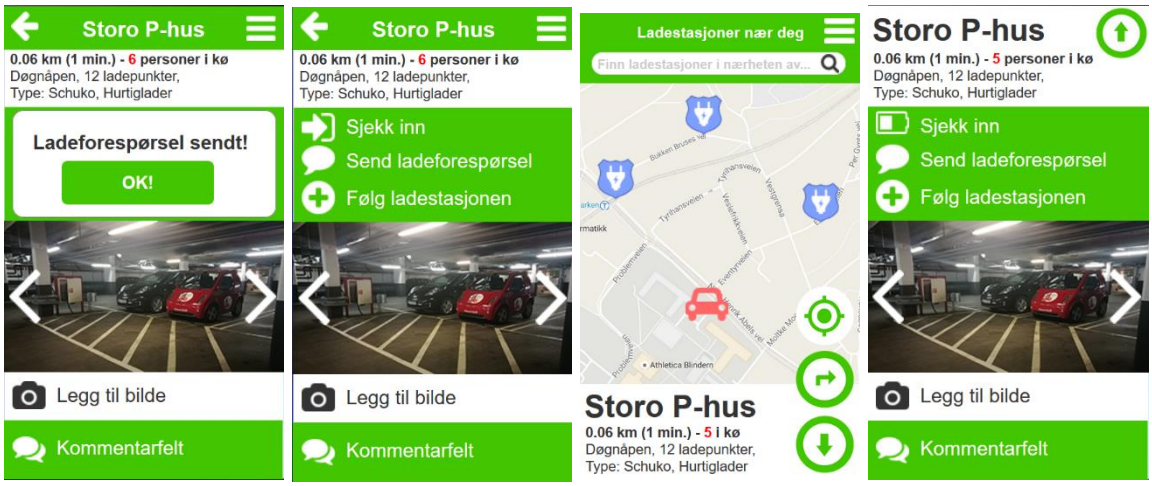



Sjekket inn 4:54 på Storo P-hus (3 i kø)
Sjekket inn 4:54 på Storo P-hus
Sjekket inn 4:54 på Storo P-hus
Sjekket inn 4:54 på Storo P-hus
Ladestasjoner nær deg
Finn ladestasjoner i nærheten av...
Vil du sjekke ut?
JA
NEI
3 i kø
Filtrer søk etter...
Kontakttype
Tilgjengelighet
Ledige plasser
Hurtiglading
Betalings-metode
Tidsbegrensing
Bare vis meg...
Hurtigladere
Ladeplasser med min kontakttype
Døgnåpne ladestasjoner
Ladestasjoner som er gratis
Gre
Grensen Oslo, Norway
Grenseveien Oslo, Norway
Grefsenveien Oslo, Norway
Grev Wedels Plass Oslo, Norway
Grefsenkollveien Oslo, Norway
Min profil
Finn venner
Legg til privat ladeplass
Hjelp
Logg ut
Legg til egen ladeplass
Navn
Gi ladeplassen din et navn
Adresse
Adresse for ladeplassen
Kontakttype
Tilgjengelighet
Tidsrom
F.eks. ukedager 8-16
Legg til ladeplass
Brukernavn
Nivå 10
Rediger profilen din
Badges (12)
Venner (5)
Ladestasjoner jeg følger (4)
Rediger profil
Hvem kan se profilen min
Alle
Mine venner
Bare meg
Hvem kan sende meg melding
Alle
Mine venner
Bare meg
Profilbilde
Endre profilbilde
Velg kontakttype
Bare vis ladestasjoner som har min kontakttype

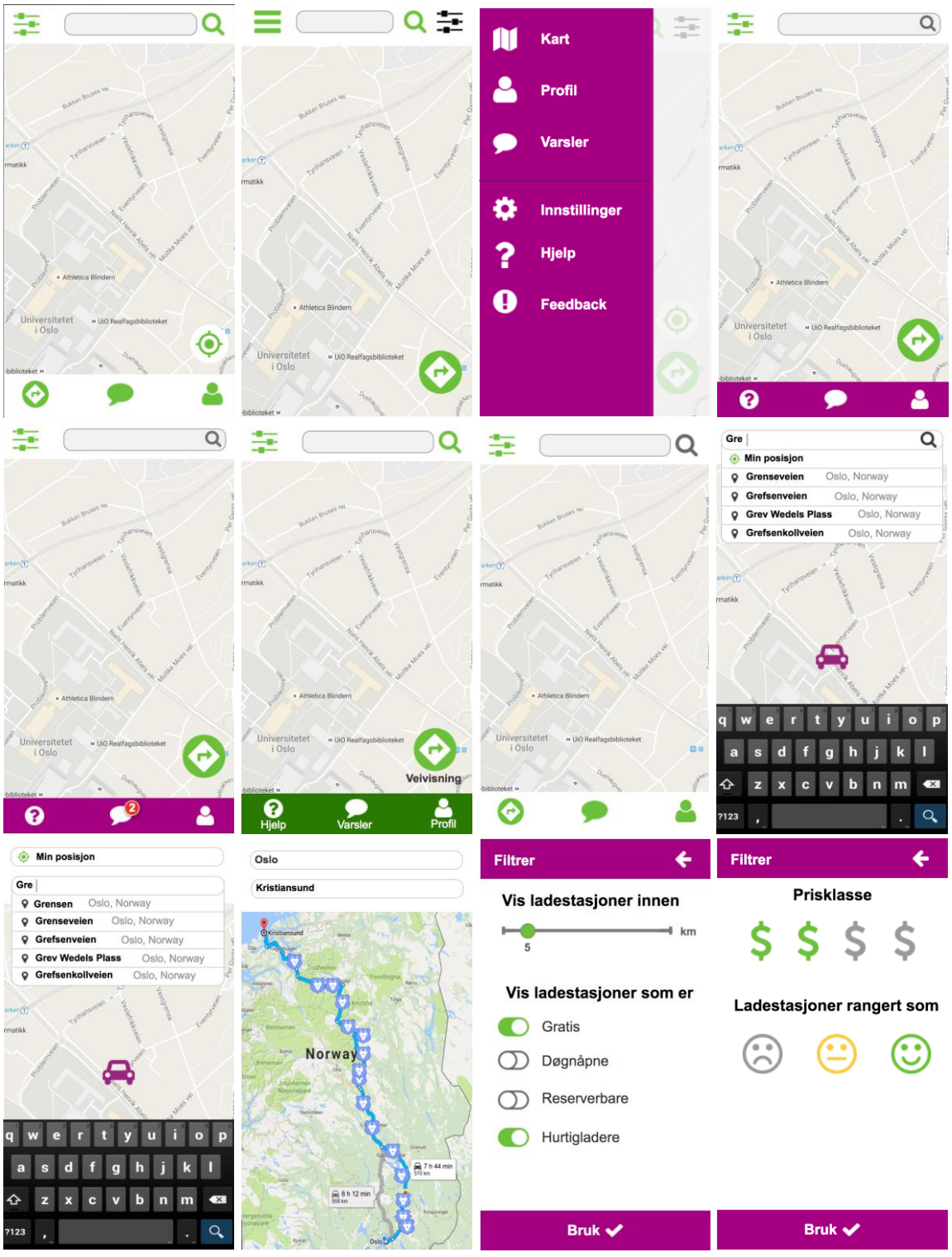

Finn venner
Søk etter brukere...
Ro
Ronjark
Robert22
Rosa_13

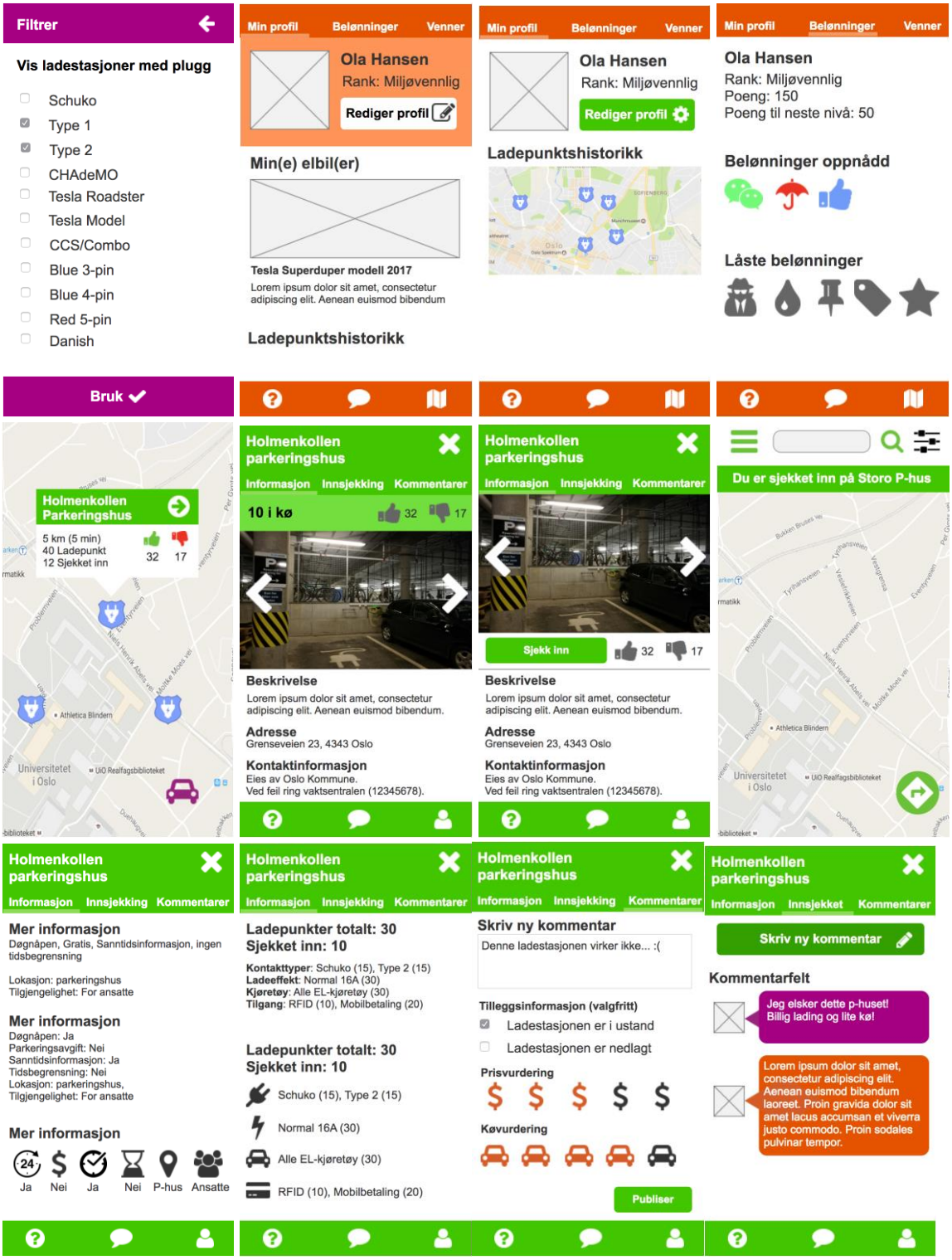

Ronjark
Ronjark
Nivå 6
Legg til venn
Badges (12)
Venner (5)
Ladestasjoner (4)
Hjelp
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean euismod bibendum laoreet. Proin gravida dolor sit amet lacus accumsan et viverra justo commodo.
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean euismod bibendum laoreet. Proin gravida dolor sit amet lacus accumsan et viverra justo commodo. Proin sodales pulvinar tempor.
Ladestasjoner nær deg
Finn ladestasjoner i nærheten av...
Storo P-hus
0.06 km (1 min.) - 5 i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Storo P-hus
0.06 km (1 min.) - 5 personer i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Sjekk inn
Send ladeforespørsel
Følg ladestasjonen
Legg til bilde
Kommentarfelt

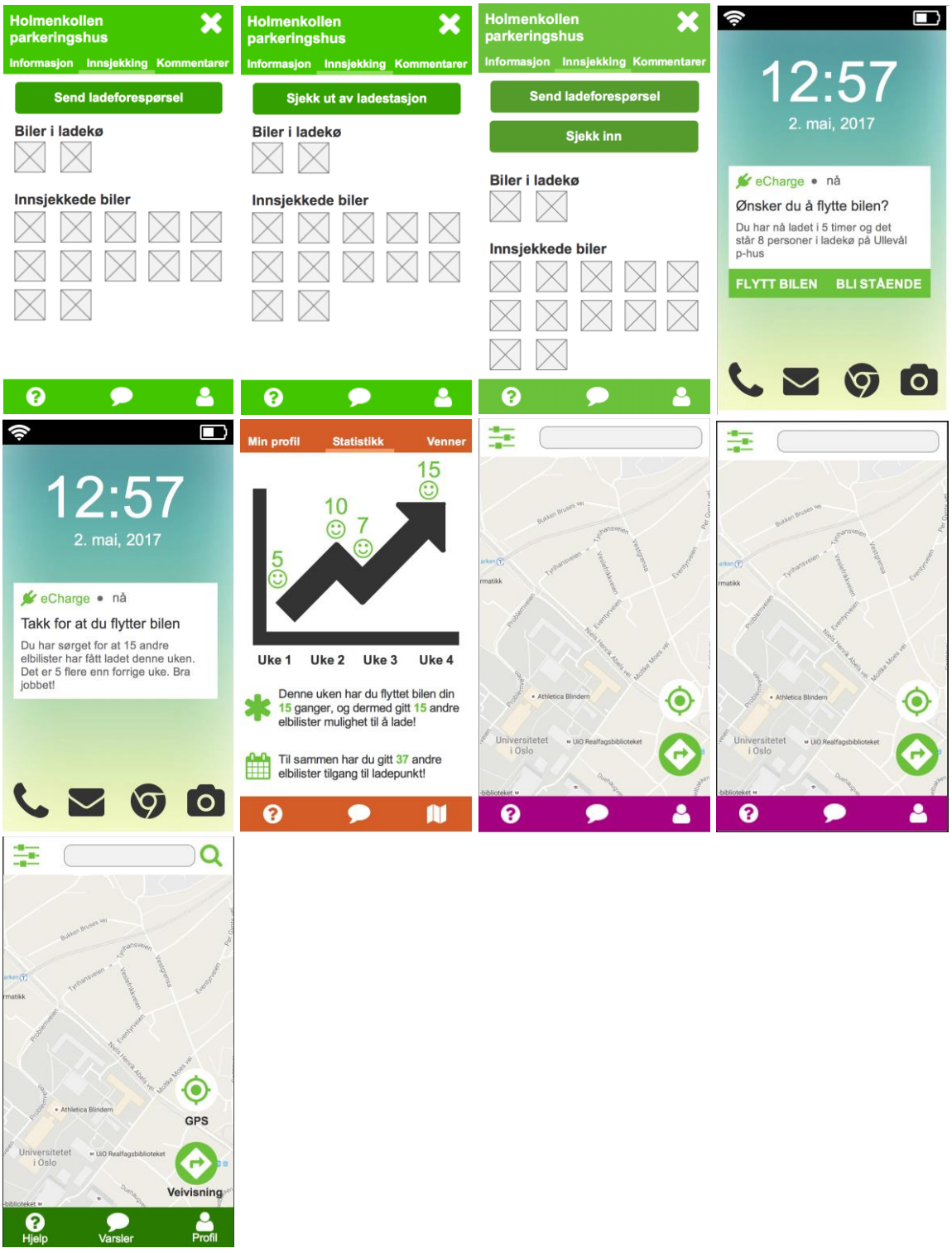

Storo P-hus
0.06 km (1 min.) - 5 personer i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Sjekk inn
Send ladeforespørsel
Følg ladestasjonen
Legg til bilde
Kommentarfelt
Vil du sjekke inn på Storo P-hus?
JA
NEI
Du er nå sjekket inn på Storo P-hus (4:54)
Sjekk ut


Storo P-hus
0.06 km (1 min.) - 6 personer i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Ladeforespørsel sendt!
OK!
Legg til bilde
Kommentarfelt
Storo P-hus
0.06 km (1 min.) - 6 personer i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Sjekk inn
Send ladeforespørsel
Følg ladestasjonen
Legg til bilde
Kommentarfelt
Ladestasjoner nær deg
Finn ladestasjoner i nærheten av...
Storo P-hus
0.06 km (1 min.) - 5 i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Storo P-hus
0.06 km (1 min.) - 5 personer i kø
Døgnåpen, 12 ladepunkter,
Type: Schuko, Hurtiglader
Sjekk inn
Send ladeforespørsel
Følg ladestasjonen
Legg til bilde
Kommentarfelt

Appendix E.5 Second prototype round




Filtrer
Vis ladestasjoner med plugg
Schuko
Type 1
Type 2
CHAdeMO
Tesla Roadster
Tesla Model
CCS/Combo
Blue 3-pin
Blue 4-pin
Red 5-pin
Danish
Min profil
Belønninger
Venner
Ola Hansen
Rank: Miljøvennlig
Rediger profil
Min(e) elbil(er)
Tesla Superduper modell 2017
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean euismod bibendum
Ladepunktshistorikk
Rediger profil
Ola Hansen
Rank: Miljøvennlig
Poeng: 150
Poeng til neste nivå: 50
Belønninger oppnådd
Låste belønninger
Bruk
Holmenkollen Parkeringshus
5 km (5 min)
40 Ladepunkt
12 Sjekket inn
32
17
Holmenkollen parkeringshus
Informasjon
Innsjekking
Kommentarer
10 i kø
32
17
Beskrivelse
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean euismod bibendum.
Adresse
Grenseveien 23, 4343 Oslo
Kontaktinformasjon
Eies av Oslo Kommune.
Ved feil ring vaktsentralen (12345678).
Sjekk inn
Du er sjekket inn på Storo P-hus
Mer informasjon
Døgnåpen, Gratis, Sanntidsinformasjon, ingen tidsbegrensning
Lokasjon: parkeringshus
Tilgjengelighet: For ansatte
Mer informasjon
Døgnåpen: Ja
Parkeringsavgift: Nei
Sanntidsinformasjon: Ja
Tidsbegrensning: Nei
Lokasjon: parkeringshus,
Tilgjengelighet: For ansatte
Mer informasjon
Ja
Nei
Ja
Nei
P-hus
Ansatte
Ladepunkter totalt: 30
Sjekket inn: 10
Kontakttyper: Schuko (15), Type 2 (15)
Ladeeffekt: Normal 16A (30)
Kjøretøy: Alle EL-kjøretøy (30)
Tilgang: RFID (10), Mobilbetaling (20)
Ladepunkter totalt: 30
Sjekket inn: 10
Schuko (15), Type 2 (15)
Normal 16A (30)
Alle EL-kjøretøy (30)
RFID (10), Mobilbetaling (20)
Skriv ny kommentar
Denne ladestasjonen virker ikke... :(
Tilleggsinformasjon (valgfritt)
Ladestasjonen er i ustand
Ladestasjonen er nedlagt
Prisvurdering
Køvurdering
Publiser
Innsjekket
Skriv ny kommentar
Kommentarfelt
Jeg elsker dette p-huset! Billig lading og lite kø!
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean euismod bibendum laoreet. Proin gravida dolor sit amet lacus accumsan et viverra justo commodo. Proin sodales pulvinar tempor.


Holmenkollen parkeringshus
Informasjon Innsjekking Kommentarer
Send ladeforespørsel
Biler i ladekø
Innsjekkede biler
Holmenkollen parkeringshus
Informasjon Innsjekking Kommentarer
Sjekk ut av ladestasjon
Biler i ladekø
Innsjekkede biler
Holmenkollen parkeringshus
Informasjon Innsjekking Kommentarer
Send ladeforespørsel
Sjekk inn
Biler i ladekø
Innsjekkede biler
12:57
2. mai, 2017
eCharge • nå
Ønsker du å flytte bilen?
Du har nå ladet i 5 timer og det står 8 personer i ladekø på Ullevål p-hus
FLYTT BILEN
BLI STÅENDE
12:57
2. mai, 2017
eCharge • nå
Takk for at du flytter bilen
Du har sørget for at 15 andre elbilister har fått ladet denne uken. Det er 5 flere enn forrige uke. Bra jobbet!
Min profil
Statistikk
Venner
15
10
7
5
Uke 1
Uke 2
Uke 3
Uke 4
Denne uken har du flyttet bilen din 15 ganger, og dermed gitt 15 andre elbilister mulighet til å lade!
Til sammen har du gitt 37 andre elbilister tilgang til ladepunkt!
GPS
Veivisning
Hjelp
Varsler
Profil

Appendix E.6 Interview Guide

Forespørsel om deltakelse i intervju om elbilbruk

Vi er to studenter som studerer ved masterprogrammet "Informatikk: Design, bruk og Interaksjon" på Institutt for Informatikk ved Universitetet i Oslo. I forbindelse med vår masteroppgave jobber vi med å utvikle en smarttelefonapplikasjon for elbilister, og ønsker i denne forbindelse et dypere innblikk i elbileieres hverdag.

En del av vår forskning går ut på å undersøke hvordan man gjennom teknologi kan motivere mennesker til å ta mer bærekraftige valg, og vi ønsker derfor å stille deg noen spørsmål om din elbilbruk og hva du finner motiverende generelt. For å illustrere ulike tenkte funksjoner i appen har vi utviklet flere prototyper som vi gjerne vil bruke som grunnlag for diskusjoner rundt behov og preferanser i løpet av intervjuet.

Intervjuet vil ikke vare lenger enn én time. Vi vil ta skriftlige notater underveis, som i ettertid vil oppbevares konfidensielt og kun bli brukt i forbindelse med vårt prosjekt. Vi registrerer ikke personopplysninger og kommer ikke til å publisere informasjon i masteroppgaven som i ettertid kan spores tilbake til deltakerne. Intervjuet er frivillig, og du kan når som helst trekke ditt samtykke uten å oppgi årsak. Dersom du i etterkant har spørsmål om prosjektet kan du kontakte Ronja Knudtsen (455 16 248), Ida Lothe (924 08 326) eller vår veileder Gisle Hannemyr (gisle@ifi.uio.no).

Jeg har mottatt informasjon om prosjektet, og er villig til å delta på intervju.

_____

Sted: _____ Dato: _____

Appendix F: Raw Data

C.3 Document analysis

Raw data from document analysis coding, coder1:
https://github.com/RonjaKnudtsen/eCharge-Masterfiles/blob/master/Document_analysis_C1.xlsx

Raw data from document analysis coding, coder2:
https://github.com/RonjaKnudtsen/eCharge-Masterfiles/blob/master/Document_analysis_C2.xlsx

C.4 Questionnaire results

Raw data from questionnaire results.
https://github.com/RonjaKnudtsen/eCharge-Masterfiles/blob/master/Questionnaire_results.xlsx