

DH2465 - Park&Charge - Group 10

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Contents

1 Executive Summary	4
2 Introduction	5
3 Problem Statement and Delimitations	5
4 Park&Charge	6
5 Background and Previous Research	7
5.1 Market	7
5.1.1 Current Players	7
5.1.2 Market overview	8
5.1.3 Current Chargeable Parking Alternatives in SRS	9
5.1.4 Market Sizing	9
5.2 Competitive Landscape	12
5.2.1 Competitive edges of Park&Charge	12
5.2.2 Potential weaknesses of Park&Charge	12
6 Description of the Study and its Results	13
6.1 Stakeholders	13
6.1.1 Stockholms Stad	13
6.1.2 Competitors – ApParkingSpot, Pavemint and Wace	13
6.1.3 SRS Electric Car Owners	14
6.1.4 Electric Car Owners visiting SRS	14
6.1.5 Car Owner In the same Garage	14
6.1.6 Q-park and Stockholm Parkering - Fredrik Söderholm	14
6.1.7 Fortum and Vattenfall	15
6.1.8 Garo	15
6.1.9 Energimyndigheten – Klimatklivet	16
6.1.10 Car pools - aimo, Bilpoolen.nu and M.co	16
6.2 Understanding the target group	17
6.2.1 Field study in SRS	17
6.2.2 Survey 1 - Getting to know the target group	17
6.3 Accessing the garages	19
6.3.1 Stockholm Parkering	19
6.3.2 Q-Park	20
6.3.3 Instabox	20
6.3.4 Access via QR-codes	20
6.4 Supply and Demand of Garage Parking Spots with Charging Stations in SRS	21
6.4.1 Supply of Charging Stations in SRS	21
6.4.2 Utilization rate of parking spots in SRS	22
6.4.3 Supply Limitations in garages	22
6.5 Design Process of The App	23
6.5.1 Discover	23
6.5.2 Define	23
6.5.3 Develop	24
6.5.4 Deliver	25
6.6 Technical implementation of the App	30
6.6.1 BuilderX	30
6.6.2 React Native	30

6.6.3	Expo	31
6.7	Business Plan	31
6.7.1	What is Park&Charge?	32
6.7.2	Experience and Skills	32
6.7.3	Business Model and Pricing	32
6.7.4	Customer Insights	33
6.7.5	Risks	33
6.7.6	Opportunities	33
6.7.7	Financial Forecast	34
7	Discussion	34
7.1	Surveys	34
7.2	Usability Testing	35
7.3	Concerns regarding Stockholm Parkering	35
8	The way forward	35
A	The App	38
A.1	The Introduction Slides	38
A.2	Sign in	39
A.3	Parking Screen	40
A.4	Renting Out a Parking Spot	41
A.5	Miljohalte	42
A.6	Profile screen	43
A.7	Database	44
B	Marketing Strategy	45
C	Private Housing Association Garages with Charging Stations	45
D	Usability Testing	46
E	Target group survey	48
F	Pricing Survey	52

1 Executive Summary

Park&Charge is a high-fidelity prototype application built and designed by us, 5 KTH students, to showcase a sharing economy solution to target the lack of charging stations for electric vehicles (EV) in Stockholm. This problem was presented to us by Stockholms Stad during early fall 2019. Since then we have designed, tested, prototyped and built a solution to said problem. Our final product has been developed based on feedback and assistance through surveys, interviews and usability testing involving many different types of expertise and perspectives. This report has been written to describe exactly what we have done as well as how and why we have done it. The report starts off by discussing the overall problem and quickly describes our solution to said problem. It then delves deeper into the context of the problem, the market in which it exists and the actors within said market. The report then proceeds to thoroughly discuss the key stakeholders, the target group, the design process and the technical implementation of that design. Thereafter the report describes the business plan of how our application would fare on the marketplace before discussing a set of key issues further. Finally, we present the way forward - what should come next.

To read more about Park&Charge we recommend that you take a look at our website:

- <https://parkandcharge.wordpress.com/>

As well as our GitHub Repository:

- <https://github.com/alexandrahotti/Park-and-charge>

2 Introduction

In the next ten years, the charging energy demand for electric vehicles (EV) in Europe is expected to grow by almost 200% as the number of EVs rapidly grows. However, a major bottleneck for this adoption to EVs is a shortage in charging infrastructure compared to the number of EVs [10]. The pace at which charging stations are being built is not keeping up with an exponentially growing trend of EVs. One reason for this slow pace is the lacking charging infrastructure, limiting the amount of charging stations that can be built into a single garage [15].

As cities aspire to become more sustainable, facilitating sustainable transportation options becomes key. In the north-eastern part of Stockholm's inner city, the district Stockholm Royal Seaport (SRS) is growing rapidly. Stockholm Stad has profiled SRS as a highly sustainable area, with its ultimate goal to have created a district free from fossil fuels [26]. The SRS project relies on the UN Sustainable Development Goals formulated in 2015 which are set to be reached by 2030 [29]. In order to achieve the overall goals, Stockholm Stad has worked towards both social and environmental sustainability and the city council decided in 2009 that the mission of SRS should be to explore what is possible today and to be a role model within urban sustainability [26]. Hence, the rising problem regarding the charging infrastructure for EVs is of high interest for Stockholm Stad.

One way to facilitate the inevitable transformation of the charging infrastructure is to utilize the existing charging spots more efficiently. Today, the most common place to charge is at home [10], either at your privately owned parking spot at your house or for city residents, at your privately rented parking spot. Consequently, these spots are often left empty during the day. This usage gap could be addressed through a sharing economy solution, where private charging stations are shared among EV owners. A marketplace for renting private charging spots - An Airbnb for parking spots!

3 Problem Statement and Delimitations

Sharing is not only saving resources, but also a way to increase interaction with others. One example where sharing could be useful is parking, especially parking slots with charging stations. As the transition to EVs is happening quicker than expected, and the conversion/supply of charging points seem to be slower than the demand, utilising the existing infrastructure would be a more efficient solution than only focusing on expanding it.

This was the starting point for the challenge Stockholm Stad had scoped at the beginning of the project. As mentioned in the introduction, the number of EVs is growing rapidly and the number of charging points is not keeping up. Furthermore, Stockholm Stad informed us that a large number of charging points is located by the sidewalks, taking up space from cyclists, pedestrians, and car drivers which is something they are trying to prevent. Instead, Stockholm Stad wishes to remove as many cars as possible from the streets and instead place them in underground garages. Moreover, it was stated that the lack of availability of charging points hindered people from purchasing EVs. Therefore, Stockholm Stad wanted to test a sharing economy solution for private charging stations using SRS as a pilot area.

Throughout this project we ended up investigating and clarifying or solving many different types of issues connected to this initial problem statement. These include:

- Who are the key stakeholders in this problem area?
 - Who is our target group?
 - What type of people buy an EV?
 - * Where do they live?
 - * Why are they driving EVs?

- * What problem do *they* want solved?
- What type of product could solve this problem?
 - How should this product be designed?
 - How do we then build this product?
 - How do we improve on this product?
- How do people charge their EVs today?
 - Where? How often?
 - If most people charge their EVs in closed-off garages - how does that affect our product?
 - * How do we gain access to the garages?
 - * How many chargeable parking spots are available in these garages?
 - What do owners of EVs prioritize when charging? - is it price, accessibility or something else?
- What does the market of EVs and charging stations look like?
 - What is the supply and demand for charging stations?
 - How would our product fit on the market?
 - How well would it do?

4 Park&Charge

In order to decrease the gap between supply and demand of charging points, we present the Park&Charge App which is based on a sharing economy solution. Two screens from the app can be found in 1. The app in its entirety can be found in A. Through our app users can either sublet their private parking spots with charging stations or rent others' parking spaces. Thus, we believe that the shortage in charging stations can be reduced via our solution. Through our app, an EV owner receives the opportunity to easily pick up the mobile phone and search for available private parking spots, e.g. when they are in an area where there are not any public charging stations available they will instead find a private parking spot where they can charge their car by using our app. We believe that the solution should be in the form of a mobile app, as the ability to charge your electric car on the go and at locations away from home and work is much higher today than it ever has ever been [10].

Therefore we have developed a high fidelity prototype app where you can both rent or rent out your parking slot. As mentioned previously the app has two modes:

1. As a customer who wants to find an open parking spot to charge his or her EV.
2. As a renter who would like to rent out his or her own private parking spot.

The idea is to initially launch the app as a pilot project within Stockholm Royal Seaport (SRS) in cooperation with Stockholm Stad. As time passes, the goal will be to make the app available in the entire city of Stockholm and eventually also all of Sweden.

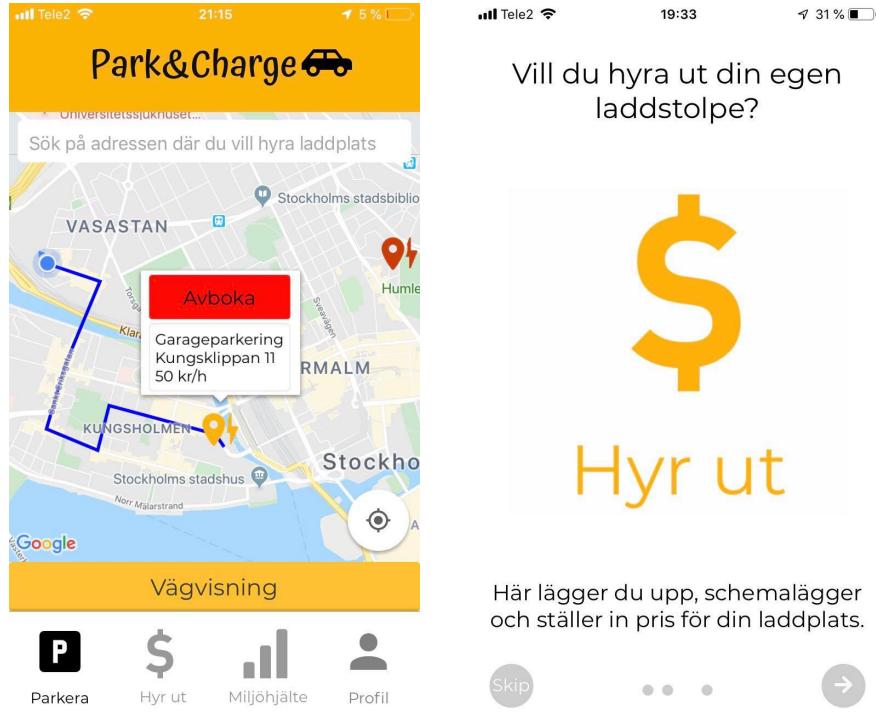


Figure 1: To the left is the main screen of the app for users looking for parking. To the right is the main screen you see when you want to rent out your own parking spot

5 Background and Previous Research

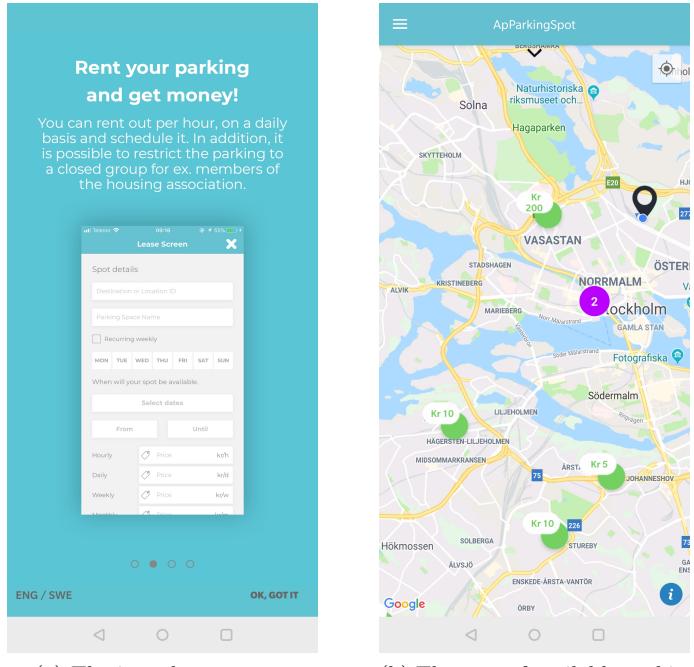
5.1 Market

5.1.1 Current Players

5.1.1.1 ApParkingSpot

In Stockholm, ApParkingSpot offers a service in which a user can sublet their private parking spot for a certain period. However, there app does not have an option to specifically search for parking spots with charging stations.

The company has been the first to implement this service in Sweden and has a current monopoly on the local market. This gives us a clear competitor and a benchmark for what our application would have to provide to succeed on the market. However, from what we gathered the application still seemed to be somewhat unsuccessful. After launching over 3 years ago the app has roughly 1000 downloads on Google Play Store [17]. Also, as of the writing of this text, only three parking spots were available in central Stockholm. Pictures of the app can be seen in Figure 2.



(a) The introductory page.

(b) The map of available parking spots in Stockholm.

Figure 2: The app *ApParkingSpot*.

5.1.1.2 Wace

In addition to ApParkingSpot, there is another app called Wace which seems to offer a very similar service in Sweden. But by looking at its data on Google Play it seems as this service has not been as successful as ApParkingSpot. It has barely any reviews and less than a thousand downloads on Google Play Store [17].

After having investigated the relevant competition of Park&Charge, i.e. players on the Swedish market, neither seem to pose a unbeatable threat due to the current low user activity. However, their low user activity could also indicate that this market might not be attractive enough to enter.

5.1.1.3 Pavemint

The sharing economy service in the US is more mature. Pavemint is an American company founded a few years ago which business idea is to connect people in need of parking spaces with people who have parking spaces to spare. As a host in possession of an unused parking spot, you can set up a personal schedule for when to make your spot available to the public and to what price. If your parking spot has some special features, such as a charging station, you are encouraged to charge extra for it. The founder states that the application works like an Airbnb for parking spots [19]. Pavemint seems to have penetrated the market better than its predecessors. They have more downloads and have many more available parking spots as of the time this text was written.

5.1.2 Market overview

The global market for electric vehicles (EV) is growing steadily at a rate of 27 % per year [11]. As the range of EVs is increasing and the prices are decreasing, the access to charging points will soon

be the number one concern for people in thoughts of buying an EV. Hence, the demand for charging spots is anticipated to increase drastically. Also, EV owners charging preferences are expected to shift from at home charging towards publicly available charging alternatives [10].

On a smaller scale, in Stockholm, the same issue arises. According to Björn Öster, Proposition Manager of Public Charging at Vattenfall, 4000 additional public charging stations needs to be installed in Stockholm until the year of 2022 [32]. Another issue with meeting the increasing demand for charging points is caused by the charging infrastructure in garages, which limits how many charging stations that can be installed in one garage according to Marcus Henriksson a Professional service manager at Fortum's on the go charging service Charge and Drive [15].

As EV owners take their cars to work or on road trips they leave their charging spots unused. This in combination with the fact that most modern EV only need to charge once every two weeks [21] means that the utilization rate of charging stations could be greatly improved. This possibility is explored further in section 6.4.2.

As the EV market is projected to grow, another key question to ask is if consumers will invest in private charging stations or will the sharing economy concept of charging stations become praxis? We believe that latter trend is favourable for Park&Charge. According to PwC, the sharing economy market is projected to grow from \$15 billion in 2014 to \$335 billion in 2025. A key driver behind this growth is affordability, as well as convenience and efficiency. However, a large obstacle according to PwC is that potential users will not trust a sharing economy company until it is recommended to them by someone they trust[23]. Thus, by providing a reliable and affordable service that match the customer satisfaction criteria, we believe the sharing economy concept of charging points will be of high interest.

Another fact which is in favor of our solution is that a key driver by sharing economy users is environmental impact. According to Öster, the largest cause of pollution in Sweden today is private cars [33], therefore electric cars is a game-changer and also aligned with the sustainability focus which permeates all sectors as well as the UN Sustainability Goals.

The demand and supply, i.e. EV and charging points, are concentrated to urban areas.[33]

5.1.3 Current Chargeable Parking Alternatives in SRS

Today in SRS the charging infrastructure that exists for electric cars consists of both public as well as private charging stations. On street level almost every parking spot that has a charging pole is a public parking spot. The number of charging stations at the scene could be considered quite low, due to the fact that Stockholms Stad wants to make the streets car-free with more room for cyclists and pedestrians. In addition to the public charging stations, both Q-Park and Stockholms Parkering own parking garages which have parking spaces with attached charging stations. Various tenant-owner associations also have parking garages where electric car owners can charge. Due to access restrictions the infrastructure of charging stations within these garages is unknown, but assumed to be quite similar to the the private owned garages.

5.1.4 Market Sizing

Below is an estimate of the potential market that could be penetrated by Park&Charge. First, a few key assumptions are listed and then our potential market share is approximated based on those assumptions.

5.1.4.1 Assumptions - Electric Vehicles Market

Narrowing down the EV market to 2019's situation in Sweden, the current fleet consists of 90k electric cars (30k battery-electric cars and 60k plug-in hybrid cars) [6]. The market for electric vehicles has grown exponentially since 2012 Q3, see Figure 3, predicting that there will exist 2.5 m electric cars in Sweden by 2030 (1.7 m battery-electric cars and 0.8m plug-in hybrid cars). Indicating that the number

of battery-electric cars will exceed the number of plug-in hybrid cars within 10 years. Consequently, the demand of charging points will increase, making Park&Charge a highly relevant solution.

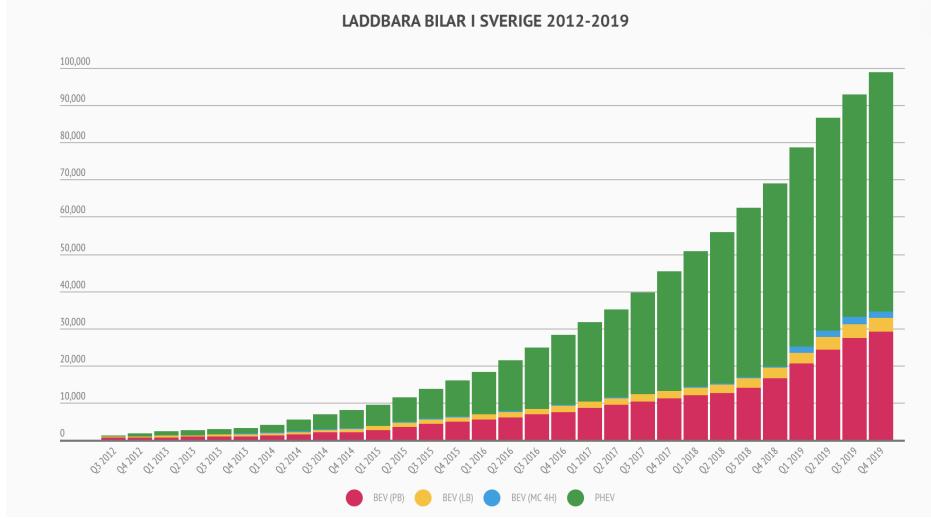


Figure 3: Number of electric vehicles in Sweden in 2012-2019

5.1.4.2 Assumptions - Charging Stations Market

In 2015 Q1, there were around 1000 public charging stations in Sweden, compared to in 2019 Q3 when the number has turned to 9000 [6]. In Stockholm, there are currently 2200 public chargers, meaning that these chargers currently make up approx. 22 percent of the entire Sweden's supply, confirming that the use of EV transportation is concentrated in urban areas. Furthermore, these statistics indicate that there is 1 public charging point per approx. 23 electric vehicles in Stockholm, presumably indicating a lack of supply. Installation of public charging stations is today a slow and expensive process, which is a potential reason for this mismatch. [11]

There was no data to be found regarding the number of private charging stations in Sweden. As a result, when estimating the market size of Park&Charge, we have assumed that 90% of EV owners have their own charging station, which results in 40.5k private chargers in Stockholm, see Figure 4 below.

Market Size (Stockholm)	2019 Q4 (today)	Comment
Number of EV	45000	
Number of Public Charging Stations	2239	
Number of Private Charging Stations	40500	Assumption

Figure 4: Market overview of supply and demand in Stockholm

Market Size (Sweden)	2015 Q1	2030	
		2019 Q4 (today)	(forecasted)
Number of EV	9000	90000	2500000
Number of Public Charging Stations	1000	9000	

Figure 5: Market overview of supply and demand in Sweden

5.1.4.3 Market size of relevant market for Park&Charge

Data	Parking time (h)	Price per h (SEK)	Transaction (SEK)
Average Transaction	4	20	80
Daily number of transactions/charging station	0,2		
Number of charging stations	40 500		
Share of potential customers	50%		
Daily total number of transactions	4050		
Annual total number of transactions	1 478 250		
Annual transaction amount for entire market (SEK)		118 260 000	
Obtained market share	5,00%		
Obtained annual transaction amount (SEK)		5 913 000	

Figure 6: Assumptions that underlie market size of sharing private charging stations in Stockholm

When estimating the market size of the market of Park&Charge, we have made several assumptions which are marked yellow in figure 6:

- Average transaction size is 80 SEK
- Daily number of transactions per charging station is 0.2, meaning there is one transaction per 5 days
- The share of private charging stations owner who are interested in using Park&Charge is 50%. This number is gathered from Survey 1, during which 47% of participants replied they would use the service.
- The obtainable market share of Park&Charge Y1 is 5%.

These assumptions combined gave a market size estimation of sharing private charging stations in Stockholm at 118 MSEK annually, of which the obtainable market share for Park&Charge is 5.9 MSEK annually, given that the obtained market share would be 5% the first year. The market share is not constant is projected to grow over time.

In order to get an idea of if there would be enough monetary incentives for private persons to start subletting their charging stations, we have compared the cost of renting a charging station from

Q-park with the revenue a private person receives by using Park&Charge. From mail correspondence with Q-Park we have found that the monthly cost of renting a private charging station from them is approximately 2500 SEK [25]. Assuming an average transaction cost of 80 SEK, 0.2 as daily transaction frequency and that 80% of the transaction amount goes to the subletter, this results in a monthly revenue of 400 SEK, meaning that the revenue amounts to 16% of the cost of the charging station and thus the cost clearly exceeds the revenue. However, monetary gains might not be the only incentive for renting out one's parking spot. This is investigated further in section 6.7.3. In addition, the fee to Qpark would have to be paid even if the owner did not use Park&Charge. As a result, the cost of the product is perhaps not directly comparable with the revenue. In other words, the revenue from Park&Charge is more equivalent to a bonus rather than profit.

5.2 Competitive Landscape

5.2.1 Competitive edges of Park&Charge

One of the key competitive advantages of Park&Charge is the expertise of our network. Our project owner is Stockholm Stad and the project is done in close collaboration with KTH. From KTH we will be able to receive insights and support about both technical and non-technical aspects. Stockholm Stad will be able to contribute with their valuable network of relevant stakeholders and institutions that affect the product launch. One such institution is Stockholm Parkering. Stockholm Stad owns Stockholm Parking which is the responsible body for providing the public charging points. This opens up for synergies and new opportunities, for instance obtaining access to more data or integrating the platform with the public charging stations. Furthermore, since Park&Charge is active in an industry that is partly regulated or communal, it is a huge competitive advantage to have close connections to such a central stakeholder as Stockholm Stad.

Lastly, Park&Charge is a young company with graduates from KTH as founders and this creates a unique brand profile. As the founding group is of moderate size, decisions and modifications of the product will be made fast, making it an agile organization that is responsive to changing customer needs.

5.2.2 Potential weaknesses of Park&Charge

Park&Charge is a new entrant, in other words not as established as the current player in terms of operations, brand recognition and best practices. Furthermore, an industry issue is that the market for sharing charging points is currently relatively small and immature. When benchmarking the user activity of the current players' platforms, in this case ApParkingSpot, we noticed that the user base is non-sufficient since there has been almost no transactions between renters and subletters in 2019. However, in December 2019, ApParkingSpot announced that they are issuing shares worth 9.5 MSEK in Sweden [1], potentially indicating that they have an optimistic belief in the market. However, it could also be a sign of that ApParkingSpot is in need of further funding since the business might not generate sufficient cash flows. Another interesting fact is that ApParkingSpot is currently valued to 26.5 MSEK [1] which shows that the market is worth something despite the low amount of user activity.

Nonetheless, A concluded in previous market research of the EV and charging point market, both markets are projected to grow to the extent where Park&Charge will satisfy a clear customer need. But as to the situation nowadays, sharing economy of private charging points is still an immature technology. Hence, a critical point in the product launch of Park&Charge is to accurately target the correct customer segment and successfully convince these consumers to join the platform.

6 Description of the Study and its Results

6.1 Stakeholders

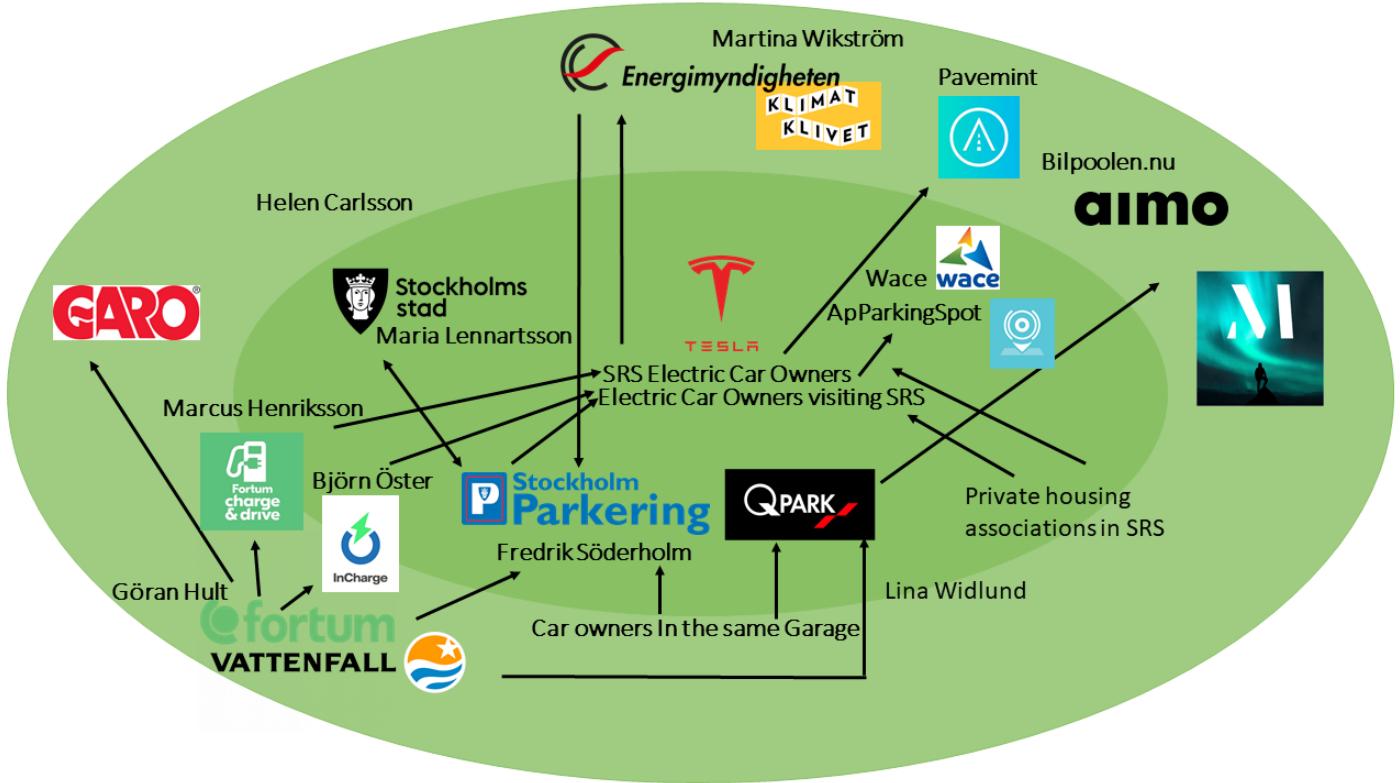


Figure 7: The stakeholders' significance and relation to each other in our project are illustrated in this figure. The primary stakeholders are located in the dark inner circle and the secondary stakeholders in the outer, lighter circle. The closer to the center a stakeholder is located the more the actor is affected by our service. The arrow signifies which actors have a relation to each other that is relevant to our project.

6.1.1 Stockholms Stad

- **Maria Lennartsson**

Lennartsson is an environmental expert. Also, she is the project commissioner and the project's primary contact person at Stockholms Stad. Maria is considered a primary stakeholder.

- **Helen Carlsson**

Carlsson works with planning, evaluating and analyzing at Stockholms stad within *Miljöbilar I Stockholm*. Helen is considered a secondary stakeholder.

6.1.2 Competitors – ApParkingSpot, Pavemint and Wace

ApParkingSpot, Pavemint, and Wace are three competing apps. They all offer a service for renting others private parking spots. However, none of these parking apps are niched towards chargeable parking spots. Also, Pavemint only operates in the United States.

If our service was to be launched this could both benefit and hindrance these actors. Since our product would be launched in collaboration with Stockholms Stad it would likely gain a lot of attraction. This would, in turn, promote the service which all competitors would benefit from. It would, for instance, be easier for others to get contracts with other parking garages and to get new users. A potential negative effect for our competitors is that since Stockholms Parkering is a big contract our solution would lose them a lot of business. Due to the great impact that our service could have on these actors, they are categorized as primary stakeholders. Except for Pavemint which is categorized as a secondary stakeholder as they have not entered the Swedish Market yet.

6.1.3 SRS Electric Car Owners

The electric car owners in SRS are greatly impacted by our solution and are therefore primary stakeholders placed in the very center of the stakeholder map. These actors will benefit from monetary gains. However, they could also be negatively affected due to potential conflicts with electric car owners renting their spots.

6.1.4 Electric Car Owners visiting SRS

Electric Car Owners visiting SRS that want to use our service are key primary stakeholders and are therefore placed in the center of the stakeholder map. These actors could be positively impacted in the short run as it would increase the number of available parking spots in the garages. However, users that prefer parking out on the streets could be negatively impacted as Stockholm Stads long term plan is to remove the parking spots placed by the sidewalks.

6.1.5 Car Owner In the same Garage

The car owners in the same garage that do not use our survey will still be impacted by it. Perhaps they will argue that having strangers in the garage puts their cars at risk. They are categorized as secondary stakeholders.

6.1.6 Q-park and Stockholm Parkering - Fredrik Söderholm

Stockholm Parkering and Q-Park are the main operators of parking facilities in SRS. Therefore, their cooperation is essential for the project to succeed. First, we would need their help and approval for installing a way for our users to get into the parking garages, see Figure 8. Also, according to the vice president at Stockholm Parkering, currently, their tenants are forbidden from renting out their own parking spots. Therefore, we would need them to change their rules for our solution to be feasible.

The rules could be different at Q-park and if they are not, they could perhaps be easier to change since Q-park is a privately owned company. However, Q-park has informed us that they are not interested in our solution, therefore, this reasoning is purely theoretical.



Figure 8: The access point to a Stockholm Parkering garage.

6.1.7 Fortum and Vattenfall

Fortum and Vattenfall are both energy producers with operations in SRS.

Apart from providing electricity, Vattenfall offers a service called *InCharge* and Fortum offers a similar service called *Fortum Charge & Drive* in Norra Djurgårdsstaden where a user can access a charging station via either an app, a key chain or a text message [14]. In the garage that we visited in SRS 4 out of the 14 charging points were part of *Fortum Charge & Drive*. Our solution could potentially take away business from Fortum. However, currently only individuals that rent a spot in the parking garage and have a key chain can access these parking spots. Therefore, since our solution would open up the garage for more people, it could perhaps increase the utilization of their service as well, which would be in line with Stockholms Stad's goal of increasing the utilization of the current charging infrastructure.

At *Fortum* we have interviewed Göran Hult. At *Fortum Charge & Drive* we have interviewed Marcus Henriksson and at *InCharge* we have been in contact with Björn Öster.



Figure 9: A charging station in a Q-park garage provided by Fortum via their initiative called *Charge and Drive*. Note that the manufacturer of the station is Garo.

6.1.8 Garo

During our field trip to Norra Djurgårdsstaden, we saw 5 different types of charging stations. All of these 5 stations were manufactured by Garo. Images of two of these station can be found in Figure 9

and 10. As our solution intends to increase the utilization of the current charging infrastructure, it could potentially financially affect Garo in the long run, since it could negatively impact the rate at which the demand for charging stations is increasing in the Stockholm area.



Figure 10: A charging station manufactured by Garo.

6.1.9 Energimyndigheten – Klimatkivet

Energimyndigheten is identified as a secondary stakeholder. Our current contact with them has been through Martina Wikström who works with Electric vehicles & charging infrastructures. They have provided us with data detailing which garages in Norra Djurgårdsstaden have applied for investment support to install charging stations. However, the data they have provided us with is dynamic and could change in the future. Since they have no clear incentive to provide us with such data in the future this could be a risk to the project.

6.1.10 Carpools - aimo, Bilpoolen.nu and M.co

During our field trip to SRS, we observed that on that day the users of the charging stations by the sidewalks tended to be cars from carpooling companies such as Bilpoolen.nu, M.co and aimo, see Figure 11. If our service were to launch and Stockholm Stad removed the spots by the sidewalks these companies would have to place their cars in the garages as well. This would decrease their visibility and availability to their customers. However, this would be considered a potential long-run effect, and therefore the carpooling companies are considered secondary stakeholders.

Another potential effect could be that these companies would like to use our service. However, for aimo the situation is a bit different. As of last spring, Q-Park is owned by the Japanese investment company Sumitomo Corporation [31], which happens to also be the owner of aimo [2]. Therefore, if Stockholm Stad were to remove the sidewalk parking spaces *Q-Park* would potentially provide chargeable spaces for *aimo* in their garages.



Figure 11: A sign and a charging station in SRS by the two carpoolsing companies M.co and aimo.

6.2 Understanding the target group

6.2.1 Field study in SRS

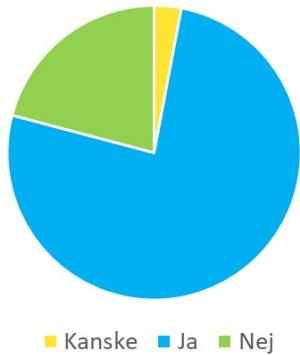
At the very beginning of the project, we visited SRS to obtain a solid understanding of the area's parking situation. A field trip was conducted during which the street environment was explored and the charging infrastructure for electric vehicles was studied. The charging points outside garages were mainly operated by carpoolsing companies, whose spots were mostly occupied. There was also a smaller number of public fast-charging stations. Moreover, charging points were found in the underground garages operated by Stockholm Parkerings, Q-Park, and various tenant owners' associations. To enter the underground garages, a blip key was required. However, we managed to enter into one of the Q-Park's garages and discovered that one of the garages contained 77 parking spots, whereof 15 offered electric charging. Among the charging stations, we identified four different manufacturers. Also, some of the charging stations, operated by Fortum, offered the possibility to pay directly using your credit card and then charge. From the visit to the garage, we were also able to conclude that the majority of the parking spots with charging stations were empty midday.

6.2.2 Survey 1 - Getting to know the target group

To understand our designated target group and their needs we decided to create and distribute a survey at the beginning of our project. We collected data from users by constructing a Google Docs Survey. For almost every question, there was an "Other" alternative where the user had the option of filling in a customized reply. These custom replies were then grouped into new categories.

The surveys were posted in three Facebook groups for electric and hybrid car owners. These groups were: *Tesla Ågare/Entusiaster Sverige*, *Elbil Sverige Forum* and *Elbil och Laddhybridbil i Sverige*. The survey got 134 replies. All of the survey questions and the replies can be found in Appendix E. An excerpt of some key findings can be found in Figure 12, 13 and 14.

Skulle du kunna tänka dig att hyra andras privata parkeringsplatser med laddningsstolpe via en app?



Vad skulle kunna få dig att vilja hyra ut din plats?

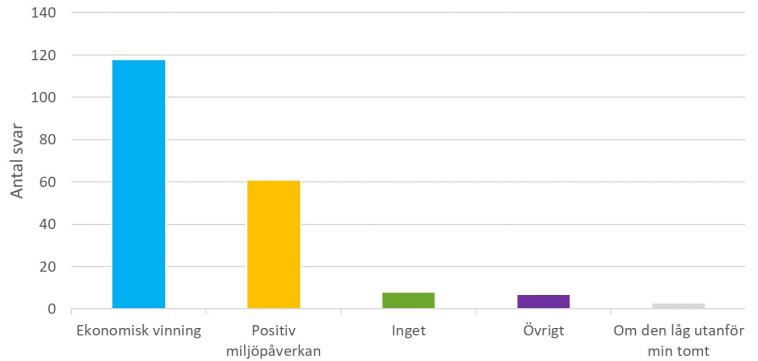


Figure 12: In the bar chart above, the users were allowed to choose alternatives from a list of incentives for renting out their parking spot. Out of the 134 replies, approximately 88 % of the participants are driven by monetary gains and 45 % is more driven by the environmental impact. When asked whether they would like to rent others private parking spot around 76 % said yes, 21 % said maybe and only 3 % said no.

Skulle du kunna tänka dig att hyra ut din privata parkeringsplats med laddningsstolpe när du inte använder den?



Finns det tillräckligt med laddningsplatser?

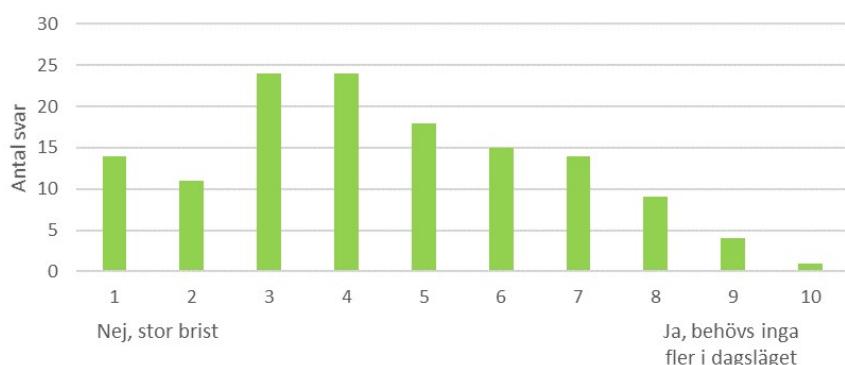


Figure 13: In the pie chart, the users were asked if they would be interested in subletting their private parking spot. Out of the 122 users that had a private parking spot, 47 % would sublet their spot, 34 % would not and 19 % were indecisive. In the bar chart to the right, the target group experience and opinion of the availability of charging points is illustrated. The majority of the replies appears to be shifted towards the left, indicating that there is a lack of charging stations available in general.

Var upplever du tillgängligheten vara sämst?

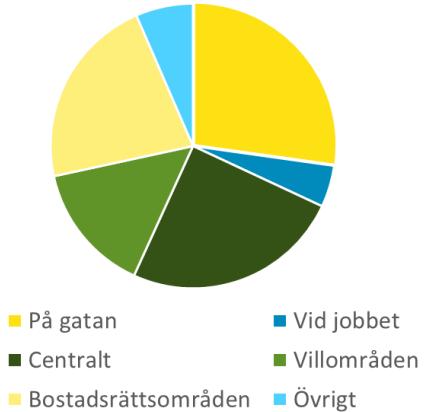


Figure 14: There seems to be a supply issue in condominium areas, central areas and on streets.

From the survey, we could see that the users thought that there is a lack of parking spots with charging stations in condominium areas and central areas. This indicates that there could be a supply issue in areas such as Stockholm and SRS. Also, the users seem to believe that there are too few parking slots placed at the sidewalks. This suggests that there is a need for opening up the potentially unutilized chargeable parking spaces which are discretely located in the garages in SRS, currently not accessible for the public in today's setting.

Another interesting finding is that, apart from the monetary gains, helping the environment was a significant reason for subletting one's parking spot. This was later explored further in our second target group survey, see section 6.7.3.

Lastly, the survey implies that there is a demand for a solution that enables one to rent private parking spots.

6.3 Accessing the garages

A goal of Stockholms Stad is to reduce the number of cars parked by the sidewalks in SRS. During our field study in SRS, we noticed that only a few of the parking spaces out on the street were available while most of the spots in the garage we visited were empty. This gave us an indication that there exists both a supply and a demand for our product. If the spots in the garages were available to our users, we could decrease the number of cars parked out on the street by moving them into the garages. Therefore, it is important to make the private parking spots in the garages in SRS accessible for our users.

In SRS, there are three types of garages, more specifically those owned by private housing associations, Stockholm Parkering and by Q-Park.

6.3.1 Stockholm Parkering

A large obstacle for the success of Park&Charge is Stockholms Parkering's resilience against our service. When we contacted a high up employee at Stockholm Parkering we were informed that it is not permitted for their tenants to rent out their parking spots in their garages. He also informed us that if they find out about anyone renting out their spot, they will immediately terminate that person's rental contract and therefore our idea cannot be applied to their garages.

One advantage for Park&Charge is our collaboration with Stockholm Stad. If Stockholm Stad wanted to proceed with our project they could put pressure on Stockholm Parkering to be more

lenient against us as they are owned by Stockholm Stad. Furthermore, one of the goals of Stockholm Parkering, formulated by Stockholm Stad is to optimize the parking capacity of Stockholm [22].

6.3.2 Q-Park

Another obstacle is Q-park. After numerous phone calls and emails, we were eventually told that they are not interested in our solution. However, if we were to initiate a collaboration with Stockholm Parkering and if this resulted in a clear demand for our solution, perhaps they might become interested in our app in the future.

6.3.3 Instabox

One startup that managed to solve a similar accessibility issue last year is Instabox. Instabox is a company that provides shipping of packages to cabinets placed in publicly accessible spots. When a package has been shipped to the cabinet the customer is provided with a pin code to open the cabinet and access the package. Several of these cabinets are, as of last year, placed in parking garages owned by Stockholm Parkering and Q-Park [7]. Thus, to access these specific cabinets placed in parking garages they are provided with an additional code to enter the garage [18].

According to Sally Persson, Expansion Manager at Instabox, they have access to these garages free of charge. Stockholm Parkering and Q-park have allowed their users access to their garages as they believe that Instabox's service creates increased value to their subletters[18]. Therefore, our strategy should perhaps also be to convince the garage owners why our service adds value to their garage subletters.

Another strategic implication is that we first should try to gain access to the same type of garages as Instabox where a pin code instead of a key card is needed for access. The benefit is that it would not require any investments to install an access point. Also, Q-park and Stockholm Parkering might be more lenient to allow our user entrance to these garages as Instabox's customers have had access to them for an entire year without termination of their collaboration.

However, as stated before, most of the garages in SRS were only accessible via key fobs and not pin codes. Therefore, this idea is mainly applicable to other areas of Stockholm.

6.3.4 Access via QR-codes

Once we have received the garages' approval for our users to enter their garages, we still need to resolve how our users will physically be able to enter.

From our field trip, we noticed that most parking lots had some form of security check to supervise who was entering the premises, see Figure 8. These usually seemed to be in the form of key fobs. This results in an immediate issue. How do we make sure that users who book a parking spot can access it?

One way of doing this would be to have a QR-reader connected to the doors of the parking lot. When a user then books a parking spot they would receive a QR-code that gives them access to the parking lot for a limited amount of time. This way the user gets easy access to the garage while the parking lot owners can be assured that the individual can not enter again and again without previously booking a parking space. This would, of course, require the garage owner or operator to install a QR-reader but there are multiple reasons for why they might be convinced to do this.[28]

- **Cost-effective and Sustainable**

The move away from physical to digital credentials is an example of how these parking lots can embrace a philosophy of sustainability and dematerialization in its security and access control offerings.

- **Convenience**

While QR code solutions are not ideal for high-security demands, they can be very helpful for improving the efficiency of handling visitor management. When a parking spot owner forgets or loses his/her key fob extra administrative work is required from the parking lot owners to set up new credentials. This is also true for when a parking spot owner moves out and the parking lot owners want to make sure that their access is no longer valid. QR-codes are easy to give out to the appropriate people and can be set to only work for a certain period or during specific hours of the day. This gives the parking lot owners more control of their security and visitor management.

6.4 Supply and Demand of Garage Parking Spots with Charging Stations in SRS

The gap between future supply and demand for charging points described in section 5.1.2 creates an opportunity for Park&Charge's solution. Given that the utilization of private chargeable parking spots is low, increasing usage of existing private infrastructure could decrease the difference between supply and demand.

Now, let's consider the supply and demand of chargeable parking spots in the Stockholm and SRS area more specifically.

6.4.1 Supply of Charging Stations in SRS

6.4.1.1 Stockholm Parker & Q-Park

In table 1, data provided by *Stockholms Parker* about their parking garages in Norra Djurgårdsstaden can be found [27]. In these garages, only approximately 6.7%–8.5% of the spots have charging stations. However, according to Stockholm Parker, they are not the owners of these properties, instead, they are simply responsible for the operations of these garages. In the properties built and operated by themselves, around 20% of the parking spots are equipped with charging points and if the demand increases, the charging infrastructure is designed such that they can increase the number of charging stations.

From mail correspondence with Q-park we found out that currently only their garage at *Grythundsgatan 7* in SRS offers private parking spots with charging stations [24].

This indicates that it would be more advantageous to first work towards gaining access to Stockholms Parkerings' garages.

Property	# parking spots	# chargeable spots	# available chargeable spots	# waitlisted people
Björnlandet	93	7	6	0
Hornslandet	82	7	1	3
Töfsingedalen	77	6	1	1
Gotska Sandön	60	4	1	8

Table 1: Data about *Stockholms Parkerings*' parking garages in SRS.

6.4.1.2 Private Housing Associations - Martina Wikström from Energimyndigheten

The second type of garage in SRS is those owned by private housing associations. Through Martina Wikström, Energimyndigheten, we were able to obtain information about the supply of charging stations in these garages [9]. She sent us data over applications for investment support to install charging stations in SRS via Naturvårdsverket's initiative called Klimatkivet. In total, they have had 60 applications for charging stations, where the smallest application included 5 stations and the largest 15. Nevertheless, the data was very limited, see Figure 15. Martina was supposed to return with more extensive data, however Naturvårdsverket was not willing to share this information with us.



Figure 15: Non public investment support in SRS - Klimatkivet

Though, by going to the locations marked on the map that she provided us with, see Figure 15, we were able to determine the addresses of these garages by using Google Street View. These addresses can be found in table 2. For more information see Appendix C.

Addresses
Taxgatan 8
Taxgatan 10
Högvilsgatan 5
Älgpassgatan 2
Slåttervallsgatan 11
Madängsgatan 18

Table 2: Addresses of private housing association garages with chargeable parking spots.

An option for us could be to initially gain access and launch our app via the private housing associations garages as a pilot project. Thus, we could learn what works and what does not work before we gain access to the large players' garages. Then we could use this as a proof of concept to Q-park and Stockholm Parkerings.

6.4.2 Utilization rate of parking spots in SRS

Currently, the available usage statistics about *Stockholms Parkerings*' parking spots is scarce. According to *Stockholms Parkerings*, they do not measure the utilization rate of their private parking spots and do not have electricity meters on their charging stations either. Why that is became clear during an interview with Martina Wikström at Energimyndigheten. Martina mentioned that there are no legal demands to report any data for private distributed charging stations and thus the garages do not keep track of their usage [9].

6.4.3 Supply Limitations in garages

In our interview with Marcus Henriksson at Fortum he mentioned that there could be limitations for how many charging stations that can be installed in an underground garage [15]. Nevertheless, he told us that there are advanced systems that can divide the electric effect between several chargers [15].

6.5 Design Process of The App

A large portion of the project was spent on building our Park&Charge application. The following sections detail both the design-oriented process as well as the technical implementation that followed. Throughout the design process of the application, the Double Diamond method was used in order to frame the problem [8]. In the Double Diamond process (see figure 16) the idea is to broaden and narrow down the problem and the solutions and alternate between these two modes. The Double Diamond involves four different phases: **discover** - the problem is studied, understood and data is gathered, **define** - the data is analyzed and the user goals are determined, **develop** - the actual design is created using various tools and methods, and lastly, **deliver** - small scale testing is conducted. The different phases were revisited throughout the project in an iterative process where the solutions that did not work were rejected and the features that did work were improved upon further.

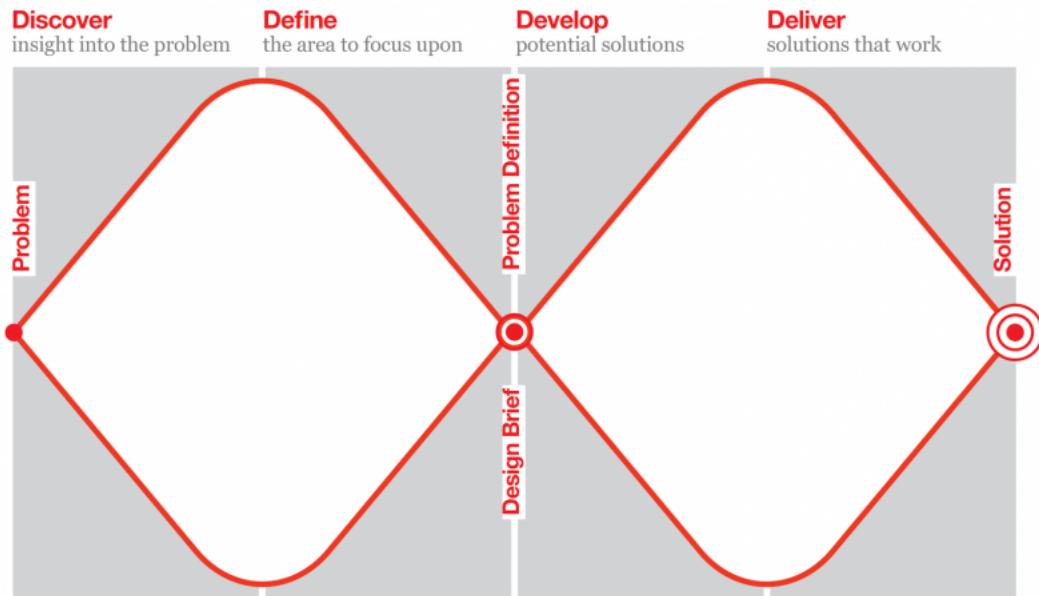


Figure 16: The workflow of the Double Diamond

6.5.1 Discover

The discover phase of the design process aims to provide a deeper understanding of the problem. For this project that involved mapping out the stakeholders and collect relevant data which is described in detail in chapter 6.1 to chapter 6.4. Following the design principle of putting people first [8] we consider chapter 6.2 *Understanding the Target Group* to be the most important part of the collected data regarding the design of the app. That part consisted of a user survey and a field study of the parking situation in SRS. From those efforts we could proceed to the next phase.

6.5.2 Define

In the define phase the problem is narrowed down and it is decided what aspects to focus the most on. One way to do this is to create a user persona [4]. A user persona is an imaginary user created based on the so-far conducted research. The purpose of the persona is to give the designers of the application the perspective of the main user group in order to understand their behavior and understand their goals and objectives. The persona is given a demographic profile, one or several end goals, a background story, and a user scenario where the problem that the application will solve for the user

persona is described. In this project one persona was created. The persona is constructed in order to mirror the typical user of our application.

Persona

Name: Daniel Lindgren

Age: 41

Occupation: Partner at a medium-sized IT-company

Goal: To seamlessly be able to drive around in his Tesla without having to struggle to find charging stations. Besides, he also wishes for the electric car community to grow and to contribute to the phasing out of fossil fuels.

Background: Daniel lives in a four room apartment in SRS with his family which consists of his wife, their two children and their Golden Retriever, Dobby. Daniel works at an IT-company where he has climbed the ranks since joining the company, after pursuing a master's degree in electrical engineering fifteen years ago in the aftermaths of the dot-com bubble. He identifies himself as a tech-geek and strives to lie at the front regarding new, technical innovations. Further, he sees himself as "woke" and cares for the environment.

Scenario: After struggling to get the kids in the car, leaving his privately rented parking spot in SRS unused, and dropping the kids off at school - Daniel is starting to get closer to work. He takes a quick glance at the panel in front of him and spots the battery level at an alarmingly low level - he will have to charge the car while he works or he will not be able to make it home. He knows that there are around five publicly available charging stations within a reasonable distance to the office but quite often they are all already in use. The first four are all occupied and Daniel's stress levels are rising. Luckily, the last parking spot is available and Daniel plugs in the charging adapter in the car and leaves. During the short stroll from the parking spot to his office he passes by a handful empty parking spots with a rather annoying sign saying "pre-rented" hanging over them.

Using the persona and its corresponding scenario we could easily think of important features for our application, such as "Miljöhjälte", where the user can see how much the amount of electricity other users have charged via the user's parking spot would correspond to in CO_2 if the person renting the spot would be driving a normal fossil fuel car. This is explained in more detail in appendix A.5.

6.5.3 Develop

The first step of the development was to create the main screens on paper in order to get an idea on how we wanted it to look. The paper prototypes can be seen in figure 17.

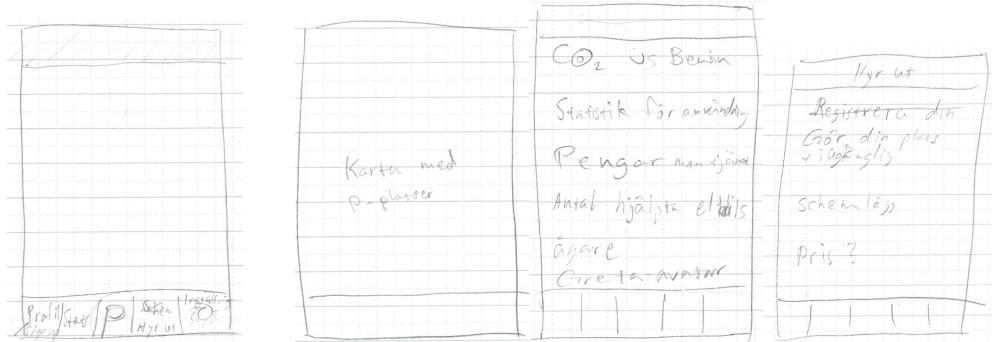


Figure 17: The first sketches of the Park&Charge

After paper prototyping we moved on to use the program BuilderX [5] to get our sketches dig-

italized. The aim of the design was to keep it clean and simple yet a bit playful. The design was developed in an iterative way, i.e some design work was done and internal feedback was received. Below, in figure 18 some of the designs experimented with can be seen. From one of the first screens done in BuilderX to the finalized one.

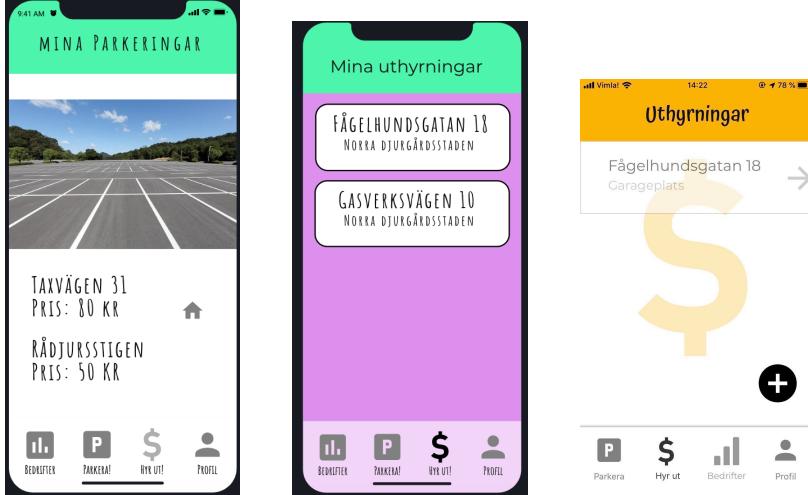


Figure 18: Different phases of the design process with the final screen of this section to the right

When the design had been completed, to the satisfaction of the group, we started to implement it with the use of React Native which is described in detail in part 6.6 *Technical implementation of the app*.

6.5.4 Deliver

The deliver phase of the Double Diamond serves to test the solution at a small scale to see what to get rid of and what to keep and improve. Our usability testing were done with a Task Analysis [30] approach and is described in section 6.5.4.

7.5.4.1 Usability Testing

When we had a working prototype people from our target group were invited to participate in a usability test. We came in contact with these individuals through our first survey where those interested in meeting up for an additional interview were urged to fill in their email addresses. Out of the 135 replies 35 people filled in their contact information and out of these individuals 5 were invited to the usability test.

Before meeting up with the users we made a list of what we believed to be our users most common goals when they use our app. According to us, the two main goals would involve booking or renting out a parking spot. These two goals were then broken down into participatory activities that would be either necessary or that would support the user in achieving the main goals. The first main goal can be found in table 3. To test the effect of the introductory slides only 3 out of the 5 users where shown these slides before taking on the below described tasks.

Goal	Book and navigate to a parking spot in Stockholm
Assumptions	You are a first time user.
Context	You are driving by Lill-Jansskogen in your electric car on your way to visit your mother. She has just moved to Norra Djurgårdsstaden and you are about to see her new apartment for the very first time. All of a sudden you notice that your car's battery level is low. Since you have your mother's address (Taxgatan 6) you decide to book a parking spot via the app Park&Charge while you visit your mother.
Success criteria	The user searches for his mother's address, finds a parking spot and navigates to the parking spot.
Subtasks	<ol style="list-style-type: none"> 1. Read through the introduction slides. 2. Log in 3. Search for the address 4. Book a parking spot 5. Start Navigation

Table 3

After the first main task was done the user was given the second task related to renting out his or her own chargeable parking spot. The second main goal can be found in table 4.

Goal	Manage your own registered parking spots by removing an existing time slot
Assumptions	You already have two chargeable parking spots registered on Park&Charge. Also, you have registered time slots for when your parking spot is available that other users can use. Right now you are logged into the app and are at the screen called: " <i>Parkera</i> ". Also, the user has seen all of the information in the introduction slides.
Context	You have registered that your parking spot at Fågelhundsgatan 18 is available for booking tomorrow when you are at work between 08 : 00 – 18 : 00. However, your daughter's preschool just called and informed you that your daughter has gotten the stomach flu and now you expect to stay home with her for a few days. You realize that you have to remove the time slots for your parking spot for tomorrow.
Success criteria	The user manages to remove one of his/hers previously registered time slots for his/her parking spot tomorrow.
Subtasks	<ol style="list-style-type: none"> 1. Use the navigation bar to go to <i>Hyr ut</i> 2. Select the parking spot at Fågelhundsgatan 18 3. Press the option to change the spots availability 4. Select tomorrow's date 5. Cancel the time slots for tomorrow

Table 4

The testing was done with one user at the time together with three members in our group. One

person mainly observed the user and took notes, the second group member measured the time it took to complete every sub task and the last person presented the user with tasks. Each task was situated in a short everyday scenario to give the user some background to why the user wants to do this specific task. The time it took for a user to complete each sub task can be found in appendix D.

After the user had completed all of the tasks the user was asked to look through the screens and make additional comments on them. The user comments can be found in appendix D.

Several users mentioned that there was too much information on the introduction slides. Here the text about the rent out page has been shortened, also a background color was added to the skip button so that it would be visible against the white screen, see Figure 19.



Figure 19: To the left are the walk-through slides before the usability testing. To the right, the users' feedback has been taken into consideration.

One user thought that having an introductory slide to explain the purpose of a profile page was unnecessary. We agreed that the meaning of the profile symbol in the navigation bar is self-evident and therefore this slide was removed.

Kontoinställningar



Profil

Under profilsidan hittar du saker
som kontoinställningar och
parkeringshistorik.

• • • •

Figure 20: The walk-through slide before the usability testing. After the users' feedback was taken into consideration, this page was removed.

Several of the users mentioned that this screen (see figure 21) was too messy. Also, one target user mentioned that the explanatory words: "Status", "Typ" and "Pris" felt redundant. The price in itself, for instance, is self-evident. Thus, to make the screen less cluttered these words were simply removed, the button text was shortened and the components were restyled to resemble other components in the app more closely.

Another user comment concerned that it was difficult to understand exactly where the parking spots were located. This was solved by replacing the status information with the parking spot addresses.

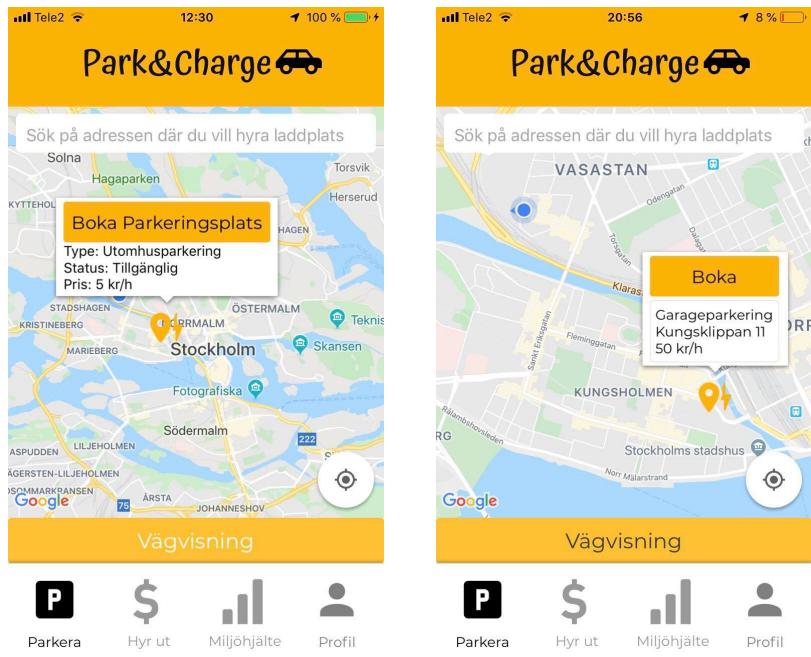


Figure 21: To the left is the parking screen before the usability testing. To the right, the screen has been changed according to the target users' feedback.

Lastly, we noticed that it took a long time for many of the users to get to the scheduling page (see figure 22) where they can rent out their own parking spots. To alleviate this issue we changed the text component: "Tillgänglighet" into "Schemalägg". However, the users that were shown the introductory slides were considerably faster at finding the scheduling page. This indicated that the walkthrough slides can make the navigation process easier.

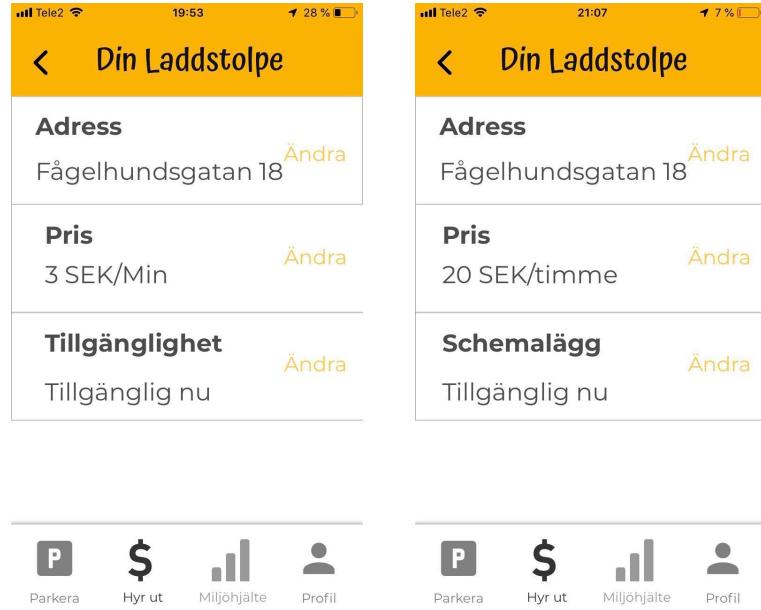


Figure 22: To the left is the settings screen for a user's private rentable parking spot before the usability testing. To the right, is the same screen that has been changed according to the users' feedback.

6.6 Technical implementation of the App

The Park&Charge application was built with the intent of providing a high-fidelity prototype that could show users what a fully functional published app would look like. The app went through multiple stages of design processes and technical implementations. Looking towards the end of this course, the app has by far been the most time-consuming part of this project. The following sections will describe multiple tools and aspects that were used in the technical building process of the app. Also, information about the database used in the project can be found in section A.7.

6.6.1 BuilderX

As previously mentioned we used the service BuilderX for designing the first digital prototype [5]. The main reason for choosing BuilderX was that the service provided React Native code that corresponded to the views designed in BuilderX. This worked well to provide us with a starting reference when writing the actual code. However, the React Native code provided by BuilderX was hard-coded in such a way that it was very hard to improve on the design of the screens without altering most of the code. This contributed to the rather long development process of the application.

6.6.2 React Native

The application was coded in React Native, an open-source mobile application framework created by Facebook [13]. We chose to write our code in React Native to take advantage of the usability and powerful features provided within it. React Native allows the user to only write JavaScript code, no HTML is required [13]. Together with Expo it allows for both emulated mobile environments and hot-reloading, described further in 6.6.3.

One of the main features and the first screen you see after opening the app is a map of your surroundings with available parking spots marked out. This was one of the features that we worked

the hardest on getting right and also one that took the most time as it evolved over multiple iterations. To make the map work properly we used multiple third-party libraries embedded in React Native code. First of all we used MapView, a Map component in Expo (see 6.6.3) that renders Apple Maps or Google Maps [3]. This let us render a functioning map with markers and user location based on information about cell towers and WiFi nodes that the mobile client can detect.

During our design process we also came to the conclusion that we wanted to enable a routing system so that the user could get the fastest possible way to a parking spot (technically a marker with a specific latitude and longitude). This was done via the Google Maps Directions API [16]. We set up a personal Google Developers account which provided us with a key that could be used for every call through the API. The Google Maps Directions API only asks for a start position (current user location) and an end destination (parking spot). With these two provided we set up our app so that it redirects you to the *Driving Mode* in Google Maps when you ask for directions to a parking spot. We did this with the idea that a user would use our app to find a parking spot and then use their phone as a GPS to navigate to the parking spot.

6.6.3 Expo

Expo is a framework and a platform for universal React applications. It is a set of tools and services built around React Native and native platforms that enabled us to develop, build, deploy, and quickly iterate on iOS and Android [12]. The most useful features we used in Expo were its fast deployment functionality and *hot-reloading*. Expo allows its developers to deploy their projects written in React Native code almost instantaneously. All a user has to do is download the *Expo App* from the iOS or Android app store and scan a QR code that is generated when the code is executed on the host computer. This starts the app and it behaves just like a real app would. Expo is very useful for us in two major ways.

First of all, Expo let us easily showcase our app on peoples personal phones. This helps the users try out our app in a more familiar environment leading to more accurate responses and feedback. When the users are accustomed to the hardware in their hands it was easier for them to give us feedback on the software running on it.

Secondly, Expo sped up the iteration process of our development through the feature *hot-reloading*. Hot-reloading means that when the code is updated on the host computer the same changes are automatically seen in the app on the phone. This meant that changes could be done and analyzed continuously without waiting for lengthy updating processes, which sped up the design and development processes. Speeding up the deployment process has not just been useful for us, the entire software development industry is rapidly moving towards shorter development cycles and more continuous deployment [20].

Regarding operating platform we decided to optimize our app for iOS to speed up our development progress. In an early stage of the development process we noticed that our code was rendered differently on iOS and Android devices. We therefore decided to proceed with the development process focusing on one operating system, which we decided to be iOS.

6.7 Business Plan

Preface: This business plan is written as if we, 5 students at KTH Tomas, Alexandra, Marcus, Daniel and Julia, would launch Park&Charge. There are several ways to launch the business, such as Stockholm Stad implementing the launch, either in-house or with external help from a software developing company. However, in order to make the estimations and launch plan realistic, we decided to delimit it to an independent launch from us, i.e. the founders.

Below is a description is our business plan. Also, the marketing strategy can be found in appendix B.

6.7.1 What is Park&Charge?

As previously mentioned, Park&Charge is a mobile application which enables drivers to share private charging points to electric vehicles. The platform will enable users to rent and sublet charging points, limited to consumers and not enterprises. The solution can be characterized with the 3 S:s: scalable, simple and sustainable. Scalability in terms of that Park&Charge initially will be launched in the Stockholm region with a focus on Stockholm Royal Seaport, and eventually quickly scaled to other urban areas in Sweden as more users convert. Simplicity conveyed through the minimalist and user-friendly interface of the app. Sustainability naturally goes hand in hand since Park&Charge facilitates parking and charging for electric vehicle drivers and contributes to a higher utilization rate of current infrastructure.

6.7.2 Experience and Skills

The founding group of Park&Charge consists of 5 Master students in Industrial Engineering and Management at KTH Royal Institute of Technology with specialization in Computer Science. The majority of competence will be provided in-house, except a smaller outsourcing initiative in the initial investment phase. This will be presented in detail in the financials later in this report.

6.7.3 Business Model and Pricing

The revenue will be based on a commission model. After having conducted a benchmark analysis of competitors business models, we have decided to apply the same commission rate of 20% of all transactions. However, what varies is our pricing strategy.

The pricing strategy was decided after doing Survey 2 (Pricing model survey). See Appendix F for all questions and their respective responses. The main question asked was which pricing model the customer would prefer out of four proposed (see Figure 23). The most popular pricing model was by far a fixed price set by us. However, this price would have to take multiple parameters into consideration including *current demand for parking spots, time of day, location of the parking spot, charging capacity of the parking spot* etc.

Scenario: Du har möjligheten att hyra ut din parkeringsplats och måste därmed sätta ett pris. Vilken modell känns mest relevant för dig?

73 svar

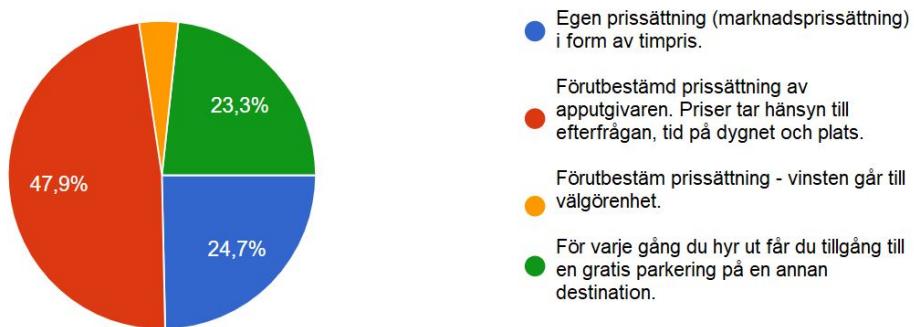


Figure 23: Survey answers for which type of pricing model the user would prefer.

The model would then calculate a set price per hour with these parameters in mind, relieving the customer from having to choose a price - simplifying the process of renting out ones parking spot.

Through our survey we received multiple comments stating the same problem: Some cars have a higher charging capacity than others. Meaning that renting out your parking spot to a Tesla Model S would be less profitable than to a Kia Soul. We first considered this a non-issue since we thought that the price per hour could be a fixed one with an additional variable price that considered the electrical costs of the charge.

While interviewing Martina Wikström (Energimyndigheten) we questioned her on this issue. She described to us that there are no legal demands to report any data for private distributed charging stations. As a consequence, most operators of parking facilities equipped with charging stations charge their customers a fixed amount every month since it is more cost-effective than to keep track of the usage. Another contributory factor to this is that the cost of the electricity needed to charge the car is close to negligible compared to the cost of having a parking spot at an attractive location. The electricity cost might therefore not be meaningful enough to impact our fixed-price pricing solution [9].

6.7.4 Customer Insights

The data related to understanding the customer in terms of behaviour, segmentation and purchase is collected from Survey 1, which is also analyzed in the discussion section of this report.

6.7.5 Risks

- Since the value of the service lies in the user activity, it is of high importance to reach the critical amount of users. If there is a non-sufficient volume of user traffic, the service will seize to work.
- When Park&Charge is launched, there is the risk of a competitive response from ApParkingSpot. What if they increase sales force or attempt to negotiate with Stockholm Stad/Stockholm Parking regarding entering a partnership?
- So far the contact with the garage operators has been turbulent. Clearly, a key issue for the projects success is to somehow gain access to the garages. If we do not succeed in finding an incentive for giving us access our project might fail.

6.7.6 Opportunities

- The service Park&Charge provides is highly scalable, easily enabling expansion in terms of other means of transportation, for instance bikes, regular parking spots, etc.
- Another expansion direction is that Park&Charge start licensing the platform. Since sharing economy is becoming increasingly common in all sorts of products and services there will be an increasing need for this sort of IT infrastructure. Example of potential interested stakeholders are Voi and Lime, given that the product of Park&Charge is superior to their in-house platform and offered at an adequate price.
- Park&Charge can also be expanded to new markets, both domestically and internationally. The market of EVs is projected to grow to the extent that the number of EV in Sweden reaches 2.3 million in 2030, compared to 90 thousand today in 2019. This represents a growth rate of 2700% growth within 10 years, signalling a highly attractive market with tremendous potential.

6.7.7 Financial Forecast

Income Statement (SEK)	0	1	2	3	4	5
Total transaction amount in app	0	5 913 000	6 208 650	6 845 037	7 923 986	9 631 654
Provision share	0%	20%	20%	20%	20%	20%
Revenue from provision/net sales	0	1 182 600	1 241 730	1 369 007	1 584 797	1 926 331
Cost of goods sold	0	(500 000)	(525 000)	(551 250)	(578 813)	(607 753)
Gross profit	0	682 600	716 730	817 757	1 005 985	1 318 578
Gross margin	0	57,7%	57,7%	59,7%	63,5%	68,5%
<i>Operating expenses:</i>						
Salary	(1 500 000)	(1 500 000)	(1 500 000)	(1 500 000)	(1 500 000)	(1 500 000)
Patent and regulatory	(50 000)	(10 000)	(10 000)	(10 000)	(10 000)	(10 000)
Technology	(20 000)	(21 000)	(22 050)	(23 153)	(24 310)	(25 526)
Marketing	(200 000)	(100 000)	(60 000)	(60 000)	(60 000)	(60 000)
Administration and overhead	(50 000)	(52 500)	(55 125)	(57 881)	(60 775)	(63 814)
<i>Sum of operating expenses</i>	<i>(1 820 000)</i>	<i>(1 683 500)</i>	<i>(1 647 175)</i>	<i>(1 651 034)</i>	<i>(1 655 085)</i>	<i>(1 659 340)</i>
Operating earnings	(1 820 000)	(1 000 900)	(930 445)	(833 276)	(649 101)	(340 762)
Operating margin	N/A	-85%	-75%	-61%	-41%	-18%
<i>Growth assumptions</i>						
Exponential growth of transaction amount	5%					
Linear growth of operating expenses	5%					

Figure 24: Five year Income Statement projection of Park&Charge

The total transaction amount of year 1 is extracted from the market sizing based on the data provided from Vattenfall and Elbilsstatistik, previously mentioned in 5.1. Park&Charge takes a provision share of 20% transaction amount. The post cost of good sold is majorly attributable to the fee to garage owners such as QPark since they presumably would require a fee for letting Park&Charge operate in the garages. The fee is supposed to reflect a compensation for the increased safety concern of letting in unauthorized consumers (customers of Park&Charge) in the garages as well as the potential negative impact on the garage owners' business.

The exponential character of the growth rate of the transaction amount derives from the fact that the market of sharing charging stations is characterized by a winner-takes-it-all attribute. The value of the service lies in the user activity. As a result, when the critical amount of customers is reached, it is more likely that the growth is going to be exponential rather than linear. The transaction amount year 1 is 5.9 MSEK, compared to in year 5 when it is estimated to be at 9.6 MSEK.

The growth of the operating expenses is not increasing at the same rate as the revenue due to the phenomenon economies of scale. Instead we have assumed this growth rate to be linear at 5% annually. Salary costs are at 25k per employee (total 5 employees) per month, resulting in annual salary costs at 1.5 MSEK. Marketing costs and efforts are intensive in the beginning of the launch, starting at 200k year 1 due to establishing rapid brand recognition, and gradually decreasing.

The financial forecast shows that it would take more than 5 years for Park&Charge to become profitable.

7 Discussion

7.1 Surveys

The first survey in the project took place at an early stage and served to provide us with a deeper understanding of our intended target group. Even though the survey fulfilled its purpose, we realized, in retrospect, that some aspects of it could have been handled differently. For instance, we should maybe had interviewed an electric car owner first in order to learn more about how it is to be an electric car owner. That way, some of the questions could have been formulated in another way to avoid misconceptions between us and the respondents.

In addition, we proposed our intended solution already in the preface of the survey which made the survey a bit leading towards our solution. Perhaps, a better approach would have been to ask the respondents what kind of solution they wanted to address the problem. This approach was briefly discussed, though the risk with not leading people is that you get bad answers. As Steve Jobs once said: *"People don't know what they want until you show it to them."*

For the second survey one major difference compared to the first was the number of responses, which went down from 135 to 73, even though it was posted in the same three Facebook-groups. One possible reason to that could have been that the questions in the second survey was longer in general, which could have affected the engagement of the respondents.

7.2 Usability Testing

We decided in the group to not bring in actual users to test our app at an early stage since we already had a rather clear vision off what we wanted. However, the consequences of not bringing users in early could be that, when brought in, they do not have the guts to criticize the product too harshly. It is easier to say something is bad if you know the person behind it has only put in a few hours of work. In our case, the users were only allowed to test the finalized prototype and a majority of the critique we got revolved around phrasing and appearance, i.e things that we were able to change quickly and easily.

7.3 Concerns regarding Stockholm Parkerings

Fredrik Söderholm at Stockholm Parkerings has repeatedly told us that our solution is not applicable in their garages since they do not allow subleases of parking spots. Would any of their customers be doing this they would break the contract. This could be interpreted as resistance against new ways to utilize their parking facilities. However, Stockholm Parkerings operates under Stockholm Stad, which should mean that if Stockholm Stad want to make this idea happen they should have the mandate to implement it.

8 The way forward

Throughout this project we have planned, projected, designed and built a sharing-economy solution to address a lack of parking spots with charging capabilities. The way forward now is to launch a profitable, sustainable solution that will help reduce the presence of cars on street roads. With Park&Charge we have created a high-fidelity prototype of what this solution could look like. However, it is far from a commercial solution, ready for a public launch. Practical issues include setting up a universal form of garage access that would enable Park&Charge users to freely travel between parking spots. However, a solution to this problem has been proposed through the use of QR-codes. Another issue is that of Stockholm Parkerings strict policy on no subleases of parking spots. However, with Stockholm Stads authority over Stockholm Parkerings, this policy could come to be changed in the future. A final issue to be considered is the maturity of the market. While the business idea has shown signs of success in other geographical markets the idea is still quite new here in Stockholm. Since Park&Charge would act as marketplace in a winner-takes-all market early entry would be critical, yet a too early entry and you risk not growing quickly enough to retain users.

By taking these risks into account and preemptively working to counteract them Park&Charge has the opportunity to be a successful product both in terms of profitability and sustainability.

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A The App

A.1 The Introduction Slides

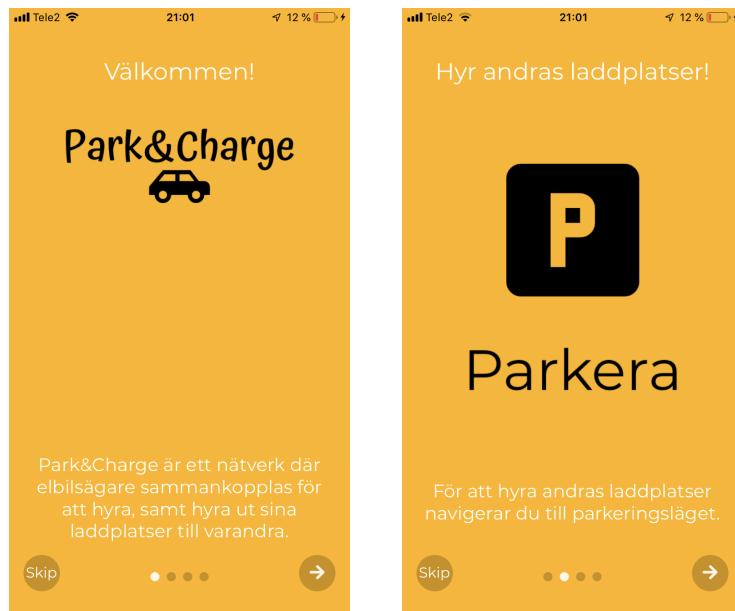


Figure 25: The two first introductory slides explaining what the app is and where to navigate if you are looking for a parking spot.



Figure 26: The introductory slide to the left explains where to navigate if you want to rent out your spot. The slide to the right is supposed to emphasize the environmental benefits of using our app. Such benefits was important to our users according to our first survey.

A.2 Sign in

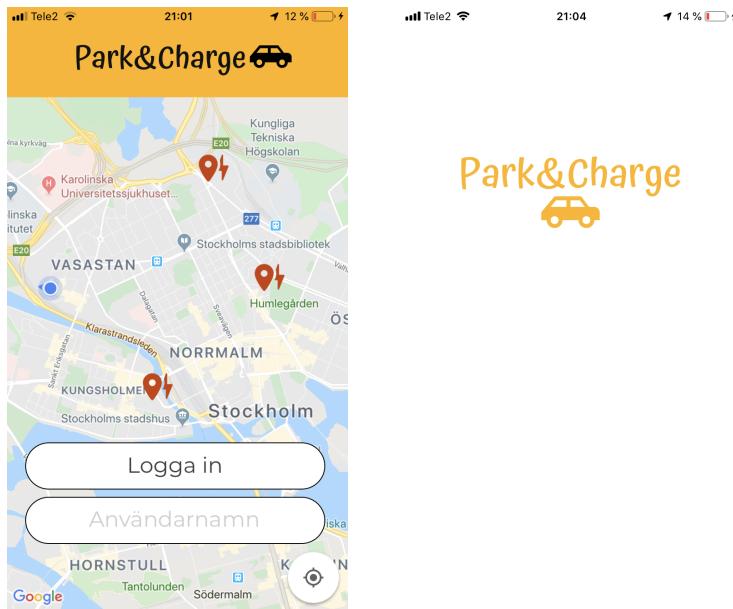


Figure 27: To the left is the login screen. In the background the user can see the pins of nearby parking spots at his or hers current location which gives an incentive to log in. When the user has entered his or hers username the splash screen to the right is displayed for about a second.

A.3 Parking Screen

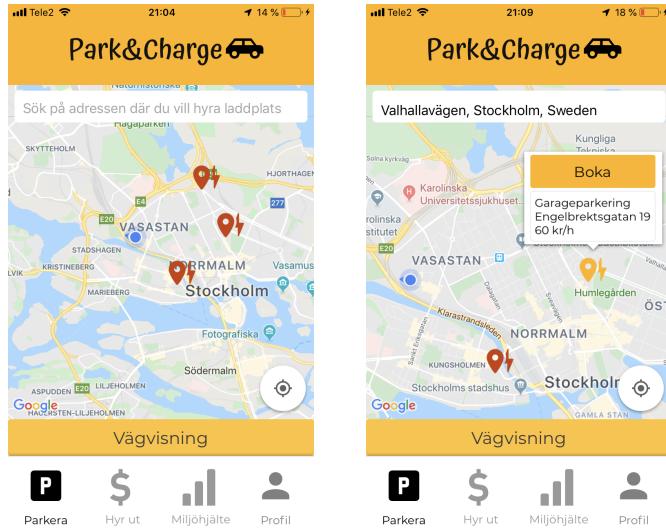


Figure 28: To the left is the main screen for users that want to use the app to book a parking spot. When a pin is pressed the user sees the screen to the right. Information about that particular parkingspot pops up and the user can book the spot by pressing: "Boka".

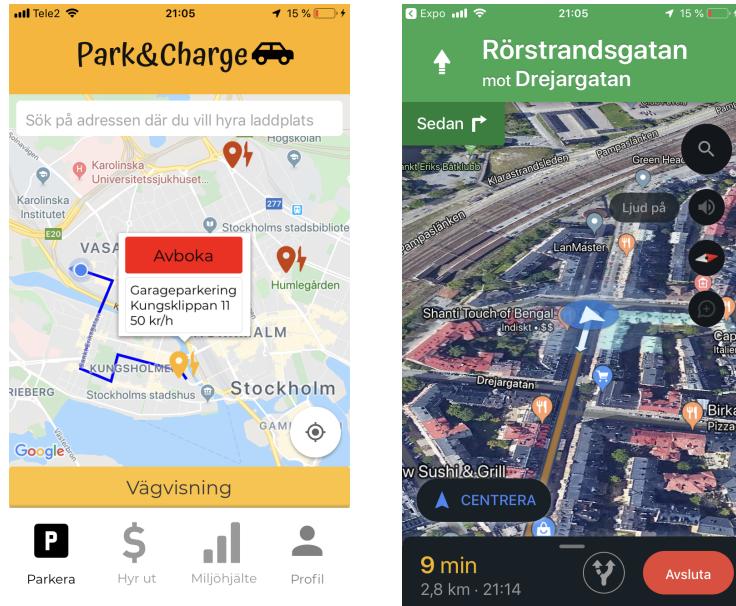


Figure 29: To the left is the parking screen after a user has pressed the button "Boka" to book a spot. When the user presses the button called: "Vägvisning" the application redirects the users to the phones pre-existing maps application.

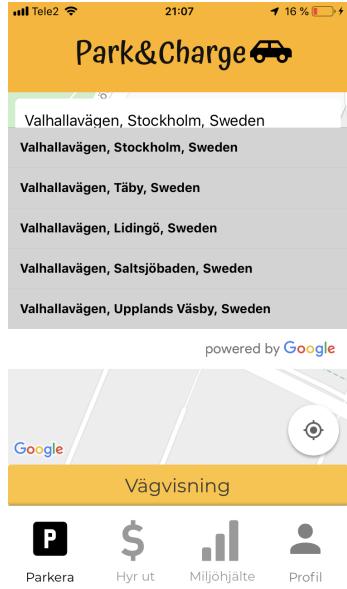


Figure 30: The user also has the option to search for a parking spot at a specific location or address via the search bar at the top of the screen.

A.4 Renting Out a Parking Spot

To rent out one's own private parking spot the user presses: "Hyr ut" on the main tab navigation bar. In Figure 31 and 32 the flow

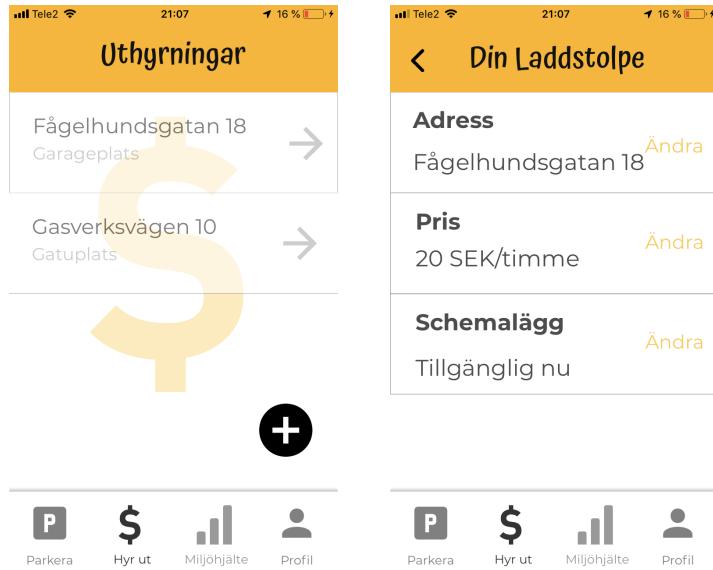


Figure 31: When the user presses "Hyr ut" the left screen is displayed. Here the user has 2 registered parking spots. When the user pressed the top parking spot he/she gets to the right hand screen (NOTE that the lines on the sides of the screen are not visible when the app is displayed on the users phone).

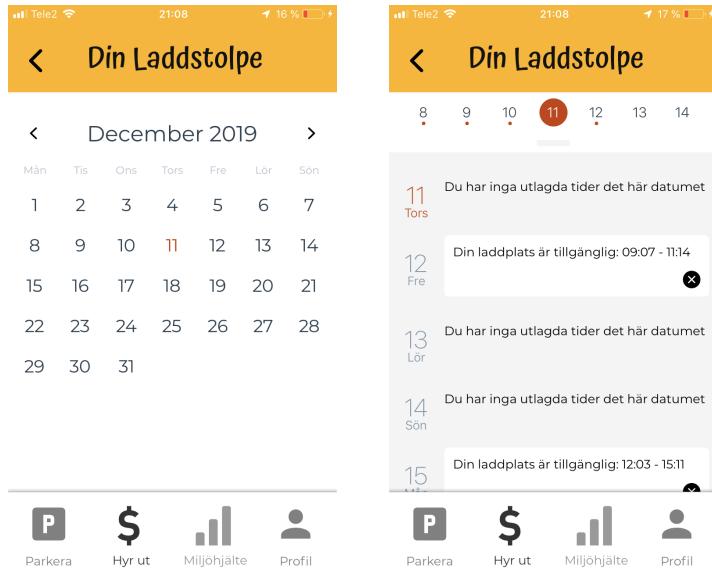


Figure 32: When the user presses ”Ändra” to the right of ”Schemalägg” in Figure 31 he/she gets to the calender screen to the right. By pressing a certain date the user comes to the right hand screen where he/she can remove and add time slots for when the parking spoot is available to other users.

A.5 Miljohjalte

In both of our surveys environmental impact appeared to be an important incentivtive for using our app. Therefore, we added a screen called: *Miljohjalte* were the users can see how much them renting out their parking spot has contributed to the environment. The CO_2 value is computed by first calculating how many hours of electricity other users have charged from the current users charging station. These electricity hours are then converted into a corresponding number of *km* that the user would be able to drive with that amount of electricity. Then, this distance is converted into a corresponding fuel amount that a normal fossil fuel car would need to drive the same distance. Finally, this fuel amount is converted into the amount of CO_2 that would be emitted from the fuel.



Figure 33: The screen where the user can see how much he/she has contributed to the environment (NOTE that the lines on the sides of the screen are not visible when the app is displayed on the users phone).

A.6 Profile screen



Figure 34: The users profile screen.

A.7 Database

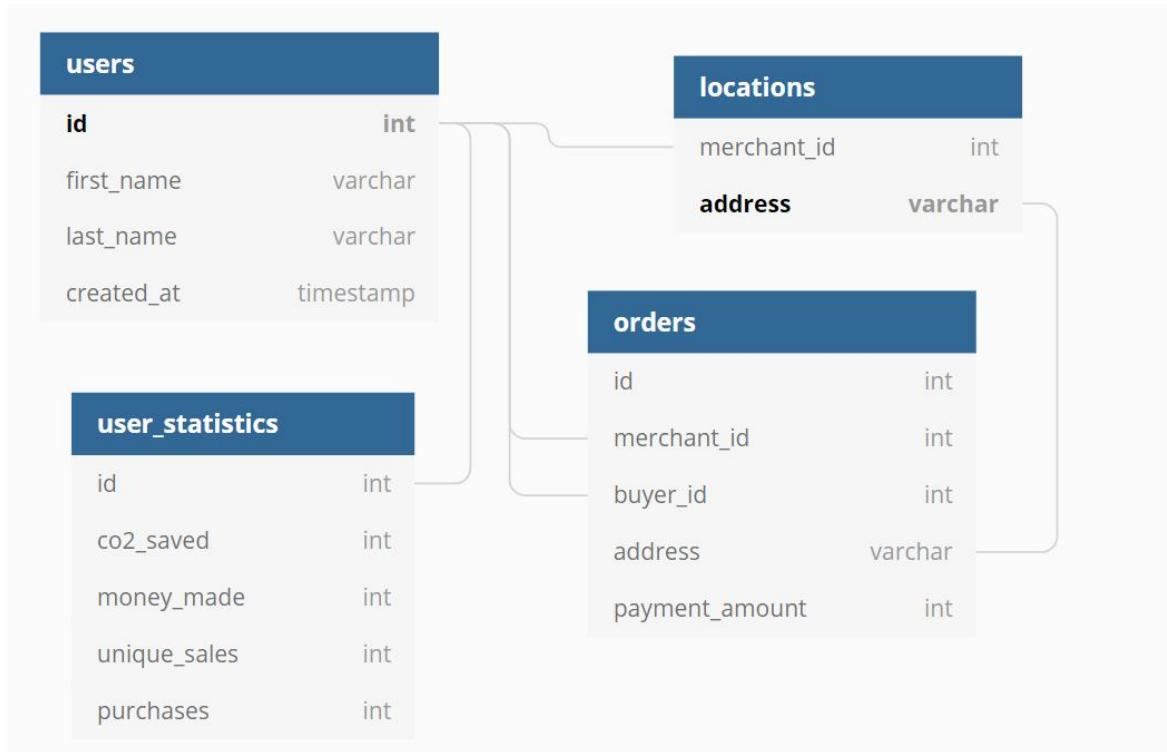


Figure 35: Rudimentary database schema for **Park&Charge**.

A schema of the database we created for the app can be seen in Figure 35. Now note that this database is the bare minimum for the current version of our app. This is why for example there are no columns for passwords or usernames. This schema was designed to give an idea as to how our data storing could work and how different elements in the tables would interact with each other. The database was designed with two aspects in mind.

1. What data do we need for the app to fully function and what data can we ethically gather from our users?
2. What data can we get access to right now without launching the app?

Regarding the first aspect, we decided that while we obviously will need a way to store data to develop a functioning app, we also wanted to respect the privacy and integrity of our users. A fully functioning version of our app will need to keep sensitive information regarding individuals, their parking habits and addresses. This sort of data needs to be correctly handled in a safe and responsible manner.

Regarding the second aspect, we made sure to design our database in a way that made sense with the information provided by Martina Wikström and Stockholms Parkering. As described in 6.4.1 we received various data on the number and location of charging stations. Even if it was not as extensive as we would have preferred we used this information to set up a basic outline of what type of data would be necessary to store. We then filled the database with the provided data for prototyping purposes.

B Marketing Strategy

The overall objective underlying the market strategy is that the aim is to gain market share fast and build brand recognition, not prioritizing profitability initially. As a result, the marketing efforts will be relatively aggressive, utilizing the constrained budget Park&Charge has in the best possible way. Park&Charge will be marketed through online and offline channels. Online marketing will constitute of Facebook ads directly to users and posts in target Facebook groups, for instance the group Tesla Enthusiasts with almost 5k members. When ordering the Facebook ads, chosen customer characteristics will potentially be men, aged 25-45, living in urban areas in Sweden. Another online marketing method is collaborating with the parking apps Stockholm Parkerings provides and explore the opportunity to put ads in the apps. Regarding offline marketing efforts, we will put posters in garages that Stockholm Parkerings owns, given that we are allowed to do that without any fee, as well as hand out flyers at critical points with high customer flow.

C Private Housing Association Garages with Charging Stations

These are garages owned by private housing associations in SRS that we know have parking spaces with charging stations since these associations have applied for the investment aid called Klimatkivet for their chargeable parking spots via Naturvårdsverket.



Figure 36: To the left is a private housing association garage located at Taxgatan 8 and the one to the right is located at Taxgatan 10.

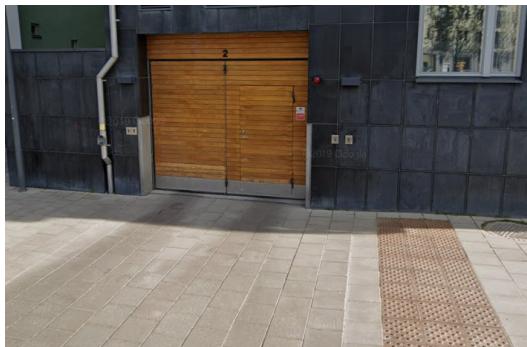


Figure 37: To the left is a private housing association garage located at Älgpassgatan 2 and the one to the right is located at Högvilsgatan 5.



Figure 38: To the left is a private housing association garage located at Madängsgatan 18 and the one to the right is located at Slättervallsgatan 11.

D Usability Testing

task 1	Go through intro slides.	
task 2	Log in.	
task 3	Navigate to a certain address in the parking screen.	
task 4	Book a parkingspoot.	
task 5	Navigate to a parkingspot. (After task 4 is done)	
task 6	Go to the schedule of your parkingspoot	

Table 5: The tasks given to the users.

	time [s]	comment
task 1		
slide 1	14	Nätverk låter lite luddigt.
slide 2	12	Enkelt att förstå.
slide 3	26	Mycket text. Rubriken är för lång: ”Vill du hyra ut din laddstolpe till andra elbilsägare?” Ni kan ta bort till andra elbilsägare. Det är självklart tycker jag.
slide 4	16	Bättre! Tydligare information. Om jag ska vara petig så skulle ni kunna byta ut ordet insats mot något annat. Det är inte så tydligt exakt vad ni menar.
slide 5	10	Tydligt. Men behöver ni verkligen förklara vad en profilsida är?
task 2	6	Det är jobbigt att tangetbordet täcker skärmen.
task 3	20	Det var intuitivt hur man skulle göra. Men ni skulle kunna ta bort texterna: ”Typ”, ”Pris”, osv. Man förstår ju vad det är utan dessa.
task 4	25	Enkelt att förstå.
task 5	8	Vägvisning skulle kunna bytas mot vägbeskrivning eller navigering.
task 6	39	Något bökgilt. Uthyrningar (rubriken) är inte särskilt tydlig.

Table 6: The user testing results for user 1.

	time [s]	comment
task 1		
slide 1	11	Formuleringen är oklar. Vad innebär nätverk egentligen?.
slide 2	8	Repetativt. Samma information ges på flera ställen.
slide 3	33	Alldeles för mycket text. Nu läser jag igenom allt men hade jag laddat ner appen och sett den här blaffan med text så hade jag bara scrollat förbi.
slide 4	17	-
slide 5	9	Kort och konkist. Bra!
task 2	7	Coolt att man kan se parkeringsplatserna
task 3	22	-
task 4	27	Jag vet inte riktigt vad som försigår här. När har jag bokat platsen? Hur avbokar jag den?
task 5	8	Knappen smälter nästan in i bakgrunden. Den borde synas mer.
task 6	42	Vad menas med Uthyrningar? Tillgänglighet borde heta något annat. Schemaläggning kanske?

Table 7: The user testing results for user 2.

	time [s]	comment
task 1		
slide 1	15	-
slide 2	11	Bra förklaring.
slide 3	29	Ni kan nog korta ner här.
slide 4	16	-
slide 5	11	-
task 2	5	Enkelt att förstå.
task 3	19	Liknar många andra appar så det var inte svårt att förstå. Det är lite mycket som sker i bilden.
task 4	23	Det är inte tydligt exakt vart platsen är. När jag ska någonstans så måste jag veta exakta adressen så att jag vet om det är nära dit jag ska.
task 5	7	Det var inte svårt att förstå.
task 6	45	-

Table 8: The user testing results for user 3.

	time [s]	comment
task 2	7	-
task 3	17	-
task 4	31	Jag förstod att jag skulle klicka på platserna men hur ska jag veta exakt var platsen ligger? Borde inte adressen finnas någonstans?
task 5	14	Det verkar fungera bra!
task 6	80	Det här var lite svårare. Vägen var inte så klar.

Table 9: The user testing results for user 4. This user was not shown the introduction slides, i.e. task 1.

	time [s]	comment
task 2	9	Tydligt.
task 3	24	Bilden är rätt rörig. Annars är det intuitivt hur man ska göra.
task 4	35	Det tog ett tag innan jag visste hur jag skulle göra.
task 5	16	-
task 6	50	Det här var väldigt bökigt måste jag säga.

Table 10: The user testing results for user 5. This user was not shown the introduction slides, i.e. task 1.

E Target group survey

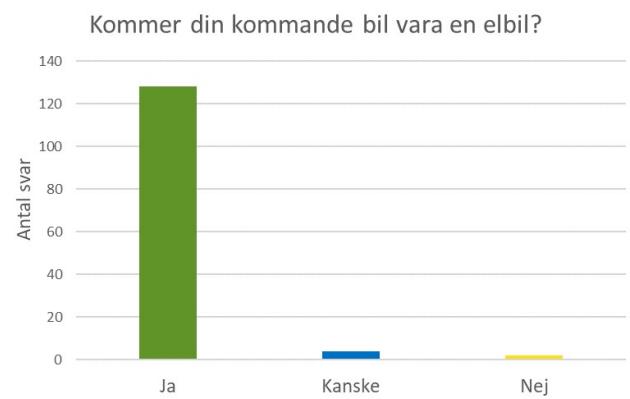


Figure 39

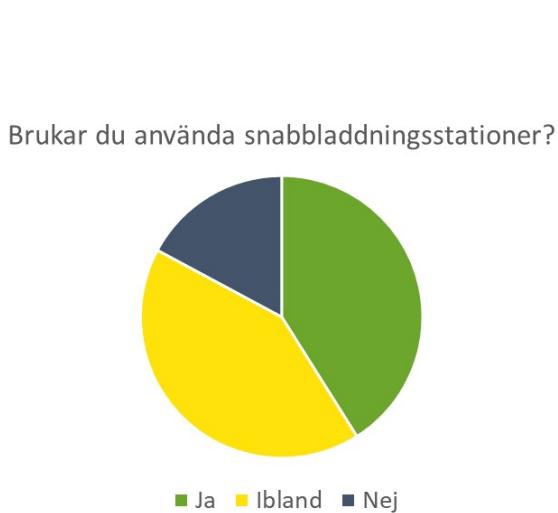


Figure 40



Figure 41

Skulle du vara intresserad av en lösning/plattform som möjliggör smidig delning av laddningsstationer mot betalning?

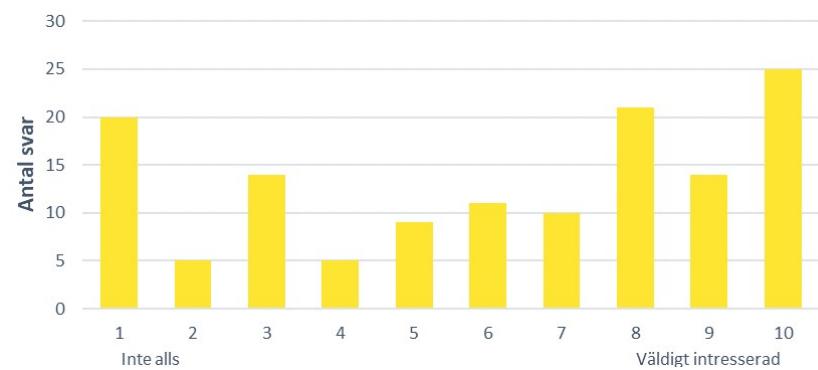
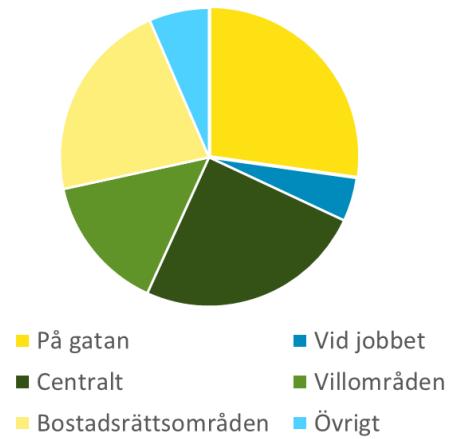
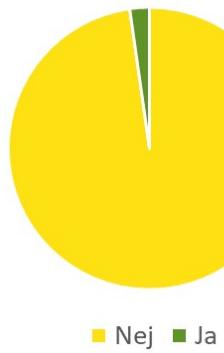


Figure 42

Var upplever du tillgängligheten vara sämst?



Hyr du idag ut och/eller lånar ut din plats till andra
på egen hand?



Vilken tid på dygnet upplever du det svårast att få
tillgång till laddningsplats?

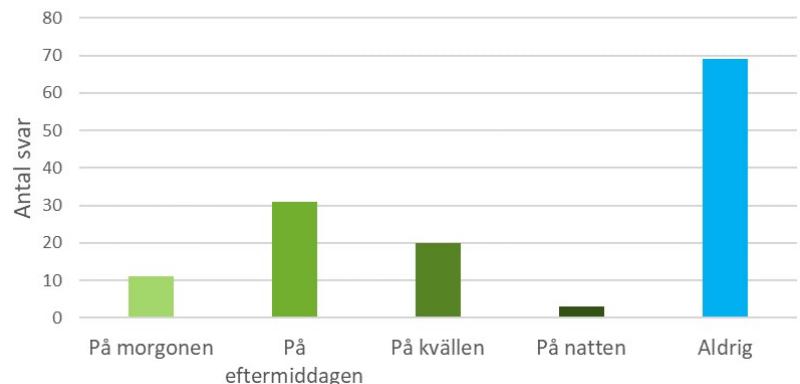
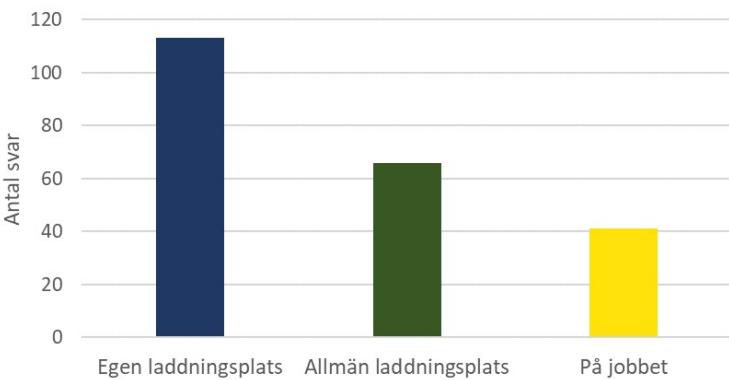


Figure 43

Hur laddar du din elbil?



Hur länge har du ägt en elbil?

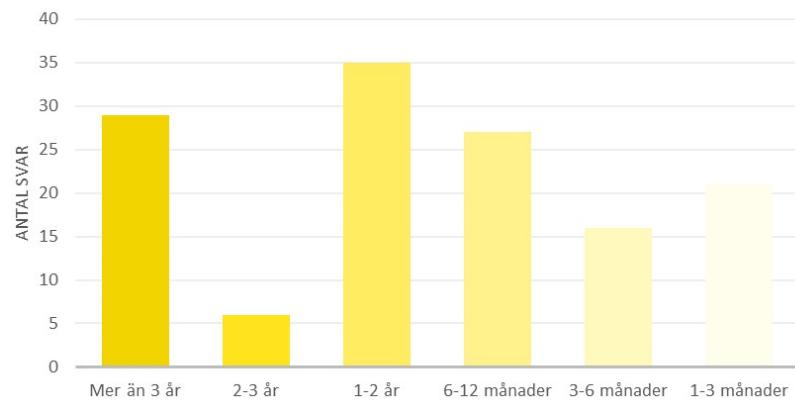
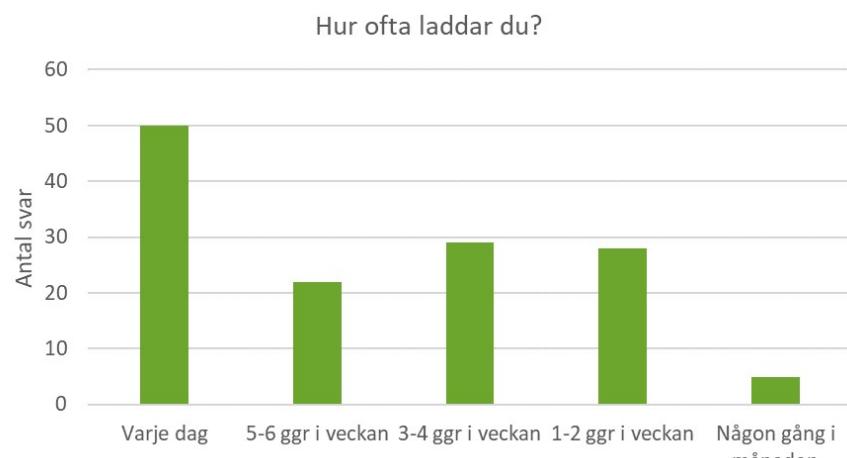


Figure 44

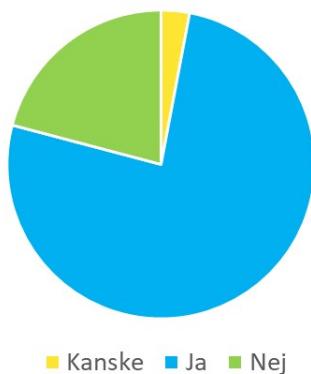


Skulle du kunna tänka dig att hyra ut din privata parkeringsplats med laddningsstolpe när du inte använder den?



Figure 45

Skulle du kunna tänka dig att hyra andras privata parkeringsplatser med laddningsstolpe via en app?



Vad skulle kunna få dig att vilja hyra ut din plats?

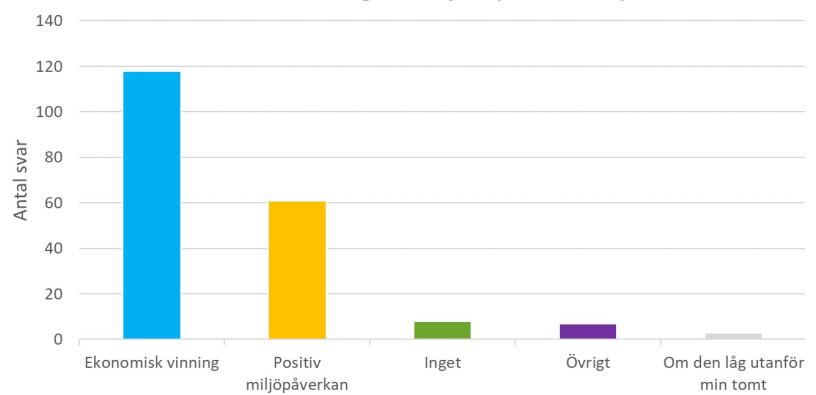


Figure 46

Vart bor du?

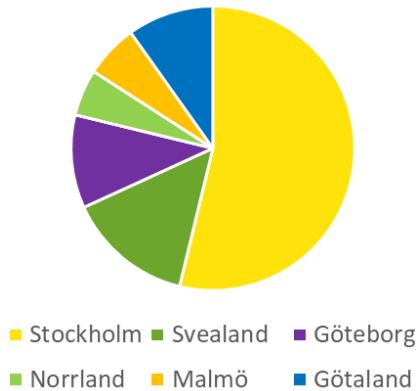
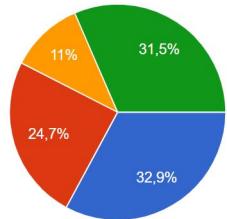


Figure 47

F Pricing Survey

Var bor du? (mest likt)

73 svar



Vad kostade din elbil/hybrid?

73 svar

- Storstad ($\geq 150\ 000$ invånare)
- Stad (50 000 - 150 000 invånare)
- Mellanstör stad (10 000 - 50 000 invånare)
- Småstad/liten ort ($\leq 10\ 000$ invånare)

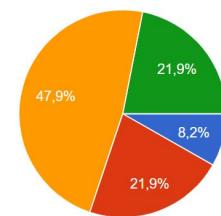


Figure 48

Scenario: Du har möjligheten att erbjuda din parkeringsplats för uthyrning (tänk dig AirBnB fast för parkeringsplatser med laddningsmöjligheter). Du har såklart även möjlighet att själv hyra de parkeringsplatser som finns tillgängliga för uthyrning från andra användare. Vad är du mest intresserad av?

73 svar

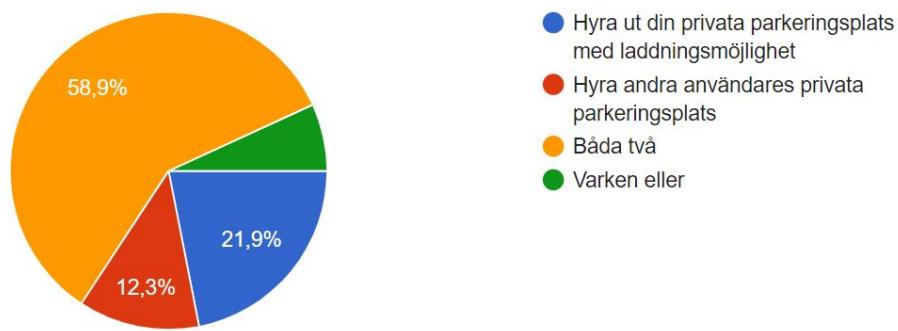


Figure 49

Scenario: Du har möjligheten att hyra ut din parkeringsplats och måste därmed sätta ett pris. Vilken modell känns mest relevant för dig?

73 svar

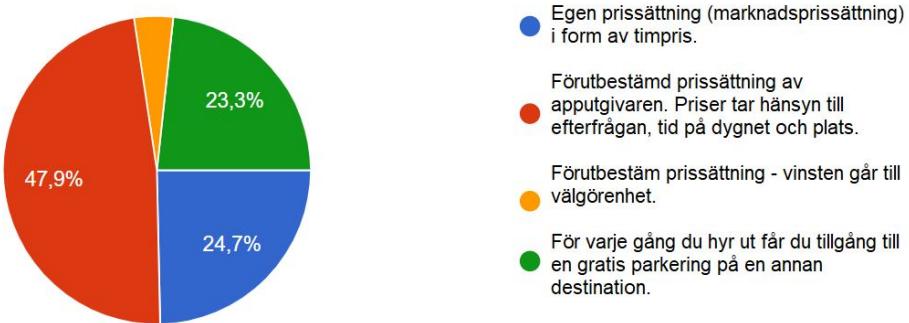
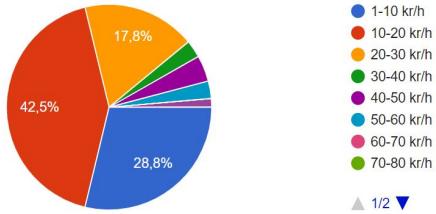


Figure 50

Förutsatt ett timpris, vad skulle du vara villig att betala max för en parkeringsplats med laddningsmöjlighet?

73 svar



Förutsatt ett timpris, vad skulle du vara villig att minst hyra ut din parkeringsplats för?

73 svar

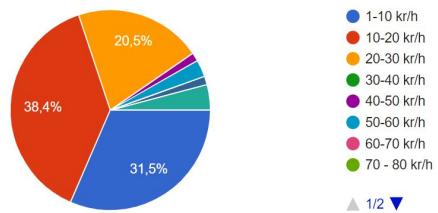


Figure 51