Cargo E-Bike as a Service

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Sammanfattning

Detta examensarbete är ett arbete utfört för forskningsgruppen Green Leap på KTH. Forskningsgruppen arbetar med att engagera design i hållbar utveckling för att verka som en katalysator för förändring. Ett projekt som Green Leap har arbetat med är Ett bilfritt år, där familjer bytte ut sina bilar mot lätta elfordon under ett års tid och deras beteendeförändringar studerades. Projektet resulterades i positiva upplevelser av fordonet lådcykel i vardagslivet utan bil.


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Nyckelord: Elektrisk lådcykel, tjänstedesign, cirkulär ekonomi
Abstract

This Master’s thesis was done with the research group Green Leap at KTH. Green Leap is working for engaging design in sustainable development to act as a catalyst for change. A project that Green Leap has worked with is Ett bilfritt år, where families exchanged their cars for lightweight electric vehicles for a year and the changes in their behaviours were studied. The project resulted in positive experiences of the electric cargo bikes in the everyday life without owning a car.

This master thesis became a concept study to investigate different possibilities of providing electric cargo bikes as a service. Research were carried out on how existing cargo bike services were conducted and user studies were conducted to get the understanding of who the users of cargo bikes were and how their needs and behaviours looked like. Through further insights from a variety of actors, five different possibilities were identified for services for the electric cargo bikes. By comparing the possibilities of the various services, there was an opportunity of designing the same cargo bike for three of the services. The common hardware had a business opportunity for establishing a common platform for different purposes. Different hardware concepts were also developed during the project to facilitate the sharing of the cargo bikes.

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Key-words: Electric cargo bike, service design, circular economy
This report is a documentation of the Master's thesis at the Industrial Design Engineering track at KTH. I would like to thank Teo Enlund who has been the commissioner and supervisor during this project. I would also like to thank Adrián Irala for a rewarding collaboration between our theses. I am grateful to all those who have been part of the project during the research and the user studies.

Marcus Steenberg

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1 INTRODUCTION

Humanity has never consumed as much energy as we do today. The climate of the earth is getting warmer and according to the UN climate panel (Climate Change, 2014), humans has influenced most of this. Earth's rising temperature is a result of continued emissions of greenhouse gases.

Transport is a big part of this and the transport of people and goods with fossil fuels is a contributing factor. Car usage has increased, and that contributes with increasing air pollution, accidents and noise.

The bicycle is the forgotten profit machine that not only reduces each individual's climate emissions, but also contribute to greater economy. And cargo bikes can be the vehicle that can provide most our needs of mobility in a sustainable way.

Meanwhile it is not sustainable that every individual shall have their own products. Being able to share resources between ourselves may give the products a greater value. The products can be used much more and it will be an effective way to conserve the earth's resources.

1.1 Background

Researchers at Green Leap at KTH in Stockholm carried out the project: A car free year – “Ett bilfritt år”, where they studied three families and how they solved the everyday lifestyle with the help of light electric vehicles instead of cars.

The result from the project showed that cargo bikes proved to be a highly appreciated tool through its loading ability. (Ett bilfritt år, 2016). This thesis was a concept study to investigate different possibilities of providing electric cargo bikes as a service.

This Master’s thesis was done in collaboration with Adrián Irala from the Industrial Engineering and Management department at KTH. Both Master’s theses produced individual outcomes. Both Master theses shared the investigation of service possibilities, while this master thesis also focused on hardware solutions, while Adrián Irala’s Master’s thesis had the purpose to research the main barriers of adoption for electric cargo bikes and study the impact of offering them as service (Irala, 2017).

1.2 Problem description

The challenges that exist today are mainly the cost of the electric cargo bike. They have a high price and it becomes expensive for individuals to purchase a electric cargo bike. It becomes also a challenge for companies to run a service with an economic sustainability. The second major challenge is the space for the bike. The cargo bike requires more space for storage than a regular bike. The last major challenge is to optimize the use of the electric cargo bikes. The challenge is to having them in use more than they stands still. A service for sharing electric cargo bikes among users is what’s missing.
1.3 Purpose

The purpose of the project is to act as a catalyst for change into a service paradigm in this segment. The way this project chose to act was through exploring different concepts of how cargo bikes could be provided as a service rather than a product. The objective for this was to allow a better bike that would be used more and to help people find this vehicle as a powerful facilitator when living without owning a car. This would in case help the transition towards a sustainable way of living.

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The project included three areas, visualized in figure 1.

- The service (how to make the bikes accessible)
- The hardware (how to design the bike to suit the service)
- The business model (how to make the concept economically sustainable).

![Figure 1: The project included the three areas](image)

1.4 Goal Setting

The goal of the project was to develop a concept of a service that includes all the three areas previously mentioned. The results had the goal to be presented through a website that would visualize the service as if it were a fully operated service on the market. The project had also the aim to visualize the final concept through a film, to provide the spectators an understanding of the service.

By making this realistic visualization, we hope to draw attention to this opportunity, both to prospect users, as well as entrepreneurs and policy makers to make it happen for real.

1.5 Delimitations

The project stayed at a theoretical level. The outcomes from the project was meant to only be concepts and suggestions. Due to a geographical limitation, the focus of the research and the outcomes of the project was primarily set on Sweden and the area of Stockholm.
1.6 **Methods**

The methods that were used in the project is presented here.

1.4.1 **Data collection**

Internet browsing and literature studies were used to gain a deeper understanding of the problems and possible solutions.

1.4.2 **User studies**

User studies have been used to gain an understanding of who the users were and their needs.

1.4.3 **Data Analysis in SPSS**

Analysis of the received data have been analysed through the software SPSS Statistics. SPSS Statistics is a powerful tool that makes it easier to manage and analyse data (Ibm.com, 2017).

1.4.4 **Concept ideation**

Concept ideation have been used to get a breadth of possible solutions to evaluate and to be discussed and tested with users.

1.4.5 **Visualization**

Digital illustrations, web design and filmmaking have been used to visualise concepts for services and hardware solutions.
This chapter presents a summary of necessary knowledge for the performed research.

2.1 Service Design
This subchapter outlines the theory behind service design and briefly explains how to apply the tools. The knowledge comes from the book: This is service design thinking by Stickdorn and Schneider.

2.1.1 The five principles of service design thinking
The five principles of service design thinking are User-centered, Co-creative, Sequencing, Evidencing and Holistic. (Stickdorn and Schneider, 2016)

User-Centered
It is important to understand the users to be able to develop the best services. Understanding who they are, their needs, their values and how to connect with them is important. Through meeting with the users and insights from them gives a deeper understanding.

CO-Creative
To be able to get the insights from the users it is important to involving them in the process. Engaging them could be through interviews, testing concepts and evaluating prototypes in an iterative process.

Sequencing
It is important to understand the whole experience, and the whole experience is divided into different sequences. One sequence for every touch point. Before, during and after the service.

Evidencing
Services often take place unnoticed in the background. By evidencing certain aspects of the service, it can explain the touchpoints or the process. The evidencing adds a tangible component into an experience and can occur in various forms like bills, brochures, email, signs etc. Otherwise the experience would have been intangible. Every service needs to design the evidence according to its touchpoints sequence.

Holistic
Holistic intension is to see the bigger picture and to see the wider context in which the service takes place. It is impossible to study every single aspect of the service but the focus should be on the environment where it takes place.

2.1.2 Product Service System (PSS)
PSS is a system where you look into both the product and the service and Stickdorn and Schneider (2016) calls this a product-service hybrid. They describe the hybrid products as products that has implemented a service in a product. The design process for these hybrid products have a process were the product design and the service design is developed in tandem.
2.2 Cargo bike
Collection of information on cargo bikes and electric bikes. Investigation of different types of cargo bikes available on the market and rules around electrically-assisted bicycles has been made.

2.2.1 Cargo bike models
There is a variety of models on cargo bikes and the website Cyklamedlastcykel.se (2017) describes 4 different models of cargo bikes.

Longtail
Longtail is a bicycle with a longer back part, giving the opportunity to pack a little extra on it, see figure 2. The bike has almost the same driving characteristics as a regular bike and it is easy to maneuver.

![Figure 2: A longtail cargo bike](image)

Mini cargo bike
This bike has smaller wheels to get more space for cargo, without making the bike too wide or long, see figure 3. The small wheels also give a lower center of gravity. With the smaller size of the bike it is easy to handle and transport.

![Figure 3: A Mini cargo bike](image)
2-wheeled cargo bike
This bike has the cargo space between the handle bar and the front wheel, which makes the bike lightweight, fast and can be tilted in curves like a regular bike, see figure 4. The bike is also easy to drive on narrow bicycle tracks and slim enough to get into bicycle storages and through narrow doors.

![Figure 4: A 2-wheeled cargo bike](image)

3-wheeled cargo bike
Three-wheeled cargo bikes usually have two wheels in the front and one at the rear but may also have the opposite arrangement, see figure 5. These cargo bikes are more stable and easy to keep the balance with. The three-wheeled cargo bikes are slightly wider and can be tricky on narrow bicycle tracks and difficult to get into the bicycle room.

![Figure 5: A 3-wheeled cargo bike](image)

2.2.2 Electric bike legislation
In order for a bicycle with an electric motor to be approved as a bike, the electric motor will only give electric assistance when the pressure in the pedals increases. That means that the motor will only boost the power from the pedals (Transportstyrelsen.se, 2017). The motor cannot have a power greater than 250W and not provide any power input at speeds above 25km/h. That includes all electric vehicles with pedals (Transportstyrelsen.se, 2017). The purpose of electric assistance is to make it easier for users, for example, in uphill or with heavy loads. If these requirements are not met, the vehicle is not considered a bike anymore. It is probably considered to be a moped and then other requirements and rules must be followed for being able to use it in traffic. It was decided to have the vehicle as a bike instead of a moped because bikes do not require a driving license and makes the vehicle more accessible to people.
This chapter describes the performed research during the project that includes market research, user studies, observations and insights from different actors.

### 3.1 Cargo bike sharing services in Europe

Services for cargo bikes are very rare, but around Europe, the cargo bike has got more attention. So, a market research was carried out to investigate existing cargo bike services in Europe to gain insight into various opportunities for providing the cargo bike as a service.

#### 3.1.1 Vienna Cargo Bike Collective LRK

LRK (Lastenradkollektiv.at, 2017) is a non-profit organization in Vienna that aims to help people to transport things without the need for cars or trucks. The cargo bikes can be borrowed with a voluntary donation. When loaning a cargo bike, a deposit of 80 € and an ID document is required. The deposit will give people means of returning the cargo bikes and it is used only to cover any damage to the bicycle if damage occurs. To book a cargo bike, the booking must be made no later than 3 days before the event. The booking is made by email to the organization, indicating the desired lending time. Currently, LRK has 11 cargo bikes with different models for different needs. The website describes what the specific model is most useful for, technical information about the model and where in the city it is located.

#### 3.1.2 Carvelo2go

Carvelo (Carvelo.ch, 2017) is a Swiss initiative for bicycles of Mobility Academy and the Funding Fund Migros. The purpose of the initiative is to promote the use of cargo bikes within companies and for private use. The carvelo2go service provides electric cargo bikes as a division service for both households and companies in a number of cities in Switzerland (Uns and Funktionierts, 2017). Through their platform, users can reserve and use the cargo bikes. Small and medium-sized local businesses become so-called "hosts" to the cargo bikes to provide the keys and batteries to users. Businesses can be anything from restaurants, post offices or shops and for being a host they get in exchange to use the cargo bikes for their own transportation needs. To access the service, users register an account for free on their website (Carvelo.ch, 2017). It costs CHF 5 for the first hour and CHF 2 per hour for the rest of the hours. When the user reached the tenth hour, it becomes CHF 1 per hour (CHF stands for Swiss francs). To get access to the booked cargo bike, the users need to show their ID document to the host and the host will provide the keys and battery to the user. Carvelo2go exists so far in the cities of Bern, Basel, Vevey and St Gallen.
3.2 User studies
The user study was conducted with the focus of finding out who the users of cargo bikes were and their travel habits with and without the cargo bikes. The user study also took into account people who did not use cargo bikes to find out the reasons for that. The user studies were conducted through an online survey and interviews.

3.2.1 Survey
The survey was conducted as an online form shared on 2 major Facebook groups, Cykla med lastcykel and Cykla i Stockholm. “Cykla med lastcykel” was a group for cargo bikes users and people interested in cargo bikes with 3104 members. “Cykla i Stockholm” was a group for bike riders in Stockholm with 3574 members.

The survey attracted a total of 85 respondents and the collected data was analyzed using the IBM SPSS Statistics software. 65 of the respondents had cargo bikes and the rest did not.

Cargo bike users
The result of the respondents from the cargo bike users is illustrated in figure 6.

The majority of the respondents lived in the municipalities of Stockholm and the suburbs of Stockholm. The gender distribution in the survey was 68% men and 31% woman. 1% of the sample preferred not to tell. 63% of the respondents belonged to the age group 35-50 and 31% belonged to the age group 25-34. Respondents aged between 18-24, 51-64 and more than 65 were 2%, 3% and 2% of the sample. Type of household they lived in were, condominiums (32%), villas (32%), tenancies (23%) and terrace houses (12%). 78% of these homes were inhabited by families with children and the three main reasons for using the cargo bikes were transporting heavy things, shopping and carrying children. The type of cargo bikes the users had were pretty even with 51% using two wheeled cargo bikes and 43% using three wheeled cargo bikes. The rest of the percentage used other types of models like bike trailers.
Non-Cargo bike users
Findings from the survey showed that it was two main reasons for not owning a cargo bike. The cargo bikes were considered expensive and storages for the cargo bikes were considered a problem. The complete survey is showed in Appendix A.

3.2.2 Interviews
Interviews were conducted with totally of four people. Two people did not own a cargo bike but were considered a potential future user. The other two people participated in a cargo bike pool.

Non-cargo bike users
The people who did not own cargo bikes were asked about their interest in cargo bikes, how their behavior would change if they would have access to one and why they did not own one. Even how a service would make them use cargo bikes. See the questions in Appendix.

Non-user #1
This person currently used a trailer behind the bike to be able to drive the kids to and from school and daycare. The reason for using a trailer instead of a cargo bike was that the trailer was the budget solution for his needs. The thing that would push him to use a cargo bike instead would be a monthly payment solution. He could consider using a cargo bike service system if it was close to home. The most important factor was to having the service convenient for him to be able to use it. He had an understanding that a change in his behavior would be needed for using a shared cargo bike service. His needs for the cargo bike service would require more planning and preparing in his everyday lifestyle.

Non-user #2
She was currently borrowing a cargo bike from work when she needed to. That had changed her behavior to using the public transport less and using bikes more. She had a distance of 17 kilometers to work and that was faster with bike than public transport. The thing that stopped her from purchasing a cargo bike was the high price and the difficulty to park it. She did not think it was safe to park the cargo bike without to locking it into something. She felt the same even if the cargo bikes was parked in the bicycle storage room in her building. She could consider using a cargo bike service depending of the price, availability and accessibility. She thinks it would be perfect for a “Bostadsrättsförening” (housing association) to have a cargo bike pool.

Cargo bike pool users
Two members in the “Gamla stan lådcykelpool” were interviewed and asked about how they used the cargo bikes and their opinions of sharing cargo bikes with others.

Common for the users were their behavior of booking the cargo bikes. The booking of the cargo bikes was a spontaneous behavior and done just before borrowing them. It could happen that the users booked the cargo bikes some days in advance, but only for unique occasions. The booking system was operated through a website and the members had the freedom to borrow the cargo bikes as long as they wanted. The unlocking of the cargo bikes was done through a keyless solution by using an app with a Bluetooth lock.

These users used the cargo bikes mainly for leisure time with their families. But they mentioned that the usage of the cargo bikes were extended after a while. A memorable example was that one user used a cargo bike to move office supplies from one office to another. The cargo bike fitted in the elevators and could be driven all the way into the rooms of the offices.
3.3 Observations
Observations of the bicycle sharing system in Stockholm were conducted.

3.3.1 City bikes Stockholm
Several tests of the bike sharing system City Bikes in Stockholm were performed to understand how the system worked from the user's point of view. The four main areas that were investigated was how to access the service, finding the bikes, user session and ending the user session.

Access
In order to access the bikes, a user account was required and that could be done on the company's website. A season ticket cost 250 SEK and was valid between 1 April and 31 October. The company provided an access card for the service but it was possible to connect the service on the public transportation access card.

Finding stations
Through the provided app, users could get information about where the stations were placed in the city, see Figure 7. The app also provided information about the number of bicycles available per station.

User session
To unlock the bicycles, the activated access card needed to be placed on a card reader, which can be seen in figure 8.

Figure 7: In use with the City bike app

Figure 8: Card reader for City bike
At the bicycle rake, each bicycle had diodes at its place that changed from a red light to a green light to indicate which bike was unlocked. That can be seen in figure 9.

![Figure 9: Indicator of the bikes status](image)

There was the possibility to adjust the seat height of the bikes, see figure 10. Unfortunately, there was not possible to adjust the handlebar.

![Figure 10: Seat adjustment](image)

The bike could be borrowed for three hours at a time and if delays of the returns occurred, a warning would be reported. After three warnings, the access for the bikes would be blocked (Citybikes.se, 2017).

**Ending the user session**

Returning the bicycles were done by placing the locking mechanism on the bike in the locking holes, which can be seen in figure 11. After locking the bike in place, the users do not need to do any other action to confirm the return.

![Figure 11: Locking mechanism](image)
Redistribution of bikes
The flow of bike use does not occur evenly in the city and therefore redistribution of the bikes is needed. Figure 12 shows the distribution unit that has transported bikes from other stations to this one.

![Redistribution unit](image)

**Figure 12: Redistribution unit**

Comments
As a beginner of cycling in the city, it was difficult to know how to get to the desired station. With a low awareness of how the bicycle roads in the city of Stockholm were located, it became confusing to drive in the city. A map showing the recommended bicycle roads would have been helpful.

The quality of the bikes varied but were sufficient to drive the needed distance. The disadvantage of a system such as this was that the use of these bikes could only happen between the specific stations and that the last bit to the destination needed to be made on foot. This system does also not allow the ability to make errands on the way because the bikes do not have any locks.
3.4 Input
A lot of input from different actors were received during the project. The inputs came from researchers from KTH, a cargo bike expert, a cargo bike pool, Stockholm Stad and an architectural design office.

3.4.1 Lådcyklar och bilfria vardagsliv
A research project from KTH (Börjesson Rivera, Henriksson and Liljenström, 2014) gave residents in Bagarmossen, a suburb south of Stockholm, access to three free cargo bikes as a cargo bike pool. The residents had the opportunity to book and use the cargo bikes between April to November 2013.

The result showed that nearly 20% of the total 260 households booked the bikes one or more times. 5% of the residents used the bikes ten or more times.

The research interviewed 12 households in depth, both men and women, people living with a partner and single people, in ages between 12-72. The interviewed included both car-free households and those with cars.

In common for the users that were interviewed in the research, was that they lived several people in the household. All of them had children in different ages but most of them with children in the school age or younger. Another common factor was that they had a desire to live a car-free everyday life. Most of them had driving license or a partner with one but they preferred to live without a car as far as possible. Some of the interviewers used bicycles to and from work and others went by the public transportation.

The users had several different kinds of transportation needs because of the desire to live a car-free everyday life. The cargo bikes were used for outings and errands, i.e. both leisure and utility trips. For example, weekly shopping to the supermarkets, transporting bulky or heavy items or for transportation of smaller children to different places.

3.4.2 Gamla Enskede Lådcyklar
Gamla Enskede Lådcyklar is a company with experience in bicycle design, environmental research and bicycle safety. They sell different models of cargo bikes but also offer bicycle transport solutions such as bicycle pools (Gamla Enskede Lådcyklar, 2017).

During a conversation with Måns Andersson from Gamla Enskede Lådcyklar, cargo bikes and cargo bike pools were discussed. The things that were discussed was the price difference between cargo bikes and regular bikes, how a cargo bike pool could be economically sustainable and in which area there was a potential in development.

Differences between bikes and cargo bikes in price
Regular bikes can be made very cheap. For cargo bikes, it is different as they have higher requirements to adhere to. The cargo bikes need to be designed to carry heavy loads and breakage is devastating. The construction and components of the cargo bike must have a higher quality and that is the reason for the higher price. The cost of repairing the cargo bikes will also be higher.

Economic solution
Gamla Enskedes Lådcyklar thinks that it is a big challenge to get cargo bike pools financial sustainable because of the expensive bikes. One possible solution that they believe in could be that cargo bike pools should be planned into the construction of new resident buildings. Construction companies could then save a lot from what they would put on parking spaces. Gamla Enskedes Lådcyklar think that it could be difficult to get the same impact on existing resident buildings.
Development
Locking and booking systems is an area of great potential in development. Sharing bicycles between people who know each other is quite simple, but when sharing between those who do not know each other, it becomes more challenging. A keyless solution with a user-friendly booking system is what should be developed. Another area for development is how to get users to take responsibility for the bicycles without the ownership.

3.4.3 Gamla stan lådcykelpool
Gamla stan lådcykelpool is an association that operates as a courtyard association in Svenska bostäder. Purchase of the cargo bikes is mainly sponsored by the tenant association Stadsholmen. The association has decided to include all residents in Gamla Stan, a cohort of 2700 people, as members of the association (Gamla Stans Lådcykelpool, 2017).

Through a conversation with Mikael Beving, one of the initiators in the association, the cargo bike pool was described in more detail.

General Information
The cargo bike pool started 2015 and currently has two cargo bikes, one Bullit and one electric driven Livelo. They also have two regular bikes and one of them is electric as well. The pool is for the residents of Gamla Stan and had 76 registered members in April 2017.

Funding
The property owner Svenska bostäder, have around 50 buildings at Gamla Stan and they dedicate part of the revenue from the rents to the pool. The residents who lives in one of their buildings can access the pool with no additional cost. For those people who does not live in a building from Svenska bostäder, but still lives in Gamla Stan, can pay a yearly subscription between 100-400 SEK. For 100 SEK, people can try the pool for a month. For 200 SEK per year, people can use the bikes up to twelve times. For 400 SEK per year there is unlimited usages of the bikes.

The cargo bike pool is a non-profit association, so they do not have the purpose to make any money from it. But they haven’t reach the state of covering all the expenses with only user fees yet. Such as maintenance and new bikes. But Mikael is considering local advertising as a high potential source of revenue. Such as local coffee shops and so on.

Usage
The cargo bike pool works experimentally. They test a lot of different things. Before purchasing a new bike to the pool, the users can test a variety of different bikes and the pool gets their feedback and purchases the bike most people wanted. They have also experiment with other electrical vehicles for the pool.

They think that it is important to have a low threshold for the user to use the cargo bikes. They have a keyless lock that uses Bluetooth technology. All members can unlock their bikes with their own smartphones. For booking the bikes, the pool uses a booking system via a website where users can see the status of the bikes, book which bike they want and register the desired time to borrowing the bike.
Gamla stan lådcykelpool thought that it was important that the usage should be unlimited in time. If users need the bike for a whole day, there should not be any problem for that. Mikael prefered an A-A model (pool). It may be a less efficient way to share bikes but the user experience would probably be better when users can borrow the bikes as long as they want.

Any member can take the bike to the associated workshop in the area. If there is a major issue with the bike, they call the person responsible of the pool. Mikael estimates that it is approximately 1000 SEK/year per bike.

**Main Challenge**
The main challenge for operating a cargo bike pool is the insurance. At the moment, the cargo bikes are so far not insurable. It makes it a challenge to operate an economical sustainable pool without economical compensation for theft.

Another issue is that there are mainly male users (up to 90%). Mikael guess that it is related to the current choice of bikes and seats. Those models maybe less appealing to women.

**3.4.4 Stockholm stad**
A meeting with Helene Carlsson at Stockholm City took place to gain a deeper understanding of what role the city of Stockholm may have in a bicycle system in the city. Helene also described a project called Civitas Eccentric that she worked with. A project founded by EU to test an interconnected transport system between local traffic, car pools, and bicycles in Stockholm.

**Stockholm's role in a bicycle system**
The city does not have the ability to operate a bicycle system in the city. The way to make it happened is through private operators who will manage and operate the system. The involvement from the city will be to provide space for the stations. The city gets a bicycle system in the city and the companies get in exchange room for the stations and bicycles.

**Dedicated parking places in the city**
During the meeting with Helene Carlsson, the problems that currently exist by car pools were explained. The companies that run the car pools want dedicated parking spots to car pools in the city, but that will be difficult to execute in practice. The city cannot provide an area for specific private actors because the area is dedicated to the public.

**Civitas Eccentric**
Civitas is an initiative that is co-founded by the European Union and was launched by the European Commission in 2002 (Civitas.eu, 2017). The purpose is to get better and cleaner transport in Europe through a network of dedicated cities in Europe. Through living labs in European cities, the initiative has tested and implemented a large amount of urban transport solutions. The results of the tests are supported and supplemented from several research projects, one of them is Eccentric. The research project Eccentric focuses on, among other things, sustainable mobility in suburban districts (Civitas.eu, 2017). The aim for the project is to test innovative sustainable mobility solutions in five living labs in Europe. The cities are Stockholm, Madrid, Munich, Turku and Ruse. The tests will integrate policies, technologies and soft measures.

Stockholm will focus on mobility as a service and test a variety of concepts for more sustainable transport in Stockholm (Stockholm.se, 2017). The project will test, among other things, a new mobility service to combine public transport, car sharing and bicycles. New electric vehicles that will be tested by users for a longer period of time. Improvement of parking possibilities in the suburban areas to facilitate transport change between cars and other means of transport.
The actors involved in this project are: KTH - Integrated Transport Research Lab, Snappcar, UbiGo Innovation, GoMore ApS, Mobility Motors Sweden, Cykelkonsulterna and Stockholms stad – Miljöförvaltningen och Trafikkontoret

3.4.5 Theory into practice

Theory Into Practice is an architectural agency in Stockholm that focuses on sustainable society development. Their approach is to combine theory and practice to lead knowledge to clear results. They work with practical research and aims to influence the society, explore new long-term models and propose alternative development paths (Theory Into Practice, 2017).

**Mo-Bo, A home with integrated mobility solutions.**

Mo-Bo is a project where Theory Into Practice examines how architecture can enhance the transition to a sustainable society. This is conceived by increased sharing and increased mobility in a housing project in Vilunda (Theory Into Practice, 2017). A meeting with Anna Sundman on Theory Into Practice took place to gain more insight about the project and information about regulations for homes with reduced parking places.

*General information*

The housing project Vilunda is a project that includes mobility service solutions in the buildings. The plan is to build 64 apartments divided between two buildings. The majority of the apartments will be family oriented but there will also be student apartments in the building. The project is planned together with many different actors and they are the municipality of Upplands Väsby, Theory into practice as architects, Laterre as the building contractor, Q Gruppen as the construction company, Cykelkonsulterna, Sunfleet and researchers from KTH.

The plan for the buildings is to design the basement into a social space instead of a parking garage. The intention is that the entire building should give the feeling of being part of the home. The buildings are located near both a train station and a shopping area and the plan is to invest in mobility services for the residents. The plan includes a car-pooling service with 3-4 cars and spaces for regular bikes and a cargo bikes pooling service. The interesting part of the project is that the buildings are located in an area designed for cars. Anna says: “It is not like Södermalm where nobody really need cars.”

If the buildings would instead have parking garages in the basement, there would fit 46 cars. Anna says that the price for parking spaces for new construction is estimated to be between 250-400 thousand SEK per parking spot. By reducing the number of parking spaces, construction companies can save huge costs on the construction sites. But this cannot be determined entirely by construction companies. There are requirements and regulations from the city about how many parking spaces per inhabitant of the new building should have, so-called p-tal.

*Green parking number*

In order to determine the number of parking spaces that need to be provided for new construction, there is something called parkeringstal (p-tal). The purpose is to ensure that the right number of parking spaces is provided (Stockholm City, 2015).

Green parking number (Gröna p-tal) is an optional addition to new construction as an adjustment of the number of parking spaces. The adjustment is based on the mobility services offered to the property and which can motivate a reduced number of parking spaces. Some examples of such services are: Car pool membership, Cargo bike pool and Home delivery storage compartment in the property.
Long term solution
The apartments will be resident owned apartments (Bostadsrätter) and it is important that the buildings are designed after the needs of the residents. The city doesn’t want the residents to vote away the mobility services in the buildings after a few years. Because then the residents in the building will have a too low Mobility index. And that will not be acceptable. The involved actors in the project have a plan to keep engaged and involved with the community and the decisions about mobility in the buildings.
This chapter describes how the insights from the conducted research turned into concrete proposals for services and the hardware.

4.1 Service development

By analyzing the performed research, the user studies and the inputs from the various experts, a variety of types of services were developed. In order to develop different concepts of services for the cargo bike, the user frequency was used as a measurement. User frequency was a good measurement for spreading the services for all different needs in society. There are users who have a great need to use the cargo bike a lot, and there are others who have less need for a cargo bike and will use it less often. For that reason, the services were mapped from a high frequency use to a low frequency use.

A high frequent user uses the cargo bike daily and must have access to a cargo bike when needed. A solution that meets the needs is the service Leasing. The user has access to a cargo bike as if it was her own.

A medium frequency use of the cargo bike fits well for the service Pooling. The insights from the cargo bike pooling studies showed that pooling had a great potential for a cargo bike service. At apartment houses, a lot of people lives in the same area, and with the medium frequent use of the cargo bike, the pooling service is a great solution for this.

With insight from the city bikes in Stockholm, the idea of adding cargo bikes to a similar system was developed. The usage might be less frequent from the individual user, but this service had a great potential for reaching many users.

A low-frequency use of the cargo bike fits well for a service that targets more spontaneous users. The cargo bikes would be scattered around the city and there would be no need to lock the bikes at specific locations. Spontaneity would be the excellent way to use this service as it becomes hard to rely on access to a cargo bike for higher frequent use. The service could also bring an interest in electric cargo bikes and act as an entry product. The service would be great for people who want to try out electric cargo bikes and that could develop people’s behaviors for a more frequent use.

Through analysis of the user studies, the purpose of the use with the cargo bike was presented. The users used, as mentioned before, the cargo bike primarily to carry children, for shopping and transport heavy things. To reduce the number of trips for the user between the various sites, a service was developed and it had the opportunity to cooperate between different stakeholders. The service became a merger between the Pooling and Station services. The user could then use the cargo bike like the Station service but all the way to the destination, like the Pooling service. The user frequency for this service will be in the middle between those two services.
4.2 Hardware development

The survey from the user studies showed that the use of the two different models of cargo bikes, two wheels and three wheels, was almost the same. Instead of developing a concept to design the optimal cargo bike, the reasoning changed and a concept for a fleet of cargo bikes was developed for the services. The range of the fleet was chosen to be designed with focus on the user needs. It was chosen to present the various cargo bikes in a Small, Medium and Large solution. The different sizes of the cargo bikes would provide different solutions for the user needs. The Small solution could solve the minor needs while the Large solution could solve all the necessary needs.

The user studies also showed that users used the cargo bikes for a variety of purposes. Carry children and transporting things requires different design in the cargo space. There was a need for an adjustable cargo space and development of different solutions occurred.
In the results chapter the results that are obtained with the process/methods described in the previous chapter are compiled, and analyzed and compared with the existing knowledge and/or theory presented in the frame of reference chapter.

Through the research and insights gained, developments of possibilities for providing cargo bikes as a service were done. It resulted in five types of services. Figure 13 shows the different types of services and their characteristics.

Below, each concept is described in detail by a description, a SWOT analysis, a blueprint, and an example of a journey map.

Two types of journey maps with the cargo bike have been presented. Shopping and drive children to and from school. According to the survey conducted at the start of the project, these two types of trips were performed most with the cargo bike.

5.1 Leasing
The advantages of leasing are numerous. A purchase of a product is a big investment but under a lease, the costs are distributed over a longer period of time. Customers do not have to own old equipment that they later have to sell. Instead, they can update to developed equipment. Insurance, additional services and maintenance costs come on a comprehensive bill that simplifies the payment for customers.

The leasing business could have two options. Delivering cargo bikes to the costumers or having the costumers come to the store and drive the cargo bike themselves.
5.1.1 Home Delivery

Description

As illustrated in figure 14, users contact the company and the company will present the needs of the users. The company delivers the desired cargo bike. Maintenance of the bike are included and users contact the company for maintenance, the company sends a person for it. In need of a new model of a cargo bike, the company delivers a new one and the old are taken back to the company.

SWOT

Figure 15: SWOT analysis of home delivery leasing service

As described in figure 15 the strength of this service is that it is very easy for the user to use the service. Users only need to contact the company from home and everything is delivered only home. It will also be simpler for the users to use as maintenance and insurance are included in the price. The weaknesses of the service are that the delivery and the repairs of the cargo bikes will be a major cost for the company. The cargo bikes are also not utilized to their full capacity. It is still unused when the user is not using it. One opportunity for the service could be the availability. The service could provide cargo bikes regardless where people live and that would be a great opportunity to provide electric cargo bikes to many. A major threat for the service would be if a company succeeds to provide electric cargo bikes with low prices. That could be devastating and there would be no need for a leasing contract. To meet this threat, the service needs to provide the customers with high-quality cargo bike and invest in services around the cargo bike such as maintenance and support.
As described in the blueprint, figure 16, customers pay attention to the service and register on the company website. Customers also register their credit card to pay for the service monthly. On the homepage, they will select the type of cargo bike they want. The chosen cargo bike will be reserved and sent out to the customer. Customers use the bikes during the desired period and in need of maintenance, they will register the needs on the website for maintenance. A service car gets to the customer and repair cargo bike. When customers need to change the model of the bike, they will do a registration on the website and the company comes out with a new bike and the old one will be brought back. When users choose to end the subscription of the cargo bike, they un register on the website and the company picks up the bike.

5.1.2 Self-pickup
Description

As illustrated in figure 17, users contact the company and they carry out leasing at the shop. The users takes the cargo bike home. Maintenance of the bike is included in the price but the user takes the bike to the store’s maintenance shop for repairs and other services. Also, the swap to other models of cargo bikes takes place in the store.
As described in figure 18, the strength of this service is the familial relationship between the company and customers when the store becomes a gathering place for the service. The company can provide a product that suit the user’s needs. Leasing, maintenance and replacement of cargo bikes takes place all under one roof.

The stores need to be locally close to make the service viable. If the distance is too far between the user and the company, the service becomes more inaccessible than available when the users themselves need to get to and from the store with a cargo bike.

A possibility for the service is to provide a lot of small shops scattered throughout the city to allow the user to reach to the local store. This gives an opportunity to increase the attention to electric cargo bikes.

A threat for the service could be that people do not dare to try the service. People with no experience with cargo bikes would have a hard time to understand the possibilities that the cargo bike could provide. To avoid this, opportunities for testing the service should exist.

As described in the blueprint, figure 19, customers get attention of the service and visit the nearest store. In the store, the costumers get details and the company adapts a cargo bike for the customer needs. The customer signs up and takes a cargo bike home. The customer uses the bike during the desired time and in need of smaller maintenance, the customers drives in with the bike to the store. Replacement of the cargo bike to other models also takes place in the store. When finished using the service, the customers return the bike in the shop.
5.1.3 Journey map
The use of the cargo bikes will be the same for both leasing opportunities.

Journey map - Driving kids

Figure 20: Journey map of driving kids with the leasing service

Figure 20 shows how a trip with children could take place with the leasing service. The user have the opportunity to use the bike from their home and drive their children to school. Then they have the option to commute to the job with the cargo bike.

Journey map - Shopping

Figure 21: Journey map of shopping with leasing

Figure 21 shows how a journey for shopping could be done with the leasing service. The user drives to the store, locks the cargo bike outside, shop and then unlocks the cargo bike and drive home.
5.2 Pooling

5.2.1 Description

As illustrated in figure 22, the cargo bikes are located in residential areas. The bikes are placed in special bike racks with power supply for charging the batteries. The access to the cargo bikes is through an app and the users need to book when they want to use it and for how long. When the cargo bike is reserved no one else can book it. The membership in the pool could be included in the rent or a separate membership.

5.2.2 SWOT

As showed in figure 23, the strength of the service is the high frequent of use of the cargo bikes because more users have access to the same cargo bikes. With visible available bikes, there is an opportunity for more spontaneous use.

One weakness with this service is that the usage could be limited. The service movement is limited to a A-A motion. Which means that the cargo bikes need to be returned to the pool so other users can use the bikes.

An opportunity for this service could be that the construction and real estate company could make a profit by providing a cargo bike pool instead of providing expensive parking spots.

If the regulations in number of parking lots would be changes to an increased number, it would be problematic for the service to be financed. This threat is hopefully very unlikely for today's concerns of the environment.
5.2.3 Blueprint

As described in the blueprint, figure 24, the residents will register in the system and download the app to be able to use the service. Users checks the availability of the bikes and reserve them for the needed occasion. When it is time for using the bike, unlocking of the bike is through the app. The user uses the bike during the booked time and returns it when the time is up. The user locks the bike in the bike rack for ending the session.
5.2.4 Journey map
Journey map - Driving kids

Figure 25: Journey map of driving kids with the pooling service

Figure 25 shows how a trip with children can be done with the Pooling service. The user reserves a bicycle at the desired time. Unlocks it and drives to the school with the kids. When the user have left the children, the cargo bikes is returned to the pool. The user commutes to work with public transportation and on the way back from work, a cargo bike is reserved. The cargo bike is unlocked and the pickup of the children takes place. The user drives home and locks the bike at the pooling rack.

Journey map - Shopping

Figure 26: Journey map for shopping with the pooling service

Figure 26 shows how a trip with the pooling service could be done for shopping. The user reserves a cargo bike. Unlocks the bike through the app and drives to the store. The cargo bike locks outside and shopping takes place. The cargo bike unlocks and the user returns home and return the cargo bike at the pool.
5.3 Station

5.3.1 Description

The Station service is illustrated in figure 27. The stations are located around the city. Users use the app to find the nearest station and to check the availability of the cargo bikes. Users have the possibility to reserve a cargo bike a few minutes before, to ensure getting one. The users have the possibility to leave the cargo bike at another station. Redistribution of the cargo bikes will be done to ensure that they are distributed evenly in the city.

5.3.2 SWOT

![Diagram showing SWOT analysis]

Figure 27: Illustration of the station service

As showed in figure 28, one strength for this service is that the cargo bikes are available to everyone in the city and the bikes can be used by many different causes and people. A weakness could be that the users need to get to and from the stations to use the service. This could cause additional steps for users to use the service. An opportunity for the service is that the stations could be a part of the city’s transportation system and a membership in the service could include all the different transport modes that the city provides. The stations position must be well placed to not create disadvantage for the users. The users should not have to walk long distances to get access to a cargo bike. Otherwise the service will be insufficient and that could be a big threat for the service. Users could choose to use other solutions for their needs and the service could become unused. To avoid this a well-worked strategy for the relocation will be required. By testing studying locations with users this can be avoid.
As described in the blueprint, figure 29, the user register in the service system in the provided app. The app is used for checking the availability of cargo bikes and booking of the bikes. The user arrives at the station and unlocks the reserved bike with the app. The user uses the cargo bike and return it to any station in the city.
5.3.4 Journey map

Journey map - Driving kids

Figure 30: Journey map of driving kids with the station service

Figure 30 shows how a trip with children could be done with the Station service. The user locate and reserves a cargo bike minutes before the needed time. The user walks with the children to the cargo bike station and unlocks it. When the user has left the children, the cargo bikes is returned at nearest station. The user commutes to work with public transportation and on the way back from work, a cargo bike is reserved a few minutes before arriving to the station. The cargo bike is unlocked and the pickup of the children takes place. The user drives home and locks the bike at the nearest station from home and walks home.

Journey map - Shopping

Figure 31: Journey map of shopping with the station service

Figure 31 shows how a trip with the Station service could be done for shopping. The user reserves a cargo bike, minutes before the needed time. Walks to the station and, unlocks the bike through the app and drives to the store. The cargo bike locks outside the store and shopping takes place. The cargo bike unlocks and the user returns home and leave the shopping bags at home. Then the user return the cargo bike at the station and walks home.
5.4 Free Floating

5.4.1 Description

The Free Floating service is illustrated in figure 32. The cargo bikes are parked freely in an area. Users locating them through an app. With the push of a button on the app, the bike unlocks. The users use the bikes and the when finished, the bikes locks through the app. The bikes need to be parked in specific areas. Otherwise, they cannot be locked, and then the fee will continue to be deducted until the cargo bike is back in the area.

5.4.2 SWOT

As showed in figure 33, one strength for the service is the convenient usages without needing to park in specific racks. The users could park anywhere within a specific area.

A major weakness for the service could be the charging possibilities. The bikes will not be charge at a bike rack so there will be a problem for charging the batteries. An alternative could be a charging unit that would drive around and replace the batteries with fully charged batteries when needed.

An opportunity for the service is that the free floating cargo bikes could give the opportunity for a more spontaneous use if they are spread and visible around the city. And this would increase the awareness of the electric cargo bike.

A threat for the service could be parking regulations of the cargo bikes. The cargo bikes need to be allowed to be parked around the city and the city needs to approve it. The parking could get a problem for others in the city. If people park them at inconvenient places, the service will get bad reputation and the city could decline the possibilities for parking. To avoid this, a development of the service should be in tandem with the city.
5.4.3 Blueprint

Companies provide cargo bikes in the city. These are parked freely around town in confined areas. Customers signing up to the service and downloading an app. The app located and reserves bikes. Customers use cargo bikes when needed and locks them in the specific area. When the batteries of the bikes needs to be charge, the company goes out and replace the batteries with fully charged batteries. The blueprint of the free floating service is illustrated in figure 34.

Figure 34: Blueprint of the free floating service
5.4.4 Journey map
Journey map - Driving kids

Figure 35: Journey map of driving kids with the free floating service

Figure 35 shows how a trip with children could be done with the Free floating service. The user locates and reserves a cargo bike minutes before the needed time. The user walks with the children to the cargo bike and unlocks it. When the user has left the children, the user commute to work with the cargo bike and locks it outside. When returning home, a new bike is located and unlocked. The pickup of the children takes place and the user drives home and locks the bike at the street outside the home.

Journey map - Shopping

Figure 36: Journey map of shopping with the free floating service

Figure 36 shows how a trip for shopping could be done with the Station service. The user locates a cargo bike and reserve it minutes before the needed time. The user arrives at the cargo bike, unlocks it and drives to the store. The cargo bike locks temporarily outside the store and shopping takes place. The cargo bike unlocks and the user returns home. At home, the cargo bike locks outside the building.
5.6 Cooperation Pooling

After reviewing the various possibilities for services, a combined concept was developed. A concept that had the strengths of Pooling and Station and joined into one concept.

5.6.1 Description

An illustration of the Cooperation Pooling can be seen in figure 37. In this concept the cargo bike pools are developed to a network of pools. A cargo bike pool can be operated by the residents in a building, the property owner, the building company, shopping centers, retail malls, workplaces, and other stakeholders. The cargo bike pool could work in the simplicity of an ordinary pool. It is used by its specific members and it is the members who have access to the bikes. The Cooperation part gives a possibility for the pool to join the cargo bike pool network. The cargo bike pools would have access to the other established cargo bike pools nearby. A solution for making this economical sustainable could be a small increase in the membership costs. The increased cost for joining the network would mainly be for the cost of redistribution of the cargo bikes between the pools.

Figure 37: Illustration of the cooperation pooling service
5.6.2 SWOT

**Figure 38: SWOT analysis of the cooperation pooling service**

As showed in figure 38, the strength of this concept is that the service is modular. It can work very well as a single pool that is only used by its members. But by expanding the service to the connecting pools will increase the usages for the members. The hardware doesn’t need to change to get the cargo bike pool to work with the rest of the system. The provider of the service takes care of the entire system and all it takes is a software update that allows the cargo bike pool to become a part of the cooperation pool.

Weaknesses of this concept is the distribution of the cargo bikes. The certainty for always having an available cargo bike will be difficult to meet. There is a risk that the cargo bikes from a pool are located elsewhere.

Synergies between different stakeholders are a great opportunity for this service. This can be a catalyst for multiple collaborations between stakeholders. It could also be a great opportunity for businesses to attract more customers.

A threat for the service could be that the collaboration between stakeholders does not work fully. This is not a serious threat for the service as it works well as individual pools.

5.6.3 Blueprint

**Figure 39: Blueprint of the cooperation pooling service**

As described in the blueprint, figure 39, the users will register in the system and download the app to be able to use the service. No matter what pool the users are members of, they checks the availability of the bikes on the app. When it is time for using the bike, unlocking of the bike is through the app. The user uses the bike during the booked time and returns it at the desired pool when the time is up. The user locks the bike in the bike rack for ending the session.
5.6.4 Journey map
Since this concept has the same characteristics as the pooling and station services, the use will be similar. Users can choose to return the cargo bikes at their own pool (pooling journey map) or leave it at another pool (station journey map).

5.7 The services chosen to focus on
Through a comparison of the five SWOT analyzes, it provided a basis for choosing which services to focus on. The analyzes of Pooling, Station and Cooperation pooling were extra interesting. The threats to these three services were considered to have a low risk to prevent the services from becoming feasible. By analyzing the cargo bike requirements for the services, there were opportunities for a similar hardware for the three services. The three services together were considered to have a strong business opportunity. By developing a hardware that fits these three different services, an opportunity was identified for the development of a cargo bike service for the needs of different customers. This could be a solution for providing electric cargo bikes as a service to a wide audience and the hardware would be independent of how the service is performed. Through an empirical study with a business model canvas, Irala (2017) identified the main challenges and opportunities for the services to succeed. The findings showed that the cargo bike pool had the most opportunities for a financial feasibility.

The leasing service is an uncomplicated service that has the ability to be executed after completed necessary financial calculations. The required leasing period needs to be long enough to get the service profitable, but at the same time at an economical level so the customers are willing to pay for the service.

With further work with solutions for locking and charging the cargo bikes, the Free-floating service could be a good compliment in the city. This could be feasible by having an agreement with the city for permission to be parked in the city.

The three services are illustrated in simple symbols in figure 40 and that symbolizes what a potential business could offer.

Figure 40: Illustration of business offering

These three services use the same technology and hardware. What separates them is how the customer chooses to use the system and that the software is adapted for each service. The electric cargo bikes are delivered with a smart bicycle rack that charges the batteries on the bikes, locks and unlocks the bike, and registers the use. Each service is provided with a unique app for its purpose.
5.7.1 Pooling

Figure 41: Illustration of the pooling service in an environment

Figure 41 illustrates a small community with a resident building with a cargo bike pool. In this service the customer chooses to have a cargo bike system only for their unique members. Only the members who registers to the cargo bike system can use the bikes. The users can register and access the pool through an app. The type of travels are A-A travels.

5.7.2 Station

Figure 42: Illustration of the station service in an environment

Figure 42 illustrates a small community with a cargo bike station at the local train station. In this service the customer chooses to make the cargo bikes available to the public. The service will be provided with a cargo bike system that will cover the desired area with cargo bikes. The IT system is adapted so that the public can register on a web page and get a user account for the system. An app allows users to access the bicycles. The type of travels are A-B travels.
5.7.3 Cooperation Pool

Figure 43: Illustration of the cooperation pooling service in an environment

Figure 43 illustrates a small community with a cargo bike cooperation pooling system. In this service the customer chooses to install a cargo bike pool for its users but at the same time become part of a local shared system. The system cooperates with other nearby cargo bike pools. Users get an option to return the bicycle from the original pool or leave the bike on another pool if this would be easier. The type of travels are A-A and A-B travels.

The difference between the Cooperation pool and the Station system is that this is a small-scale system that private operators can choose to connect to. This system has no requirement to satisfy the public, but only its own customers and potential partners. If shopping malls, workplaces and residential areas choose to join this system, the use of the cargo bikes can be used to a maximum. “The last mile” problem disappears when users can use the bikes all the way home. This is important because the home is the focal point of the use of cargo bikes.
5.8 Website and film

To provide a better understanding of how the use of the services and how it may look, a website was developed. The website was developed with the user in focus and visualized the services step by step for the user. The link to the web page is http://www.ettbilfrittar.se/cargo.

![Figure 44: Illustration of how a website could look like for the services](image)

Figure 44 illustrates ways to use the website for the services. Suggestions for the website was to locate cargo bike stations, reservation of a cargo bike and the possibility to lock and unlock through the website.

Together with the Gamla stan lâdcykelpool, a film was produced with the purpose to show how the services worked from the user's perspective. The film is available on the same web page.
This chapter presents ideas on hardware solutions that could get the services to reach out to more potential users. Types of cargo bike models, chosen components, the design on the cargo space and a suggestion on the bicycle racks will be presented.

6.1 Cargo Bike Fleet
To reach out to as many people as possible the services should provide a range of different models of cargo bikes. The different types of cargo bikes will have different properties and be used for different needs. The cargo bikes have been chosen to be made in three different sizes. A Small, a Medium and a Large type of cargo bike.

6.1.1 Small

Figure 45: Concept of the Small cargo bike

Figure 45 shows the cargo bike: Small. This bike is designed for the everyday user who needs some extra carrying support on the bike. The bike will be easy to use and it will not be too different from a regular bike. The cargo space has a capacity of approximately 30 liters. That should be enough to carry bags and packages.
6.1.2 Medium

Figure 46: Concept of the Medium cargo bike

Figure 46 shows the cargo bike: Medium. This bike is designed for the user who needs more carrying support for the bike. The bike has two wheels and has a cargo space between the steering wheel and the front wheel. The bike is easy to drive and handle thanks to its two wheels. The cargo space has a capacity of approximately 150 liters. That should be enough to accommodate smaller children, tools or unpleasant things such as recycling.
Figure 47: Concept of the Large cargo bike

Figure 47 shows the cargo bike: Large. This bike is designed for the user with the need for a lot of cargo opportunities. The bike has three wheels to provide extra stability when driving. The cargo space has a capacity of approximately 250 liters. That should be enough to accommodate a couple of children, pets or heavy and bulky items such as furniture.
6.2 **Hardware**

These cargo bikes are designed to be used a lot and by many people. The components for this kind of usages needs to last long, be weather resistance, low need for maintenance and protected for vandalism and unauthorized people for touching the components. This subchapter describes the selection of the chosen components.

6.2.1 **Shaft drive**

The choice of drivetrain for the cargo bikes is a shaft drive, see figure 48. This component is chosen primarily for its properties to be protected from the environment and the low need for maintenance. This will in the long run be an economic solution, from the business point of view, because it will reduce maintenance costs of the cargo bikes. The shaft drive also becomes an excellent choice for a sharing bikes because the drivetrain has a smaller risk of getting damage during use due the protected design.

![Shaft drive](image)

*Figure 48: Shaft drive*

6.2.2 **Electric motor**

The position of the electric motor is chosen to be mid-mounted. The reason for this is to get the same position of the motor on the three different models of the cargo bikes. A mid-mounted electric motor also provides a good weight distribution on the cargo bike (Elcykelvaruhuset.se, 2017). Another advantage is that it will be more convenient to remove the wheels when the electric motor is not mounted in the wheel.

6.2.3 **Airless Tires**

Flat tires may not be a major cost of maintenance, but avoiding it with today's technology will make the cargo bike service less dependent on maintaining the tires. A solution for this could be airless tires. The airless tires could also bring confidence to the users with the knowledge of not having any problem regarding flat tires.

6.2.4 **Battery**

The battery is mounted on the bicycle frame and is charged through two battery terminals integrated in the bicycle frame. Through a unique bike rack, the battery terminals get connected to the power supply and the battery will charge.
6.3 Cargo space design

In order to meet the needs of different groups, it becomes important that the space in the cargo bike can be used in different ways. This can be done in several ways but this is one proposal. Designing the cargo space into a versatile space through an adjustable design can be a solution to meet different needs with the same hardware. The cargo space would have three different shapes to meet the three biggest needs and can be seen in figure 49. Those needs are:

- The ability to close and lock the cargo space.
- The opportunity to sit in the cargo space.
- An open cargo space for loading big items.

A suggestion of how this could work would be a durable and waterproof textile that could be opened and closed with a zipper. The textile would have some features that would let the textile fold as a seat.
6.4 Rack Design
The design and the features of the cargo bike rack become a key to provide the cargo bikes as a service. A proposal for a bicycle rack has been developed and it both locks and charges the cargo bikes, see figure 50.

![Figure 50: Concept of the rack design](image)

6.3.1 Design
The bicycle rack is designed with reference to the bicycle frames of the cargo bikes and fits the three different models because the bikes are designed to have the same geometry on the frames. Figure 51 shows the design of the bicycle rack.

![Figure 51: The construction of the bike rack](image)
The locking is done by connecting the two cylinders on the bicycle frame to the two holes in the bicycle rack. This can be seen in figure 52.

![Figure 52: The locking mechanism](image)

A mechanism in the bicycle rack locks the cargo bike, as previously described, and the battery is charged through the two battery terminals on the cylinders, which can be seen in Figure 53

![Figure 53: Illustration of the charging](image)

### 6.3.2 Technology

To get a user-friendly solution for locking the bicycles, this concept would have a keyless solution. Through wireless technology, such as Bluetooth, users could unlock the cargo bikes with their mobile phones.
Discussion of the outcome has taken place in three areas. Analysis of the process, analysis of the investigated services and analysis of the proposed hardware.

7.1 Analysis of the approach and the tools used.

The user studies in this project provided a good basis for obtaining an understanding of the use of cargo bikes. The conducted survey revealed who the users were, how their travel habits looked like and what their needs were. A sample of 85 people gave a rewarding and reliable result through a response group with a geographic and demographic spread. The analyzes from the survey provided a good support for the remaining project, with the knowledge of the needs to be met for potential users.

The user studies also included a couple of interviews aimed at potential users of a cargo bike service and members from a cargo bike pool. The purpose of choosing potential users of a cargo bike service to interview was to find out more in detail what their needs were and how they might consider joining a service for cargo bikes. The purpose of interviewing members from a cargo bike pool was to get insight into how their habits looked like. The answers from the interviews were rewarding and important for the continuation of the project. Due to lack of time and lack of valuable people to intervene, only four people were interviewed. An improvement could have been made and the results of the user studies could have provided more details and information if more people had been interviewed.

Insights from different stakeholders was a very rewarding approach to the project. Information from a cargo bike expert, a cargo bike pool research project, Stockholm City and an architectural agency aiming to develop a mobility housing without parking lots, gave a wide range of insights about the challenges that existed to be able to provide cargo bikes as a service in the city of Stockholm. Despite the different viewpoints of the cargo bike as a vehicle, most of the stakeholders had a common view that a cargo bike pool had great potential as a solution to a cargo bike service.

The tool journey map was used to map certain types of trips. The presented journey maps were one-dimensional and of course there are a variety of ways those trips could take. But the purpose of this tool was to visualize one type of trip in order to compare the use between all the services.

A possible approach that was lacking in the project could have been more involvement from potential users. One possibility would have been to work with one or several focus groups that would both been part of the development of the different solutions, but also providing feedback on the various proposals developed during the project. Through a repeatedly discussion with a focus group, the results would have been more user oriented. This was not done due to lack of time unfortunately.
7.2 Service analysis

Through the conducted studies, five types of services for the cargo bike were described. Probably there are a lot more alternatives, but these five were considered to have a good spread on different possibilities.

The three selected services were considered to have a business advantage over the two other services. The two other services should not be ruled out to be less successful but those two were less adjustable for changes. Leasing as a service could solve many people's problems with providing electric cargo bikes with a monthly cost, instead of the high purchase price. The users who have space for storage of a cargo bike and the need of a cargo bike a lot, leasing becomes an excellent solution. For the free-floating solution, there were three major challenges. To provide the cargo bikes with full battery, to lock the cargo bikes safely without the risk of theft, and permission to park in the city. With more time to solve the main challenges and with more input from the city about regulations, a more detailed concept could have been developed.

As mentioned earlier, the three other services that were chosen to be continued with, had a business advantage. With same hardware for the three services, a company can provide to a large market with the same product.

A great potential for the pooling service is apartment building. There are many people living in the same area and usually car parking is limited. It has been described in the report that, in the event of constructing a new apartment building, construction companies can save an incredible amount of money by providing the building with a cargo bike pool instead of building parking lots. The rents for the apartments could then be lower plus and the residents would have access to a cargo bike pool. But at existing apartment houses, the problem arises that the parking lots are already built. Providing residents with a cargo bike service would increase the rent at the apartments if the service would be included in rent.

The Station service becomes an uncomplicated solution for cities and municipalities. Bikes in a system of stations scattered in the city are an exciting service in many major cities. By providing cargo bikes together with the usual bikes in the system, the service is quickly implemented.

The idea of a synergy between different stakeholders is a very interesting thought. The fact that the different stakeholders could operate a cargo bike pool but also collaborate with others so that users can move and fulfill their needs between the various places, creates a high level of user-friendliness in the society. The synergy could be developed in a variety of ways, and with the increased use of cargo bikes in the community, stakeholders could adapt their business to the cargo bikes as they adapted to the car earlier. The idea of integrating the cargo bike into different businesses is infinite. In the future, cargo bikes may be brought into grocery stores like today's shopping carts and allow users to shop efficiently and smoothly.

Something that needs to be investigated with Station and Cooperation services will be the redistribution of cargo bikes. It is likely that the cargo bikes will tend to end up in one direction. That means that the cargo bikes will eventually be unevenly distributed. And unlike City bikes in Stockholm, where the bikes could be lifted on a car, it will become more problematic with the much larger cargo bikes. There is certainly a lot of different suggestions on how this could be solved. Everything from encouraging users to leave the cargo bikes on specific stations, to employees who will be driving the cargo bikes to the needed stations.
One theory that were developed during the project was that a service may not look the same everywhere. A cargo bike service may have different needs depending on the demographic and the geographical area. The key for providing a service of this kind will be to make the service flexible and adjustable for the customers' different needs. Both to develop a hardware and a software that, with simple adjustments, can work for the various services.

Another insight that emerged during the project was the involvement to a service. With a high level of involvement, users will take more responsibility for the products in the service. Gamla stan cargo bike pool had this feeling in their cargo bike service. Their cargo bike pool was part of a community. Bikes were shared between neighbors and there was a sense of trust within the pool. That feeling can be a key to a well-functioning service.

7.3 Hardware analysis
The choice of providing a service with different models of cargo bikes came from the idea that the services will need to be able to meet many different needs. Comparing the cargo bike with car services on the market, the car services have a variety of models for the different user needs. The same approach should be made for the cargo bikes. The service would then get a wider range of users and more people could live a car-free everyday life.

The proposal for the bike rack was only conceptual but the concept addressed three important challenges. To be able to lock the cargo bike safely and easily, while simultaneously supplying the battery with power, and that all three cargo bike models fits the bike rack.

By having a bike rack with power supply, allows the bike rack to have smart features like having a keyless solution. The thing that should have been done in the concept was working more with an interface between the users and the bike rack. If this interface should be on the bike rack, on the phone or on both, is something to investigate further.

The choice of designing the cargo bikes in the way that was made, was for the possibility of locking, regardless of the size of the cargo space. All three models have the same geometry on the bicycle frame and could therefore be fitted within the same bike rack.

Establishing an adjustable space on the larger cargo bike models was chosen to increase the usefulness of the service. Users can then adjust the cargo space for their needs when needed. This can be a major advantage to the services compared to having solutions where users need to adjust the space with removable parts. The use can be more spontaneous and the cargo bike can approach the characteristics of the car.

7.4 Financial analysis
In order to implement services such as these, an economical calculation of how it could be economically feasible will be needed. It will also be necessary to calculate the size of the services, that means the number of cargo bikes that will be needed to meet the local needs. Adrián Irala made some of these calculations where he used the data from the conducted survey, some insights from the meeting with the experts and with statistics of Stockholm with the information of resident density. This information can be found in Adrián Irala's report, Irala (2017)
8 CONCLUSIONS

The aim of the project was to investigate the various possibilities for providing the electric cargo bike as a service. With the performed research and the concept ideation, the conclusions is that a service should be developed with the user in focus. Users should have access to the cargo bikes near their homes, as user needs are mainly from and to the home. Cargo bikes should be able to meet different needs through different models and different adjustments in cargo spaces. Since the cargo bike is a fairly unknown vehicle at the moment, it has to be a low threshold for users to try a cargo bike service.

For an economically sustainable service, the solution is that a cargo bike service should be included in a building when a construction company builds a new apartment building. Fewer parking lots are required from the city due to the mobility service. The cost of constructing the apartment building reduces significantly.

There is a business advantage to operate a variety of services using the same hardware. There is an opportunity to provide cargo bike services for different stakeholders with the same system. One service may have the difficulty meeting a large group of people. But a service that can take several forms and adapt to situations, can meet more needs. Production costs will also be significantly lower, and management of the services becomes easier.

The cargo bike can be a tool for a car-free lifestyle for many. The habits with the cargo bike should be placed closer to the habits of the car than the habits of the bike. For a city environment, the cargo bike will meet most of the car's necessary features. Through an increased understanding of the use with the cargo bike and changes in the human habits, cargo bikes has the possibility to be a part of the noted vehicles in the cities. With increased attention from the cities and politicians, the cargo bike could affect the decision-making in the cities for a better infrastructure.
9 RECOMMENDATIONS AND FUTURE WORK

In this chapter, recommendations on more detailed solutions and/or future work in this field are presented.

Summary of recommendations are presented here.

- Participation from potential users
- Simulation
- A pilot project
- Attention to the cargo bike as a vehicle
- Work on solutions for the hardware.

Participation

The next step is to show the results and suggestions to both potential users and potential stakeholders. This is important to be able to get valuable feedback on the outcome and to introduce the concept to the public. To get valuable feedback, surveys and interviews should be done to get both quantity and quality of the answers.

Simulation

To see the patterns of movement for how the use of the cargo bikes could look like for the various services is to use a simulation tool. That could provide insights into how many cargo bikes that will be needed in the services and how critical the redistribution will be.

Pilot projects

Pilot projects would be very valuable in order to study how different types of services would fit in the society. To compare the different services with each other through user would be valuable for further development of a service.

More attention to electric cargo bikes

To get more people to understand the benefits of the electric cargo bike as a vehicle, the electric cargo bike should get more attention. The vehicle must appear more on the streets but also the possibilities of usage must be highlighted. By communicating all the characteristics of the electric cargo bike to the public, could be important for extending the popularity cargo bikes in the society.

Hardware

The hardware solutions were only at a conceptual level in this project. Continuing working with different hardware solutions for the electric cargo bike is important. In that process, it becomes important to include users, manufacturers and repairers, among others, to get a product that is adapted for those groups who will be in contact with the products.
REFERENCES

Literature:

Research papers
Börjesson Rivera, M., Henriksson, G. (2014) Cargo Bike Pool: A way to facilitate a car-free life?. KTH Royal Institute of Technology, Division of Environmental Strategies Research*


Websites


Figure

Figure 2-5


Icons:
The icons in the figures are from the Noun Project https://thenounproject.com

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Urban Transportation Habits and Cargo Bikes

We are two students from KTH that are doing our thesis about cargo bikes. The purpose of the project is to explore the possibility for a sharing service of electric cargo bikes. We are conducting this survey to find out about general transportation habits, who the users of cargo bikes are and what cargo bikes are used for.

*Obligatorisk

Tell us a little bit about you...

1. Where do you live? (city/region/ of residence if you live in Sweden, Country if you are not from Sweden)

2. What is your gender?
   Markera endast en oval.
   - Female
   - Male
   - I prefer not to say

3. How old are you?
   Markera endast en oval.
   - 18
   - 18-24
   - 25-35
   - 36-50
   - 51-65
   - >65

4. What is your current occupation?
   Markera endast en oval.
   - Employed
   - Out of work
   - Homemaker
   - Student
   - Retired
   - Unable to work
5. What is your annual income (in SEK)?
   *Markera endast en oval.*
   - [ ] Less than 100,000
   - [ ] 100,000 - 300,000
   - [ ] 300,000 - 500,000
   - [ ] 500,000 - 700,000
   - [ ] More than 700,000
   - [ ] I prefer not to say.

6. Type of household
   *Markera endast en oval.*
   - [ ] Condominium
   - [ ] Tenancy
   - [ ] Terrace house
   - [ ] Villa
   - [ ] Other

7. How many people are living in your household?
   *Markera endast en oval.*
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6
   - [ ] More

8. How many of those are children?

9. If you have children, what ages are they?

   ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________
10. What type of driving license do you have?
   Markera alla som gäller.
   - None
   - A
   - B
   - C
   - D

11. Do you have access to a car?
   Markera endast en oval.
   - Yes, I own a car
   - Yes, I can borrow a car when I need to
   - No

General questions about your everyday urban transport habits
We're interested in knowing about your everyday transport habits (excluding vacations, long trips and occasional trips).

12. How many times a week do you perform the following activities on average?
   Markera endast en oval per rad.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never</th>
<th>Not on a weekly basis</th>
<th>1 - 2</th>
<th>3 - 5</th>
<th>6 - 10</th>
<th>More than 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going to work</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Going to school</td>
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<td></td>
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<tr>
<td>Go shopping</td>
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<td></td>
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<tr>
<td>Go to the gym/other sport activity</td>
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<tr>
<td>Dropping off children</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Travel within the job</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Go to other regular activities/hobbies</td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
13. What is the average distance of the trips you make to perform those activities?

*Markera endast en oval per rad.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>None</th>
<th>Less than 1km</th>
<th>1 - 2 km</th>
<th>2 - 5 km</th>
<th>5 - 10 km</th>
<th>More than 10 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going to work</td>
<td></td>
<td></td>
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<tr>
<td>Going to school</td>
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<td>Go shopping</td>
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<tr>
<td>Go to the gym/other sport activity</td>
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<tr>
<td>Dropping off children</td>
<td></td>
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<tr>
<td>Travel within the job</td>
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<tr>
<td>Go to other regular activities/hobbies</td>
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</tr>
</tbody>
</table>

14. What transport mode do you mainly use for making those trips?

*Markera endast en oval per rad.*

<table>
<thead>
<tr>
<th>Activity</th>
<th>None</th>
<th>Private motorised vehicle</th>
<th>Public transport</th>
<th>Bike</th>
<th>Walking</th>
<th>Cargo bike</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going to work</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Going to school</td>
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<tr>
<td>Go shopping</td>
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<tr>
<td>Go to the gym/other sport activity</td>
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<tr>
<td>Dropping off children</td>
<td></td>
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<tr>
<td>Travel within the job</td>
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<tr>
<td>Go to other regular activities/hobbies</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cargo Bikes**

Cargo bikes are bicycles designed for carrying loads, from bulky or heavy goods to small children.
15. Do you own/use a cargo bike or a bicycle trailer? *
Markera endast en oval.
☐ Yes  Fortsätt till frågan 18.
☐ No    Fortsätt till frågan 16.

Cargo Bikes

16. Why are you not using them?
Markera alla som gäller.
☐ I didn’t know what a cargo bike was before/ I don’t have enough knowledge about them
☐ I’m familiar with cargo bikes but my current transport modes cover my needs in a better way
☐ My transport needs can’t be covered with cargo bikes
☐ I can’t afford to buy one
☐ I currently lack of a parking/storage space for a cargo bike
☐ I don’t have the need that often
☐ Ovrigt:

17. What factors do you consider that need to be improved in order for you to use cargo bikes?

__________________________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________________________________________________

65
Cargo Bikes

18. How long have you been using a cargo bike?
   Markera endast en oval.
   - Less than 1 year
   - 1-3 years
   - 3-6 years
   - More than 6 years

19. What kind of cargo bike do you use?
   Markera alla som gäller.
   - 2 wheelers
   - 3 wheelers
   - Trailer
   - Övrigt:

20. What model of cargo bike do you use?

21. Do you use an electric cargo bike?
   Markera endast en oval.
   - Yes
   - No

22. What is your main usage of the cargo bike?
   Markera alla som gäller.
   - Carry children
   - Transport of heavy stuff
   - Carry shopping and groceries
   - Carry work gear
   - Övrigt:
23. In which seasons does your cargo bike become one of your main transport modes?

Markera alla som gäller.

- [ ] Winter
- [ ] Spring
- [ ] Summer
- [ ] Autumn
- [ ] It is never one of my main transport modes

24. What are your main reasons for not using the cargo bike?

Markera endast en oval per rad.

<table>
<thead>
<tr>
<th>Reason</th>
<th>I don't agree at all</th>
<th>I partially disagree</th>
<th>I partially agree</th>
<th>I totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad weather conditions</td>
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<tr>
<td>Long distances</td>
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<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Too heavy/bulky load</td>
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<td></td>
</tr>
<tr>
<td>Safety</td>
<td></td>
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<tr>
<td>City infrastructure</td>
<td></td>
<td></td>
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<tr>
<td>Puncture / need of repair / maintenance</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

25. What features do you miss on your cargo bike?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

26. If you compare the cargo bike with other modes of transport, what are the benefits of the cargo bike compared to other ways to move cargo?

Markera endast en oval per rad.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>I don't agree at all</th>
<th>I partially disagree</th>
<th>I partially agree</th>
<th>I totally agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>It's easier to move around in town</td>
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<tr>
<td>It's quicker to arrive at your destination</td>
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<tr>
<td>It's less stressful to drive</td>
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<tr>
<td>It makes the trips more enjoyable</td>
<td></td>
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<tr>
<td>It's easier to travel with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It's easier to keep time with</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>It's a healthier option</td>
<td></td>
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</tr>
<tr>
<td>It's a safer option</td>
<td></td>
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</tbody>
</table>
27. Do you have any general comments about your experience with cargo bikes that you would like to share with us?


Bike-sharing services

28. Do you use any bike-sharing service? *
Markera endast en oval.

☐ Yes  Fortsätt till frågan 29.
☐ No  Fortsätt till frågan 30.

Bike-sharing services
29. What do you use them for?
   Markera alla som gäller.
   ☐ Everyday transport needs
   ☐ Tourism in the city
   ☐ Occasional needs
   ☐ Leisure time
   ☐ Övrigt: ________________________________

Do you want to submit your contact information?

30. Do you want to be involved in this project by example, attend an interview? If so, provide your contact information.
   * Markera endast en oval.
   ☐ Yes  Fortsätt till frågan 31.
   ☐ No    Fortsätt till Thank you!

Contact information
This notification is not mandatory, you can still say no. We will not share your contact information to third parties. If you prefer to contact us later instead, you can do it by sending us an email to cargo@ettbilfrittar.se

31. Name
    ________________________________

32. Email
    ________________________________

33. Phone number
    ________________________________

Thank you!
Press submit to send in your survey

Tillhandahållits av
Google Forms