The Comeback of the Cargo Bike: This Time as a Service?

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by

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Comeback av Lastcykel: Den här Gången som en Tjänst?

av

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Abstract

Cargo bikes are a special type of bicycles built with the main purpose of moving freight. From the beginning of the 20th century, cargo bikes were commonly used means of transport. However, they stopped being a common alternative with the appearance of the car and its fast diffusion in the 1950s and 1960s.

Nowadays, the cargo bike is making a comeback with the main potential of, precisely, substitute car trips in urban areas. In cities like Copenhagen, it has become a main transport mode for 26% of families with two or more children. However, despite of their potential and success of adoption in Denmark, cargo bikes have not had the same impact in Sweden.

To explore this circumstance, this study will research the mobility habits of the cargo bike users and their attitudes towards the cargo bike through a survey involving 85 cargo bike enthusiasts and two in-depth interviews. Furthermore, this study will analyze the potential of increasing the adoption of the cargo bike by offering it as a service through interviews with four different stakeholders. This analysis will rely on literature regarding theories of diffusion of innovations explain the adoption phenomena together with product-service systems and business models.

The results of this study identify the users of the cargo bike as enthusiasts of a car-free lifestyle, and concludes that a cargo bike pool has the biggest potential to support the adoption of the cargo bike by users who don’t necessarily share this behavior, although with some limitations. This research also identified main challenges and opportunities of development in the offering of cargo bikes as a service.

Key-words: Cargo bikes, diffusion of innovations, product-service systems, business models, bike-sharing, pool, lease
Comeback av Lastcykel: Den här Gången som en Tjänst

Adrian Irala

Sammanfattning


Nu gör lastcykeln en comeback med största potentialen att ersätta bilresor i stadsområden. I städer som Köpenhamn har det blivit det främsta transportmedlet för 26 procent av familjer med två eller fler barn. Trots deras potential och framgång i Danmark har lastcyklarna inte haft samma genomslag i Sverige.

För att undersöka denna omständighet har detta projekt undersökt lastcykelanvändarens rörelsevanor genom en undersökning med 85 lastcykelentusiaster och med djupare intervjuer. Dessutom analyserades potentialen att öka anpassningen av lastcykeln genom att erbjuda den som en tjänst genom intervjuer med olika intressenter.

Resultatet av denna studie identifierade användarna av lastcyklar som entusiaster till en bilfri livsstil. Slutsatsen blev att en lastcykelpool hade den största potentialen att främja en anpassning av lastcyklarna för användare som inte nödvändigtvis delar detta beteende, men med vissa begränsningar. Denna undersökning har också identifierat de viktigaste utmaningarna och utvecklingsmöjligheterna för erbjudandet av lastcyklar som en tjänst.

Nyckelord: Lastcykel, diffusion av innovationer, produkt-service system, affärsmodeller, cykeldelning, pool, leasing
ACKNOWLEDGMENTS

Thanks to Marcus, for sharing with me this great trip into the cargo bike world, and to Teo, for introducing me into it in the first place.

My gratitude to all the cargo bike enthusiasts that agreed to be part of this research, and all the interviewees for their time, guidance and keen involvement.

Thanks for the ride!

Adrian Irala

Stockholm, June 2017
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1. INTRODUCTION

In this chapter, the background and problem formulation are presented. Then, the purpose and research question are formulated. Finally, this chapter concludes with the expected contributions and delimitations of this research.

1.1 Background

Humanity has never consumed as much energy as it does today. The climate of the Earth is getting warmer and according to the United Nations’ Intergovernmental Panel on Climate Change (2016), human activity has influenced most of it. Transportation of people and goods with fossil-fuel vehicles is a significant contributing factor. Private car usage has increased, and that also contributed not only to the increment of air pollution, but also to traffic congestion and accidents in our cities which, in Europe, host around 75% of the population (European Commission, 2014). Indeed, 40% of all CO₂ emissions of road transport is accountable to urban mobility (European Commission, 2015), and every year, Europe loses 1% of GDP due to traffic congestion (European Commission, 2011).

Given the current situation, cities all around the world are pushing different strategies for their urban mobility plans for the future. That is the case of the City of Stockholm, home to more than 920,000 residents (Sveriges Officiella Statistik, 2016) and everyday host of 570,000 workers. The region is expected to experience a 25% increase in population by 2030, and is aiming towards an efficient transport system with a gradual reduction of the proportion of journeys by car, aspiring to reduce road traffic emissions by 30% in 2030 and become a fossil-fuel free city by 2050 (Stockholms Stad, 2012).

Among the different alternatives to the car, cargo bikes are the most suitable to satisfy urban transport freight needs. In fact, according to Cyclelogistics (2011), 51% of motorized trips (private and commercial) related to transporting freight can be performed by bicycles and cargo-bikes. Cargo bikes, frequently referred to as freight bicycles, are bicycles designed for carrying loads, from bulky or heavy goods to small children.

While cargo-bikes have been around for almost as long as the regular bicycles, its adoption by the general public is still very limited, and only in cities with a strong bike culture heritage like Copenhagen show a high acceptance of this option as an alternative (Cyclelogistics, 2011). Sweden is still part of those countries that show little adoption of the cargo bike by its inhabitants.

The diffusion of the adoption of cargo bikes in Sweden could be achieved with the implementation of shared mobility alternatives such as product-service systems. Product-service systems (PSS) are a combination of tangible products and intangible services that together can fulfil specific user needs (Tischner et al., 2002), offering one single solution that can improve competitiveness while promoting sustainability. Following the classification proposed by Tukker (2004), product service systems can be grouped into three main categories: product-oriented services (where selling a product remains the main activity), use-oriented services (in which a product is still involved but changes are applied to the business model, the customer paying for the usage but not for the ownership of the product) and result-oriented services (where a solution is offered without specifying the involvement of a particular product).
These PPS are also opening the door to new and innovative business models that have the potential to create and capture sustained value: from a change of paradigms in the revenue streams to new structures in production cost and added service activities, all with the goal of satisfying the new value propositions.

Different use-oriented services have been implemented in our cities over the years to promote the shift in urban transport habits, generally adopting one of its three main forms: leasing, renting/sharing or pooling. Probably the biggest example of this are bike-sharing systems, which have experienced a growth since 2008 that has outperformed the growth of every other form of urban transport, going from 100 schemes operating in 2008 to more than 350 in 2010 (Midgley, 2011).

1.2 Problem description
The cargo bike, although being identified as having great potential for transporting freight in the area of urban private logistics, has not have a successful acceptance in Sweden yet. This, together with the global interest to reduce car usage, rises the concern about the reasons why this alternative mode of transport has not been commonly adopted in the country. The success of previous product-service systems in mobility suggests that a solution around offering the cargo bike as a service could have an impact in the adoption of this mobility alternative.

1.3 Purpose
The purpose of this thesis is to research the main barriers of adoption that cargo bikes are currently facing in private urban mobility logistics in Sweden and investigate the impact of offering them as service in their diffusion. The goal of the research is to provide with an empirical contribution to the understanding of cargo bike users’ transport behaviours and attitudes as well as the current implementation state of product-service systems alternatives for the cargo bike.

1.4 Research Questions
This research will answer a general research question by providing answers to three different sub-research questions.

**GRQ:** What is the potential of increasing the adoption of the cargo bike in private logistics by offering it as a service?

- **RQ1:** What are the main barriers of adoption of the cargo bike?
- **RQ2:** How do different service solutions support the adoption of the cargo bike?
- **RQ3:** What are the main challenges and opportunities for a successful performance of these solutions?

1.5 Expected contribution and delimitations
This thesis will contribute with a study of cargo bike users’ mobility behaviours and attitudes from a perspective of diffusion of innovations. This perspective will also be used to study the potential that product-service systems could have in the adoption of the cargo bike. From the literature review, there is a deficiency of empirical studies regarding the motivations and barriers of adoption of this
mobility alternative in urban transportation habits and the role that product-service systems have in this process that this research will try to fill.

This thesis will focus primarily on users that already showed a degree of interest in cargo bikes and thus the answers will be limited to the particularities of these users. The product-service systems studied in this research will be limited to use-oriented services and, more precisely, to the alternatives of lease, pool and share. Also, this research will be limited to a theoretical framework of diffusion of innovations, product-service systems and business models. Due to geographical limitations, the focus of this research and outcomes of the thesis will be primarily set on Sweden and the Stockholm area.

1.6 Outline

This section summarizes the outline of this research.

Chapter 1: Introduction

In this chapter, the background and problem formulation are presented. Then, the purpose and research question are formulated. Finally, this chapters concludes with the expected contributions and delimitations of this research.

Chapter 2: Research Method

This chapter explains the methodology that will be followed through this research, including the literature review, empirical study and analysis. This chapter concludes with a reflection about the quality of the methodology regarding its reliability, validity, generalizability and ethics.

Chapter 3: Literature Review

This chapter presents the relevant literature and theories reviewed and shows the current gaps identified. It starts with a framework around urban mobility in Sweden and cargo bikes and continues with the collection of theories regarding diffusion of innovations, product-service systems and business models. This chapter concludes with the description of notable bicycle-related product-service systems.

Chapter 4: Results

This chapter presents the results of the empirical research in two main sections: the first section contains the primary sources related to the users’ perspective consisting of a survey and two in-depth interviews with potential cargo bike users; the second section presents the stakeholders’ perspective with four interviews organized around the business model canvas.

Chapter 5: Analysis and discussion

In this chapter, the literature and theories studied in chapter 3 will serve as the framework to analyse the empirical results obtained in chapter 4. This chapter will treat the adoption of the cargo bike, relevant factors related to product-service systems, product-service systems as enablers for the diffusion of cargo bikes and challenges and opportunities in the business models of cargo bike product-service systems.

Chapter 6: Conclusion and future research

This chapter presents the answers to the research questions of this thesis. Then, it provides a discussion around the implications of the research and the quality of the methods used. Finally, this chapter concludes with the suggestions of future research.
2. RESEARCH METHOD

This chapter explains the methodology that will be followed through this research, including the literature review, empirical study and analysis. This chapter concludes with a reflection about the quality of the methodology regarding its reliability, validity, generalizability and ethics.

2.1 Research design

The purpose of this research is to explore the potential that a cargo bike service offer could have for increasing the adoption of this mobility alternative in private logistics in Sweden. The approach of this research combines innovation diffusion theories with product-service systems, two areas that, together with cargo bikes as an urban mobility option, have not been addressed in the literature jointly. This scarcity of academic material motives this study as at the same time shows a gap in the literature that this research aims to fill.

This research was conducted through an iterative approach in which the problem formulation, method, research questions, purpose, and background will be updated driven by the findings learned as the research goes forward (Blomkvist & Hallin, 2014).

The research process included a literature review that was performed during the entire study and also enclosed two phases: an empirical study where primary data was gathered from interviews and a survey, and the later analysis of this data with the literature studied as its framework.

2.1.1 Literature review

Following recommendations from Collins & Hussey (2014), a broad search of literature was performed, and in the process it was structured and examined to determine its relevance to this project to later be narrowed down.

Firstly, a review of current urban mobility patterns in Sweden and state of the cargo bikes was conducted to set the context. The theoretical frame of reference for this master thesis combines knowledge from three main areas: diffusion of innovations, product service systems and business models, all recommended by the institution representatives. Diffusion of innovations theory was used for the description of the adoption phenomenon of the cargo bikes and supported the analysis for answering RQ1, while product-service systems and business models served as the theoretical reference to set the framework from which to analyse the empirical study and provide answers RQ2 and RQ3.

A state of the art in these fields of study was carried out continuously through this research. The knowledge acquired through the review of this literature was used to set a reference system from which to start answering the research questions, to identify gaps in the literature and to help shape the empirical data collection.

The proposed literature and theory was obtained through the use of different academic databases such as Google Scholar, KTH Biblioteket and KTH Primo and includes articles from journals, reports, books and other publications, using in the search the keywords showed in Table 1.
### Field | Search words
--- | ---
Urban Mobility in Sweden | “urban mobility”, “Sweden”, “cargo bike”, “transportation”
Cargo bike as a service | “bike-sharing”, “cargo bike”, “service”, “BSS”, “user”, “habits”, “behaviour”
Business Models | “business models”, “service”, “bike-share”
Diffusion of Innovations | “diffusion of innovations”, “barriers”, “adoption”, “chasms”, “groups of adopters”

Table 1: Search words used in the literature review

#### 2.1.2 Empirical study

The empirical study was conducted with the following approach (summarized in Figure 1):

- **Users’ perspective**: consisting of a survey targeting cargo bike enthusiasts and two in-depth interviews with potential users (User A and User B). The results obtained were later analyzed to provide an answer to RQ1 and RQ2 with the literature and theoretical framework.

- **Stakeholders’ perspective**: consisting of four interviews with different actors of interest in a product-service solution for cargo bikes (Provider, Operator, Architect and Municipality). The results obtained were later analyzed to give an answer to RQ2 and RQ3 with the theories studied.

### EMPIRICAL STUDY

<table>
<thead>
<tr>
<th>Users’ Perspective</th>
<th>Stakeholders’ Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey</td>
<td>Users interviews</td>
</tr>
<tr>
<td>User A</td>
<td>User B</td>
</tr>
</tbody>
</table>

Figure 1: Overview of the empirical study

**Survey**

The purpose of this survey was mainly exploratory and had the aim of acquiring both qualitative and quantitative data from a targeted audience of cargo bike owners and potential users. The focus on these groups of users was motivated by the diffusion of innovations theories studied in the literature review, as they are identified to be of great relevant in the adoption process and thus of high interest in this research. This method was the preferred instrument as it allows to reach a large audience while being economically convenient and fast in the collection of information (Fowler, 2009). This group of individuals was target using an existing database of cargo bike owners provided by Green Leap (a research group at KTH) as well as Facebook and LinkedIn groups of cargo bike users. The construction of the survey followed Creswell’s (2004) recommendations regarding its design, population sample and instrumentation. The survey was built with single choice, multiple choice and open-end questions and consisted of four sections: first, a socio-demographic section to characterize the sample followed by an urban transport habits section (based on and constructed from the literature studied of urban mobility patterns) and two different sections regarding the usage and relationship of the respondent with cargo bikes; one for respondents who did not own a cargo bike and other for respondents who did (specifically designed based on diffusion of innovations theories and cargo bikes literature). The
platform used for its development was Google Forms and it was distributed through the same digital channels used to identify the sample in the first place (Facebook and LinkedIn Groups).

**Interviews**
All of the interviews (both users and stakeholders) were semi-structured, which allowed the formulation of some questions in advance but also the possibility of asking new ones during the interview to explore different areas of interest raised by the interviewees (Collins and Hussey, 2014). Semi-structured interviews are a source of qualitative research that best suits with the exploratory nature of the research questions raised, especially since the researcher had limited knowledge about the main influencing factors in the subject (Blomqvist & Hallin, 2015). All of the questions were constructed based on the theories and the literature review.

**Users interviews**
The research on the users’ side was completed with two in-depth face-to-face semi-structured interviews of potential cargo bike users (User A and User B) chosen from the survey sample. The reason for the election of this mixed methodology (combining the quantitative and qualitative research from the survey with the qualitative research from the interviews) relies on the advantages of the interviews for deeper understanding and exploration of the social phenomena (Gill et al., 2008). The focus of the questions was on awareness, potential use of cargo bikes, change in their current transport habits, barriers of adoption, and potential of PSS solutions to support answering RQ1 and RQ2.

<table>
<thead>
<tr>
<th>User Respondent</th>
<th>Duration</th>
<th>Date</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>User A</td>
<td>60min</td>
<td>25/04/17</td>
<td>Live Interview</td>
</tr>
<tr>
<td>User B</td>
<td>90min</td>
<td>26/04/17</td>
<td>Live Interview</td>
</tr>
</tbody>
</table>

Table 2: User interviews

**Stakeholders interviews**
The sampling of these semi-structured interviews was carried out to target representative stakeholders covering the full range of possible product-service systems that include cargo-bikes (lease, pool and share alternatives), with the aim of collecting their personal experiences and knowledge in the field of applied product-service systems and the business model associated to each option. It is important to mention that the aim of these interviews was not to define in detail the business model elements of each scheme, but rather identify the main elements and challenges for its successful performance according to these actors, and thus provide answers to RQ2 and RQ3. It is also relevant to mention that each stakeholder had a different business point of view, as the identity of the customer changes depending on the stakeholder. However, the interviews were conducted to present the results from the point of view of the user of the service. In total, four interviews were conducted. For the lease alternative, a company that provides cargo bikes was interviewed (Provider). The interviews regarding a pool solution also included the same Provider (as the company also specialized in bicycle pool solutions) and targeted two additional stakeholders: an organization that operates an experimental cargo bike pool as a “courtyard association” for a district in Stockholm (Operator) and an architecture studio currently designing a residential housing with shared mobility solutions and services that includes a cargo bike pool (Architect). Finally, for the sharing system, although a solution of this type is currently inexistent, a member of the Municipality of Stockholm
(Municipality) was interviewed about different possible alternatives, as well as the involvement of the city in these schemes.

<table>
<thead>
<tr>
<th>Stakeholder Respondent</th>
<th>Profession</th>
<th>Duration</th>
<th>Date</th>
<th>Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architect</td>
<td>Architect</td>
<td>60min</td>
<td>27/03/17</td>
<td>Live Interview</td>
</tr>
<tr>
<td>Municipality</td>
<td>Project Manager at Municipality</td>
<td>90min</td>
<td>29/03/17</td>
<td>Live Interview</td>
</tr>
<tr>
<td>Operator</td>
<td>Cargo bike pool operator</td>
<td>60min</td>
<td>15/04/17</td>
<td>Live Interview</td>
</tr>
<tr>
<td>Provider</td>
<td>Cargo bike provider</td>
<td>30min</td>
<td>01/05/17</td>
<td>Phone Interview</td>
</tr>
</tbody>
</table>

Table 3: Stakeholder interviews

2.1.3 Analysis
Analysis of the data from the survey followed a multi-method approach since the survey provided both qualitative and quantitative data from the sample (Watkins & O’Neil, 2013). The quantitative data was analyzed using descriptive statistical methods such as cross-tabs, tables, and charts. This information was analysed using the software SPSS Statistics, and later compared and explained using the literature and theories studied.

The analysis of the data collected from both set of interviews was performed using a general procedure involving data reduction, data displays and conclusion and verification, as proposed by Collins and Hussey (2014). This process followed a thematic approach, in which the categorization of the data was mainly determined by the literature reviewed, but also some of the categories were define during the analysis. After its reduction, data was analyzed, compared, and explained using the literature and theoretical framework.

2.2 Quality of the Methodology

Reliability
Reliability refers to how accurate and precise the research has been; more specifically, the differences that would emerge in the results if the same research was carried out by another researcher (Collins & Hussey, 2014). Regarding the literature reviewed and theories included, although it was impossible due to practical reasons to assure all the relevant content available was investigated, the theories and literature collected were produced by sources widely referenced and accepted, which adds to the increase of the reliability of this study. However, the predominance of the qualitative research, the novelty of the field studied and low number of stakeholders and users identified and interviewed withdrew the reliability of this research. The semi-structured nature of the interviews can’t assure the reliability of the study either; nevertheless, the reliability in the interviews was improved by making sure that each person interviewed answered to the same set of questions of their group. A test-group was used to enhance the reliability of the survey (Collins & Hussey, 2014), and was carefully chosen
so it represented the range of its different sections and socio-demographic characteristics. The feedback provided by this group was taken into consideration in the developing of the final version.

Validity
Validity is described as how accurate the phenomenon studied is described by the results of the research (Collins & Hussey, 2014). The small sample of stakeholders interviewed lowered the validity of the research. Although the stakeholders interviewed showed different degrees of expertise in the field of the study (mostly due to its novelty and current underdevelopment, which also prevented the complete identification of all the perspectives involved), they were considered to represent fairly the main perspectives and hold sufficient experience in their fields for increasing the accuracy and validity of their answers. Regarding the users surveyed and interviewed, the low number of responses also lowered the validity of this study. A larger sample with a higher representation of different socio-demographic and behavioral characteristics would have improved the validity; however, the delimitations to the group of users studied and exploratory nature of the research allowed to obtain deeper understanding of behaviors, which is considered to be very valuable in the contribution of this thesis. The two in-depth interviews shared geographical residence and a major number of socio-economic characteristics, which allowed its comparison and added to the validity of the study.

Generalizability
Generalizability of the research refers to the degree in which the results obtained from the sample studied can be claimed to represent the whole population it belongs to, and thus be generalized (Collins & Hussey, 2014). The geographical delimitations considered in this thesis and its subsequent economical, behavioral and political implications (of high relevance in this field of study) limited the generalizability of the research. The interviews conducted, as it has been stated, had a low representation and consequently also lowered the generalizability of this study. However, this allowed a local and deeper understanding of the subject treated. The survey developed was merely exploratory and it focused on a specific group of population with the purpose of acquiring a better perception of the habits, expectations and attitudes of this group. Though its aim was the identification of patterns from the raw data (Collins & Hussey, 2014), it must be stated that the information gathered from this sample can’t be generalized.

Ethics
This research followed the Swedish Research Council’s ethics requirements for social science studies in the country. All the surveyed and interviewed participants were informed about the study and its purpose, and agreed to to participate in it. All of the interviewed participants remained anonymous throughout this study, whereas survey respondents could choose not to share their personal information. Additionally, the author compromises to use the data collected for the only purpose of this study.
3. LITERATURE REVIEW

This chapter presents the relevant literature and theories reviewed and shows the current gaps identified. It starts with a framework around urban mobility in Sweden and cargo bikes and continues with the collection of theories regarding diffusion of innovations, product-service systems and business models. This chapter concludes with the description of notable bicycle-related product-service systems.

3.1 Urban Mobility in Sweden

Urban mobility habits in developed countries have experienced profound changes during the last century. The bicycle, which was the principal mean of urban transport in 1950 with a global average of 14.000 kilometres per person per year (Gilbert and Perl, 2008), has experienced since then a continuous decline in usage (Agervig Carstensen and Ebert, 2012). This drop was partly caused by the successful adoption of the car by industrialized societies in their urban mobility habits, going from its complete absence in the beginning of the last century to completely dominate the private transportation scene, with a global average of 9.490 kilometres travelled per person per year in 2010 (EC, 2012).

This is the case of Sweden, where in the year 2014-2015 an average of 8.078 kilometres were travelled per person by car, while the bicycle and walk, together, just accounted for an average of 407 kilometres per person (Sveriges Officiella Statistik, 2016). According to official statistics, the car was the mode of transport in that year for 53% of all journeys, being the most used mean for business, work, service, shopping, leisure and other purposes, while 29% of the journeys were made by foot or bicycle, and 15% by public transport. This official data source, however, did not specify the usage of cargo bike as a transport mode.

<table>
<thead>
<tr>
<th>By foot, bicycle</th>
<th>Car</th>
<th>Public transport</th>
<th>Other mode</th>
<th>Information not available</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business, work and study-related</td>
<td>12%</td>
<td>26%</td>
<td>11%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Service and shopping</td>
<td>4%</td>
<td>9%</td>
<td>1%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Leisure</td>
<td>13%</td>
<td>16%</td>
<td>2%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Other purpose</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>All</td>
<td>29%</td>
<td>53%</td>
<td>15%</td>
<td>2%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 4: Percentage of journeys a year by main purpose and main mode of travel year 2014–2015

The average number of weekly journeys per person as well as the average distance travelled per journey by the Swedish population in the year 2014-2015 is presented in the Table 5:
### Mobility in Stockholm and Urban Strategy

In the city of Stockholm, the bicycle is used by 10% of inhabitants as a main mode for going to work and school (Stockholms Stad, 2014). According to city statistics, the bicycle is quicker than the car to move around the city in peak hours, and it is considered to be an acceptable mean of transport for traveling times up to thirty minutes or distances inferior to ten kilometres.

In its Urban Mobility Strategy (Stockholms Stad, 2012), the City of Stockholm remarks the importance for the city’s urban transportation to change its focus from “travelling of vehicles” to “travelling of people and goods”. As so, defends the reduction of proportion of journeys by car (“a city of cars” instead a “city for cars”), supported by an increase of usage of public transport, bicycle and walking with the vision for 2030 that, at least, 15% of all commuter trips performed in peak hours in the city should be by bicycle, locating pedestrian and bicycle trips at the top of the city’s transportation hierarchy.

The modal shift from private cars usage to pedestrian and shared alternatives has been supported by different authors in the literature (Banister, 2008). Shaheen and Cohen (2007) discussed that the costs related to car ownership (such as buying, fuel and maintenance), together with limitation policies for car circulation are encouraging factors for citizens in their change of transport behaviour. On the other hand, Forward (1998) identified that the choice of cycling as a transportation mode is related to lifestyle, life situation, and social norms.

### 3.2 Cargo Bikes

Cargo bikes are a special type of bicycles built with the main purpose of moving freight. In fact, during its first years, that date almost as far as the regular bicycle, it was used to transport different kinds of goods (most commonly for commercial use, such as letters, newspapers, dynamite or food), but also children (Cyclelogistics, 2011). From the beginning of the 20th century, cargo bikes were commonly used means of freight transport; however, they stopped being a common alternative with appearance of the car and its fast diffusion in the 1950s and 1960s (Gruber, Ehrler and Lenz, 2013).

Cargo bikes, and more specifically electric ones (regular cargo bikes equipped with a motor powered by a battery), stand between regular bicycles and cars in cost, range and payload (Lenz and Riehle, 2013). While standard bikes can carry weights up to 25 kg (apart from the weight of the cyclist), cargo bikes have the capacity to carry between 50 and 250 kg (Lenz and Riehle, 2013).

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Average number of journeys per person and week</th>
<th>Average distance travelled (in kilometres) per journey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business, work and study-related</td>
<td>4.9</td>
<td>21</td>
</tr>
<tr>
<td>Service and shopping</td>
<td>1.33</td>
<td>20</td>
</tr>
<tr>
<td>Leisure</td>
<td>3.22</td>
<td>45</td>
</tr>
<tr>
<td>Other purpose</td>
<td>0.35</td>
<td>51</td>
</tr>
</tbody>
</table>

Table 5: Average number of journeys and average distance travelled in Sweden by purpose in 2014-2015 (Sveriges Officiella Statistik, 2016)
Potential of the cargo bike in private urban logistics

According to Lenz and Riehle (2013), “cargo bikes have the greatest potential in urban areas for transporting freight/loads due to their ability to work around congestion and access areas with environmental or delivery period restrictions.” Wrighton and Reiter (2015) also identify the potential of these bikes in the area of urban private logistics (shopping, leisure and commuter trips, due to the short distances of these trips and light weight of the transported goods), while different authors have researched the advantages of using cargo bikes for transporting gear and children (Harris et al., 2011; Lovejoy et al., 2012; Powell and Tanz, 2000).

Moreover, some authors claim that cargo bikes have the potential to substitute car trips in urban areas (Piatkowski, Krizek and Handy, 2015), both for existing cyclists with the aim to cover their utilitarian transport needs (La Ferla, 2010; O’Connor, 2011) as well as for those who do not use bicycles (Riggs, 2016).

In fact, a study from Cyclelogistics (2013) suggests that bicycles and cargo bikes can uptake half of all urban motorized trips associated with transport of goods, of which one third would be commercial and two thirds private. The study claims that 70% of shopping, 44% of leisure, and 50% of commuting trips can be shifted in transport mode to the cargo bike (considering a freight of less than 200kg and distances inferior to 7km).

Adoption of the cargo bike in urban transportation

Many authors in the literature have identified the potential benefits, current uses and recent speed of adoption of the cargo bike in different business solutions (Lenz and Riehle, 2013; Gruber et al., 2014; Gössling, 2013).

Cargo bikes usage in private logistics has increased over the past couple of decades (La Ferla, 2010; O’Connor, 2011). The Netherlands and Denmark are the European countries with most citizens using the bike for transporting freight. In the Netherlands, 65% of all bikes are used for transporting goods, while Copenhagen has experienced a vast increase in usage of the cargo bike over the last 10-15 years, where 26% of families with two or more children own a cargo bike to transport their children and groceries, as a replacement for car. Moreover, there are more than 40,000 cargo bikes circulating in Copenhagen, that account for 6% of all the bikes in the city. (Cyclelogistics, 2011).

However, despite of their potential and success of adoption in Denmark, cargo bikes have not had the same impact in Sweden. According to Börjesson and Henriksson (2014), this might be associated to
issues such as their bigger parking space requirements or the fact that cargo bikes are yet considered a niche bike. Different authors have also identified this lack of recognition among general users of the potential of the cargo bike to represent a suitable mode of transport as an obstacle to its adoption (Gruber et al., 2014; Lenz and Riehle, 2013; Reiter, 2013). Other relevant factors for the acceptance of the cargo bike as an alternative and substitutive transport mode identified in the literature are the technical and economic viability, ease of use and complexity (Heinrich et al., 2016).

3.3 Diffusion of Innovations

The approach of this thesis is to study the cargo bike as an innovation, and research its adoption using diffusion of innovation theories with the aim of exploring how to accommodate and support the introduction of cargo bikes into Sweden’s urban transportation habits.

It is important, in the first place, to identify in the literature the definition of innovation. According to Diewald (2001), an innovation is “the development and application of something new, including combining pre-existing elements into a new system”. For Rogers (2003), “an innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption”. Moore (1999) also distinguishes between continuous and discontinuous innovations: continuous innovations imply a regular upgrading and do not require a change in the behaviour for the users, while discontinuous innovations demands a shift in the behaviour of the users or their relationship with other existing products/services (Moore, 1999).

Groups of adopters

Many theories have been developed over the years in recent literature to explain how innovations spread through social systems, the theory “Diffusion of Innovations” developed by Everett Rogers (2003) been among the most known and accepted. Although it was first published in 1962, this theory remains today as a referent used by multitude of experts to explain consumer’s behaviour of acquiring innovations. In his theory, Rogers identifies five different categories of users in a given market according to the length of the time required for each group (measured in percentage) to adopt an innovation, referred to by Rogers as the “rate of adoption”. These categories are innovators, early adopters, early majority, late majority and laggards:

Innovators, often guided by their enthusiasm (and are often referred to as “enthusiasts”), aggressively pursue the adoption of the innovation and consider being the first ones of huge importance (Rogers, 2003). Although they are a reduced group, they are very valuable for being the first customers in the market to convince, and demand fewer requirements than the rest (Moore, 1999).

Early adopters, also enthusiasts of the innovation, are on the other hand guided by its potential benefits. As Moore (1999) states, they are “visionaries looking for a fundamental breakthrough”, and adopt the innovation only when it covers their needs accordingly, but without relying their decision on external opinions. However, they have the power to influence the behaviour of future adopters, and thus are responsible for the success of the diffusion. Moore (1999) also considers this group to be the least price-sensitive of all.

Early majority seeks for practicality in innovations and, unlike the previous groups, rely on external opinions before adopting them, and their decision is partially influenced by the adoption of previous groups. They are a large group and are essential for profitability and growth (Rogers, 2003). Also, they are more price-sensitive (Moore, 1999).
Customers that belong to late majority tend to be more conservative, and they only become adopters of the innovation once it has been widely accepted in the social system and become a standard in the market (Rogers, 2003).

Laggards are the last group adopting the innovation. They are characterized for being sceptic and, in some cases, are forced by the social system to adopt an innovation, even though they are not eager to do so (Rogers, 2003).

Furthermore, Moore (1999) considers that the division of the users of an innovation into these categories is only appropriate when they are included in what he calls a market: “a set of actual or potential customers for a given set of products or services who have a common set of needs or wants, and who reference each other when making a buying decision”.

The Figure 3 shows two different curves: a bell curve representing the different categories of adopters, (where each division has been placed at standard deviations of the mean), and an S curve that represents the adoption of an innovation (in terms of market share) over time.

![Figure 3: Diffusion of innovations and S Curve (Rogers, 2003)](image)

Rogers (2003) also noted that the perception of the characteristics of the innovation by the different groups of adopters influenced the process of innovation, identifying five different factors: relative advantage (of the innovation over current alternatives, the greater this factor, the faster would be its rate of adoption) compatibility (the consistency of the innovation with the potential adopters’ values and needs), complexity (the difficulty of understanding and using the innovation), trialability (the opportunity of experimenting with the innovation prior its adoption) and observability (of the results of the innovation to other groups, the more visible the easier it would be for the innovation to be adopted by them).

“The Chasm”

Although Rogers pictured the transition between these groups as continuous, Moore (1999), on the other hand, discovered from experience a flaw in this theory, and thus expanded this theory adding gaps between each group. These fissures represent the difficulty of a psychographic group to adopt an innovation if it was presented in the same way as the group before, and help explaining why some innovations fail to reach the mass market.
The first “crack” is placed between the group of innovators and early adopters, and occurs when an innovation fails to be enthusiastically perceived as a main benefit (Moore, 1999). However, the largest and most significant gap is the “chasm”, found between early adopters and early majority.

This chasm is closely related to the differences between early adopters and early majority: while early adopters are market specialists and more interested in “shaping the future” with a “radical discontinuity”, early majority are market generalists and expect an improvement in their present productivity, thus are more interested in “evolution” rather than “revolution”.

As it was stated before, early majority base their decision of adopting an innovation on good references of existing users, but due to these differences with early adopters, they tend not to rely on opinions of this group. This creates a paradoxical situation, in which early majority is mostly influenced by members of their own group, hence the difficulty for an innovation to cross this chasm (Moore, 1999).

**Crossing “the chasm”**

Crossing the chasm would require, taking a niche market approach, with the main focus in creating a referenceable customer base for the early majority group (Moore, 1999). In order to achieve this, the customer group that is being targeted would need to have its demands completely satisfied. However, Moore (1999) remarks that crossing the chasm in the consumer market is significantly more difficult than in the business markets, “where the economic and technical resources can absorb the challenges of an immature product and service offering.”

Rogers (2003) proposes that for accessing the early majority, it is important to lower the entry cost and guarantee the good performance of the innovation, and, in some cases, push the innovation through a redesign process in order to maximize its ease and simplicity of use.

**The cargo bike as a successful innovation: the case of Copenhagen**

Following these diffusion theories, Copenhagen could be studied as an example of how the cargo bike has successfully been adopted in private logistics by users of the early majority (in the family-market, as it has been adopted by 26% of it). It is relevant then to explore the circumstances that supported this diffusion.

According to Rogers (2003), the factors that influence the adoption and diffusion of innovations can either be deterring or encouraging. Deterring factors are perceived by the adopters as efforts such as financial investments or a shift in habits, while encouraging factors are perceived as anticipated
benefits. Transport and economic policies, which can be of either nature, are among the most effective factors influencing the shift of transport modes in private logistics and can promote the adoption of the cargo bike (Wrighton and Reiter, 2015). In fact, deterring policies such as indirect measures that restrict driving and parking cars in the city as well as increase associated costs have the potential to encourage the usage of alternative modes such as the cargo bike (Gruber et al., 2014; Reiter, 2013; Russo & Comi, 2012). However, the success of the adoption of the cargo bike in Copenhagen was mainly achieved thanks to the implementation of encouraging measures. Back in the 1970s with the Renaissance of the bicycle culture in the city (Agervig Carstensen and Ebert, 2012) and then in the 1990s with the political will of “becoming the world’s best bicycle city”, the municipality promoted different policies and strategies supporting the bicycle, together with the implementation of infrastructural changes (Gössling, 2013), with the aim of achieving by 2015 a minimum of 50% of all commute trips to work or education place to be travelled by bicycle (City of Copenhagen, 2007). These strategies of change in transport behaviour and infrastructure served as base for the later adoption of the cargo bike in the city. The encouraging measures implemented by the city of Copenhagen support the statement made by Pucher et al. (2010), who claimed that the “attractiveness of the bicycle” is interlinked with the “perceived unattractiveness of the car”, as noted by Gössling (2013).

Sochor, Strömberg and Karlsson (2014) affirm that the diffusion of innovations in mobility requires the integration of multimodal transport alternatives into a “collective transport”, and so it cannot be achieved solely by the development of a single mode or by just focusing in converting car trips. Also, they considered the development in Information Technologies (IT) of great influence in these diffusions.

As stated by Heinrich et al. (2016), cargo bikes “are a promising vehicle for innovative urban logistics concepts in terms of sustainable urban transport”. The issues raised in this section regarding the diffusion of innovations and Moore’s approach to crossing the chasm inspire to research whether offering the cargo bike as a service (rather than as a product) for private logistics could have any impact in the success of its diffusion. In order to do so, theory related to product-service systems will be studied.

### 3.4 Product-Service Systems

The concept of “product-service systems” (usually referred to in literature as PSS) has been widely addressed in the literature, with different authors proposing their own definition. Tischner et al. (2002) define PSS as the combination of product(s) and service(s) that together can satisfy a specific need of a customer. Likewise, Goedkoop (1999) and Mont (2002) identify these as key elements of PSS, in which products are the tangible commodities of the offer and services the activities performed in benefit of the client. However, they expand the definition of PSS to incorporate a third essential element, the system, as the interactions between this group of products and services included in the offer.

This combination of products and services and the complete scheme involved behind allows PPS to have the capacity of improving competitiveness over the offering of a single product or service while, at the same time, promoting sustainability. In fact, most authors find sustainability at the core of PSS (Manzini et al., 2001), as a result of the shift in the customer’s behavior from complete ownership of a certain product to “relevant function usage” (Manzini and Vezzoli, 2002; Maxwell and van der Vorst, 2003; Stahel, 1986).
**Types of product-service systems**

The change in product ownership together with the offering of functionality creates a wide range of different types of PSS. Here, authors also differ on the different subdivisions, although all of them seem to agree on the identification of three main categories (Baines et al., 2007): product-oriented services, use-oriented services and result-oriented services (Cook, 2006). Tukker and van Halen (2003) also examined the literature and identified different models within these three main categories based on their economic and environmental characteristics and whether the value mainly resides in the product or the service content of the offering (see Figure 5).

![Figure 5. Product Service System categories (Tukker, 2004)](image)

In product-oriented services, the selling of a product remains as the main activity in the business model, where ownership completely shifts from the provider to the customer. However, these systems also involve the addition of complementary services to the product, most commonly in the post-sale phase, and often related to ensure the durability and continued functionality over time (Baines et al., 2007); this is the case of product-related systems [1], in which these activities are typically maintenance, supply of consumables or a recycling agreement. The other type of product-oriented services, advice and consultancy [2], is leagued to the additional offering a personalized assistance for improving the efficiency of usage of the product (Tukker, 2004).

Use-oriented services still include a product at the center of the offering, but now the main changes are applied to the business model: in these systems, the ownership of the product stays with the provider, and the product is not sold, but rather used by the customer. This allows the provider to implement different activities that can maximize product usage by different users and thus supply a larger demand (Baines et al., 2007). Tukker (2004) distinguished three models in this category, in which the main differences lie in two concepts deeply related to the lack of ownership: accessibility and availability. In product lease [3], the provider often takes responsibility on maintenance and repair and control activities, while the customer pays a regular fee for a personal and private access to the product. Product renting/sharing [4] differs from product lease in user access, as now a single customer is not the only user of the product (lacking of private access), which is available to be used sequentially by other users at other times. Finally, in product pooling [5] the accessibility to the product is similar to renting but its usage by the users is not sequential but simultaneous.
The third category, result-oriented services, changes completely the focus to create an offer that is based on selling a solution, without specifically implying the involvement of any particular product, allowing a higher degree of customization (Baines et al., 2007). Activity management [6] involves the outsourcing of certain activities of the client (usually not-core), that are performed by the provider, while in pay-per-service units [7] a product, although is still part of the deal, is not sold to the customer, but what it is offered is the outcome of the product itself. Functional result systems [8] are the most abstract of all, since a client buys the delivery of a result (functional), but the provider is not constrained to a particular technological system (Tukker, 2004).

The identification in the literature of these three main categories of PSS suggest three different approaches to consider a PSS around cargo bikes. This study will be limited to the category of use-oriented services for its relevance in the mobility industry.

**Barriers of adoption of product-service systems**

The adoption of a PSS requires both cultural and corporate shifts. This has been found by different authors in the literature to be the main barrier of adoption for PSS: from the users’ perspective, this shift requires to start valuing having their needs covered rather than owning a product (Goedkoop et al., 1999; Mont, 2002), while for an organization, the major concerns might be related to pricing inexperience and fear of assuming the risks that were previously owned by the customers (Baines et al., 2007).

The success of a PSS is also highly dependent on the culture it is being implemented. As Shehab and Roy (2006) noted, “PSS have been more readily accepted in the communal societies of Scandinavia, the Netherlands and Switzerland”.

### 3.5 Business Models and PSS

Built-in the definition of the different types of PSS presented before is the concept of business models. Business models are an essential part of product-service systems. As Manzini and Vezzoli (2002) state, “the product-service system is the result of a strategy that shifts business focus from designing and selling only physical products to deliver a system of products and services that together are capable of meeting specific customers’ demands”.

However, as it occurred before with PSS, many authors have written about business models, yet there is not a consensus in the literature about a single definition (Preciado & Oliva, 2011), mainly because business models are often referred to as different things depending on the author (Linder and Cantrell, 2000). According to Linder and Cantrell (2000), a business model is an organization’s “core logic for creating value”. Rajala and Westerlund (2005) specify that this value is created for the customers, and consider part of the definition the mechanisms that convert market’s opportunities into benefits, while Baden-Fuller et al. (2008) refer to this fact as capturing value for the stakeholders.

Nevertheless, recent literature is focusing more in frameworks rather than definitions. These frameworks are instruments designed to develop and evaluate the viability of business models (Horsti et al., 2004). There are also multiple approaches by different authors in the literature, most of them consisting of different elements and components. However, they are all organized around the concept of value (Richardson, 2008). That is the case of the framework proposed by Richardson (2008), who identifies three different value elements: value proposition, value creation and value capture.
<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>Contains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value proposition</td>
<td>The value that will be delivered by the firm to its customers, why the customers will be willing to pay for this value, and the organization’s approach to its competitive advantage.</td>
<td>(i) The offering, (ii) The target customer, (iii) The basic strategy to win customers and gain competitive advantage</td>
</tr>
<tr>
<td>Value creation and delivery system</td>
<td>How the organization will create and deliver value to its customers and the source of its competitive advantage.</td>
<td>(i) Resources and capabilities, (ii) Organization: the value chain, activity system and business processes, (iii) Position in the value network: links to suppliers, partners and customers.</td>
</tr>
<tr>
<td>Value capture</td>
<td>How the firm generates revenue and profit.</td>
<td>(i) Revenue sources, (ii) cost structure</td>
</tr>
</tbody>
</table>

Table 6: Richardson’s Business model framework (Richardson, 2008; Bocken et al., 2013)

But among all of the frameworks proposed in recent literature, and based in these value elements the one of the most popular is the one proposed by Osterwalder and Pigneur (2009). This framework identifies up to nine different elements: value proposition, customer segments, channels, customer relationships, key resources, key activities, key partnerships and cost structure. These elements are structured in a resulting Business Model Canvas. Barquet et al. (2011) identified in the literature different characteristics of product-service systems related to each one of these elements; the description of these elements alongside with the related PSS characteristics can be found in Table 7:

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
<th>PSS (use-oriented service)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value proposition</td>
<td>Overall view of the organization’s offering of products and services valuable for the customer segments targeted by the company.</td>
<td>Based on the integration of a product and a service (Tischner, 2002), where the ownership of the product stays with the provider and the user buys the access to it (Tukker, 2004).</td>
</tr>
<tr>
<td>Customer Segments</td>
<td>The different groups of customers the organization is offering value to that share the same needs.</td>
<td>Customers that accept not to be the owners of the product, that prefer making low investments (Tukker, 2004; Tischner and Verkuijl, 2002).</td>
</tr>
<tr>
<td>Channels</td>
<td>The means of delivering the value proposition to the customer segments.</td>
<td>Transitions in product usage can occur more smoothly since they do not involve the complexities of selling a product (Tukker, 2004; Tischner and Verkuijl, 2002).</td>
</tr>
<tr>
<td>Customer Relationships</td>
<td>The links the organizations establishes with the customer segments.</td>
<td>Ensuring long-term relationships require new direct-relation approaches (Mont, 2004).</td>
</tr>
<tr>
<td>Key Resources</td>
<td>Configuration of resources needed to create value.</td>
<td>“PSS require important investments in to human resources to cover the added customer’s needs” (Tan and McAlloone, 2006; Mont, 2004)</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Key Activities</td>
<td>Ability to perform a pattern of actions necessary for value creation.</td>
<td>“Providers of PSS should shift their focus from activities related to the product towards activities related to the customer” (McAlloone, 2006)</td>
</tr>
<tr>
<td>Key Partnerships</td>
<td>Cooperative agreement between different partners and suppliers in order to create value.</td>
<td>“A partnership network is essential given the increased complexity of the value proposition and the added competences needed.” (Mont, 2002)</td>
</tr>
<tr>
<td>Cost Structure</td>
<td>Cash outflows as the result of all the means employed in the creation of value.</td>
<td>“Cost structure and price setting is a challenge in PSS, since various costs are absorbed by the provider. PSS providers need financial partners or to hold the financial resources needed to support their cost structure” (Mont, 2002).</td>
</tr>
<tr>
<td>Revenue Streams</td>
<td>Cash inflows as a result of the delivery of the organization’s value proposition to the customers.</td>
<td>Special attention to the availability of the product, since it determines the payment by the user (Tukker, 2004). Sharing of the product can lead to lower needs of capital in the system (Tukker, Tischner, 2006).</td>
</tr>
</tbody>
</table>

Table 7: Osterwalder and Pigneur (2009) business model framework with added column related to PSS adapted from Barquet et al. (2011)

The relevance of addressing PSS from a business perspective motivates to conduct the empirical study using the framework proposed by Osterwalder and Pigneur (2009) to identify the main challenges, key elements, and opportunities for the successful performance of a service.

**Added value and new challenges in the business models of use-oriented services**

The creation of added value is the most important feature from which PSS benefit in their business models. This added value is sourced from satisfying customer’s needs in an integrated and customized way, but also from building loyalty through special relationships (Mont, 2000; Tischner, 2002; Mont, 2004). In turn, this capacity of fitting the customers’ needs allows PSS to achieve higher levels of competitiveness and faster introductions of innovations to the market (Tukker, 2004).

Tukker (2004) went forward and observed four key economic elements related to value capture and creation that they considered to be fundamental for measuring business success of a PSS: market value, production costs, capital needs and barriers to access.

In market value, they distinguish between tangible and intangible value, both approached from a customer perspective: tangible value is rational and objective for the customer, and can be measured with certain accuracy as it involves the resources, time and capital saved; intangible value, on the other hand, is subjective and involves the step in which the offering stops being a product to become an experience. Intangible value is complex to measure, but it is considered by Tukker to be the most relevant of both.
Production costs in PSS include traditional expenses such as resources, time and capital needed, that are often connected to the tangible market value. However, product-service systems account for a “hidden” production cost, which is the risk and uncertainty that the provider has to deal with due to the added difficulties and swift in responsibilities that are on the user end (Tukker, 2004).

The capital needed for PSS, as stated by Mont (2002), remains as a challenge for these systems, since added to the production of the product are the extra investments required to complete the service around the solution offered (Tukker, 2004).

The last major economic element is the ability to capture value through sustained low barriers for accessing the service. One of the main barriers identified was the upfront payment of a product by the customer; PPS have the capacity to lower this barrier by offering access to the product with a fee-solution instead. Lowering barriers additionally have a positive impact on developing customer loyalty and on the speed of innovation as, together with partnership cooperation creates an open environment in which more customers can use the product and offer insights (Tukker, 2004).

For product lease, the hidden production cost for the provider is related to the risk of product deterioration by user maltreatment. The capital needs for these providers would be high, as their cost structure is augmented with the ownership of the products leased. On the other hand, this create market value to the customer and lower the barriers for accessing the product, as it would now require low initial investments (Tukker, 2004).

Product renting/sharing and pooling require a tangible sacrifice from the user as the access to product is limited, but in turn this sacrifice lowers the access barriers. On the provider side, these schemes would require high capital needs due, again, to the ownership of the product, although, according to Tukker and Arnold (2004), this would be lower than it was in the leasing option, due to the sharing nature of this PSS (that requires less products to supply a bigger demand).

Most companies operating use-oriented services buy the products they lease/share/pool and do not take part in their designing process (Tukker, 2004).

3.6 Use-oriented services in mobility: the bicycle and the cargo bike

At this point, it is relevant to mention the particularities of use-oriented services in mobility, especially in cycling solutions. While product lease conserves the meaning given by Tukker (2004) (that is, the personal and private access to a product), bicycle pool is referred to in literature as the shared access (usually by a closed group of users) to a fleet of bicycles.

The review of current literature, theories and existent solutions that include cargo bikes in product-service systems was concluded unsatisfactorily, with the exception of experimental cargo bike pools (Börjesson and Henriksson, 2014; SeestadtFLOTTE, 2014). Hence, the need of further empirical research in the area of PSS involving cargo bikes.

On the other hand, there is a substantial amount of literature regarding public sharing systems for the bicycle. Since the aim of this thesis is to explore the different PSS alternatives for the cargo bike, and given its “bicycle nature”, it is convenient to study these systems.
**Bike sharing**

Bike sharing is described by DeMaio (2009) as the “short term bicycle rental available at unattended stations”, allowing A to B trips in which a bicycle can be picked up at a station and returned to another. In product-service system terms, bicycle sharing allows the use of the bicycle avoiding ownership costs and responsibilities (Shaheen et al., 2010).

The ultimate goal of these schemes is, according to Shaheen et al. (2010), to expand and integrate the bicycle into transportation systems to make them an attractive mobility alternative for daily inter-city trips. These trips covered by the bike-sharing schemes are considered to fill a niche in urban transportation in terms of cost and length (Quay Communications, 2008):

![Figure 6: Bike-sharing systems in urban mobility (Quay Communications, 2008).](image)

The first bike sharing system in Europe appeared in Amsterdam in the 1960s, but it was stopped due to the maltreatment and theft of the bikes (DeMaio, 2009). However, these schemes have experienced a tremendous diffusion over the last decade, with more than 150 running systems in Europe in 2012 (Parkes et al., 2013):

![Figure 7: Diffusion of bike-sharing schemes in Europe and North America (Parkes et al., 2013)](image)

In Stockholm, CityBikes (SCB) was the first public bike-sharing scheme adopted by the city, back in 2006. Of the 160 stations and 2,500 bicycles originally planned, in the year 2017 it already included
1,500 bicycles distributed in 140 stations (CityBikes Stockholm, 2017). The scheme, opened from April to October, offers a seasonal pass for 300 SEK, as well as a casual membership of 3 days for 165 SEK, with a limitation of time usage of the bicycles of three hours per session. The access to the system is linked to the public transport card.

The conversion of private car trips into bike-sharing schemes has been considered by different authors as a cultural shift outcome of the implementation of these systems, although the replacement rates in different cities has been overall low in comparison with modal conversion of walking and public transport trips (Fishman et al., 2013), with the examples of 2% of car trips replaced in London (Fishman et al., 2014), 7% in Lyon (Fishman et al., 2013) and 9.6% in Barcelona (Rojas-Rueda et al., 2011). In fact, the study of bike-sharing customer segments show that users of these schemes are more likely to be involved in cycling with independence of bike sharing schemes being available (Shaheen et al., 2014). Nevertheless, bike-sharing schemes have also had a proven success of pushing the adoption of the bicycle in those places where they were present, as in cities like Paris or Lyon, bicycle usage increased in 70% (Bremner and Tourres, 2008) and 44% (Buhrmann, 2008) during their first year of operation, respectively. According to Shaheen et al. (2012), the product-service system benefits of the bike-sharing schemes (addressing bicycle ownership issues such as storage, maintenance and parking) have the potential to encourage the shift in transport behaviour among users who are not regular cyclists.

The main barriers of adoption that these schemes have found are related to their integration with public transport (Goodman and Cheshire, 2014; Ogilvie and Goodman, 2012), mandatory legislations, instant accessibility, cycling infrastructure and road safety (Fishman, Washington, & Haworth, 2012). Moreover, proximity to the nearest station and density of stations have been considered by different authors as encouraging elements for bike-sharing usage (Fuller et al., 2011; Ricci, 2015; Shaheen et al., 2012).
4. RESULTS

This chapter presents the results of the empirical research in two main sections: the first section contains the primary sources related to the users’ perspective consisting of a survey and two in-depth interviews with potential cargo bike users; the second section presents the stakeholders’ perspective with four interviews organized around the business model canvas.

4.1 User Perspective

The diffusion of innovations theories studied in the literature (3.3) will be used to describe the phenomenon of adoption of the cargo bike. These theories involve different groups of users with different habits and behaviours which are the root of the barriers for adopting innovations. The identification of these barriers constitutes the answer to the RQ1 and, to achieve it, a characterization of users of the cargo bikes will be carried out following the methodology. This results will be later analysed according to the literature.

4.1.1 Survey

The survey had an exploratory approach and targeted Swedish cargo bike enthusiasts with the aim of collecting knowledge regarding their urban transportation habits and their attitudes towards cargo bikes. The survey attracted a total of 85 respondents. The survey was structured with the following structure: in the first place, the respondents were asked to answer to a set of socio-demographic questions; secondly, they were presented with a section regarding their urban transport habits that led to two alternative sections, one for respondents who did not own a cargo bike, and one for those who did.

Socio-demographic profile

The sample was characterized regarding six different socio-demographic factors: place of residence, gender, age group, occupation, annual income and type of household.

All of the respondents of the survey lived in Sweden: 34% had their residence in Stockholm, 6% where from Goteborg, 5% from Uppsala, and the rest 55% were from other Swedish municipalities. Thus, the information gathered from this method can be later analysed using the literature review and Swedish context provided.

The gender distribution was uneven, as 67% of the individuals participating in the survey were men and 30% women (3% of the sample preferred not to tell). Although the sample covered the complete adult age range, the majority of respondents, a total of 63%, belonged to the age group of 35-50, followed by the group of 25-34 with 31%. Respondents aged between the ranges of 18-24, 51-64 and more than 65 were 2%, 3% and 2% of the sample, respectively. None of the surveyed individuals were under 18 years old.
Regarding their current occupation, the vast majority of the respondents (81%) were employed by a company at the moment, 9% were entrepreneurs/self-employed, 6% were time students and the 4% remaining were retired and homemakers. Half of them had an annual income inside the range of SEK 300-500K, the rest distributing between the ranges of SEK 100-300K (21%), SEK 500 -700K (16%) and less than SEK 100K (10%). Only 3% of the sample had an annual income of more than SEK 700K.

A question regarding the type of household they lived in was asked, resulting in a more even distribution between condominiums (36%), villas (27%), tenancies (24%) and terrace houses (13%). The relevance studied in the literature of using cargo bikes for transporting children motivated the characterization of the families of the respondents: 83% of these homes were inhabited by families with children (three or more people), the most common structure being households of four people in which two of them were children (44%), families with one child (16%) and families with three children (12%) whereas the remaining were families with more than three children (10%). Homes composed of two people and without children accounted for a total of 18%.
The predominance of certain socio-demographic characteristics of the sample resembles the profile of cargo bike users studied in the literature (3.2); however, it will limit the generalizability in the later analysis (as it was described in the methodology chapter).

The relevance of the substitution of car trips in urban mobility suggested in the literature motivated the study of car ownership in the sample. Only 14% of the respondents did not have a driving license, while 78% of them held a B-type license. When asked about accessibility to a car, almost half of them (48%) owned a private car, while 30% stated that they could access a car whenever they needed to and just 22% did not own or have access to a car.

Urban transportation habits

The purpose of this section of the survey was to characterise the sample’s transport habits to allow later in the analysis a comparison with the average transport habits of the country reviewed in the literature, as well as to empirically contribute to the characterization of cargo bike users’ habits. For that, building from the study by Sveriges Officiella Statistik (2016), the respondents were asked about their main transport mode, average distance travelled and frequency of trips for the following purposes: go to work, go to school/university, go shopping, go to a sport related activity, drop-off children, travel within their job and travel for other regular/leisure activities.

- Go to Work: This activity was performed on a weekly basis by 88% of the sample, keeping coherence with the socio-demographic characteristic studied related to occupation. Half of the respondents performed this activity with a frequency of 3-5 trips per week. 27% of the sample went to work 6 or more times a week, while 14% went to work less than 3 times. The distance travelled for this purpose by 30% of the sample was over 10km, while 22% travelled between 5-10km each trip, 30% between 2-5km and 9% of the respondents travelled less than 5km for this activity. The main mean of transport to go to work was the bicycle, used by half of the respondents, followed by the cargo bike (21%) and public transport (19%); the car was the main transport mode for only 6% of the individuals. The Figure 10 visualizes the complete crossover between distance and frequency involved in the activity “going to work”.

![Figure 10: Activity Go to Work](image)

GO TO WORK

- Distance: >10 km: 16%; 5-10 km: 11%; 2-5 km: 20%; 1-2 km: 4%; <1 km: 2%
- Frequency: 3-5 trips/week: 20%; 1-2 trips/week: 4%; 1-3 trips/week: 2%; 6-10 trips/week: 4%
• Go to School/University: this activity was performed on a weekly basis by just 24% of the sample. The majority of respondents that performed this activity (58%) did so with a frequency of 3-5 times per week, for distances between 2-5km.

• Go Shopping: the totality of respondents of the survey affirmed that they performed this activity, although 8% did not do so on a weekly basis. The majority of the respondents went shopping 1-2 times per week (59%), and frequencies in the range of 3-5 and 6-10 times per week were indicated by 27% and 6% of the sample respectively. Regarding distances, 72% of the sample travelled between 1-5km to perform this activity, while 12% went distances smaller than 1km and 10% travelled between 5-10km. None of the respondents went shopping more than 10 times per week or travelled distances further than 10km. The main transport mode employed was the cargo bike, used by 39% of the sample, followed by the bicycle by 26%, and the car by 17% of the respondents. The Figure 11 visualizes the complete crossover between distance and frequency involved in the activity “go shopping”.

![Activity Shopping](image)

**Figure 11: Activity Shopping**

• Sports-related activities: sport activities were performed with a frequency of 1-2 times a week by 32% of individuals, while 18% exercised 3-5 times; on the other hand, 39% claimed to never perform this activity. The majority of respondents that went exercising travelled distances between 1-5km (39% of the total of respondents). Their preferred mode of transport was the bicycle (31%), followed by walking (13%) the cargo bike (9%) and the car (5%).

• Dropping Children: Although 83% of the respondents affirmed to live in a household with children, 68% dropped their children at school and different extracurricular activities. Most of these individuals dropped their children on a basis of 3-5 times per week (33%), while others performed this activity 6-10 times (17%) and 1-2 times (13%) per week. The most common distances travelled by the respondents who performed this activity were between 1-2km (21%), between 2-5km (20%) and less than 1km (19%). To do so, 34% of the sample used the cargo bike as their main transport mode at the same time as the bike was used by 20%, while just 7% preferred to go walking and only 5% used the car. The Figure 12 visualizes the
complete crossover between distance and frequency involved in the activity “dropping children”.

Figure 12: Activity Dropping Children

- Travels within work: The majority of the respondents (70%) indicated that this activity was not performed with weekly frequencies, as 18% of the total sample performed this activity 1-2 times per week and only 9% did so 3-5 times on a weekly basis. The most common distances travelled for this purpose were more than 10km (19%) and in the ranges between 5-10km and 2-5km (11% each). Regarding mode of transport, 22% of the sample used the bicycle for travelling within their work, while public transport, cargo bike and the car was used by 11%, 8% and 7% respectively.

- Leisure and other: a majority of 61% of the sample affirmed to perform weekly trips of this nature, with 44% of the respondents taking leisure trips and trips of other nature 1-2 times per week, and only 15% performed these activities between 3-5 times. The most common travelled distances were those in the range of 2-5km (24%) and 5-10km (19%). The preferred mode of transport for 38% of them was the bicycle, followed by the cargo bike (24%) and the car (9%).

In summary, the majority of the respondents indicated shopping, going to work, dropping children and leisure/other as the main purposes in their urban transport habits, with a predominance in their modes of transport of the bicycle, the cargo bike and the car in all of them, while the frequencies and distances travelled varied in each activity surveyed.

Then, the participants of the survey were asked whether they owned a cargo bike or not. 65 of them were cargo bike owners (76%), while the 20 remaining did not have a cargo bike of their own (24%). At this point, the survey took a different path according to this answer: respondents who did not own a cargo bike and respondents who owned a cargo bike. Both paths focused on the attitudes of the respondents to the cargo bike.
Respondents who did not own a cargo bike

By isolating the results of urban transport habits of the respondents that did not own a cargo bike from those who did, some main differences of the two groups were found in the main mode of transport employed for each activity. Most of those who did not own a cargo bike used the bicycle to go to work as their main mean of transport (60%), while the car was the most popular for going shopping (45%). The majority of respondents who did not own a cargo bike did not perform the activity of dropping children (60%). For leisure and other activities, the usage of the car rose in this group up to 20%. In summary, the absence of the cargo bike for this group was translated into a bigger use of the regular bicycle and the car.

With the RQ1 in mind, this group of participants were asked about the reasons why they did not own a cargo bike, with the intention of identifying key elements that could later be analysed as barriers of adoption:

- Not enough information: When asked about whether the reason why they did not have a cargo bike was because they did not have previous or enough knowledge about cargo bikes, the totality of respondents of this group did not consider this fact as relevant.

- Their current transport modes covered their needs in a better way: only 16% of the respondents that did not own a cargo bike indicated this factor as relevant reason.

- Cargo bikes weren’t a suitable solution for covering their transport needs: the vast majority of this group (90%) did not consider this to be a relevant reason for not owning a cargo bike.

- Their economic situation did not allow them to afford buying a cargo bike: 42% of respondents in this group affirmed this reason to be of relevance.

- Lack of storage/parking space: a majority of 53% of respondents of this group considered this to be a main factor for not owning a cargo bike.

- Their expected frequency of needing a cargo bike was not high enough to consider owning one: 32% of individuals of this group stated this as a main reason.

- Other: this was an open answer option in which respondents could raise other reasons why they did not own a cargo bike that weren’t covered in the previous alternatives. The main concerns that they brought up regarded safety perception while driving the cargo bike and the potential risk of theft when the bike was parked.

The Figure 13 visualizes all of this reasons:
The cross-study between these reasons and socio-demographic characteristics of the sample offered the following findings: All the respondents who stated that they couldn't afford a cargo bike had an income of less than SEK 500K/year. Also, all of the respondents who indicated the lacking of parking/storage space as a main reason for not owning a cargo bike lived in either condominiums or tenancies.

The group was finally asked about the factors that they considered to be enablers for them to start using a cargo bike. This was an open question in which the most common suggestion was that having the possibility of accessing a cargo bike through a service-oriented solution would allow them to become cargo bike users, and the second most frequent consideration was that the availability of parking/storage spaces and safe locking both at the origin and destination of their trips was a potential enabler factor to start using a cargo bike.

**Respondents who owned a cargo bike**

By isolating the urban transport habits results of cargo bike owners from the complete sample it was possible to determine the role of the cargo bike in their daily transportation activities, as collected in Table 8:

<table>
<thead>
<tr>
<th>Transportation Activity</th>
<th>Cargo bike owners that use the cargo bike as their main transport mode for the activity (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go to work</td>
<td>26</td>
</tr>
<tr>
<td>Go to school/university</td>
<td>11</td>
</tr>
<tr>
<td>Go shopping</td>
<td>51</td>
</tr>
<tr>
<td>Go to sport-related activity</td>
<td>12</td>
</tr>
<tr>
<td>Dropping children</td>
<td>45</td>
</tr>
<tr>
<td>Travel within work</td>
<td>11</td>
</tr>
<tr>
<td>Leisure/other</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 8: Cargo bike as the main mean of transport for cargo bike owners by purpose.
When asked about the main purpose for using their cargo bike, 83% of cargo bike owners responded to use it for transportation of their children, 60% for carrying shopping and groceries, 38% transported heavy loads and just 8% used it for work-related purposes.

![Figure 14: Purposes for using the cargo bike](image)

To allow a later analysis of the consideration of the cargo bike as an innovation for this group of users, a question regarding how long they had owned their cargo bikes was asked. Most of the respondents of this group were recent cargo bike owners: 41% have had a cargo bike for 1-3 years, while 27% have had it for less than a year; 23% were 3-to-6-year cargo bike owners, and just 9% have had a cargo bike for longer than 6 years. Ownership of the two main types of cargo bikes did not differ much as 51% of the respondents of this group had a 2-wheeled cargo bike, while 43% owned a 3-wheeled one; 5% claimed to own both types of bikes. The cross study of type of cargo bike owned with previous socio-demographic characteristics did not show any relationship with gender, age, income, occupation or home structure. Most of the cargo bikes owned by the respondents of this group were also electric (56%).

To study the influence of the weather conditions in the usage of the cargo bikes, respondents were asked about their usage during all the seasons: cargo bike usage wasn’t dependant of the season according to the owners surveyed, as 85% of them used their cargo bike as a main mean of transport in spring and summer, 83% also used it during autumn and even 68% affirmed that the cargo bike remained as a main transport option during winter.

Then, owners of the cargo bike were asked about the benefits of using their cargo bike for moving cargo (including children and loads of different weight) compared to other transport modes, in order to study their attitudes towards cargo bikes. To answer this question, the participants of this survey were presented with a total of 7 different affirmations following the structure of a Likert scale, in which the respondent had to decide whether they “Totally disagree”, “Partially disagree”, “Partially agree” or “Totally agree” with these statements. The results are presented in the Figure 15:
The results showed a large satisfaction of cargo bike owners for using their cargo bike in all the categories covered, specially claiming it to be an advantageous mode of transport in terms of duration of trips, ease of use and safety, while the ease of driving the the cargo bike in town was the least supported statement. Additionally, the analysis of the results showed a decreasing perception of safety of the cargo bikes with the increase of distance travelled.

The last question asked to cargo bike owners was related to the reasons they considered to be relevant for not using the cargo bike. Again, this questions were presented with a total of 7 different affirmations following the structure of a Likert scale. The results are presented in the Figure 16:

This time, the results were more diverse. However, most of cargo bike owners agreed in some degree that the city infrastructure, the need to travel long distances and the need of maintenance were the main reasons that discouraged them from using their cargo bikes. Moreover, the analysis of this responses showed that maintenance was more relevant for women than men, that bad weather conditions as a reason for not using the cargo bike increased its importance with age, and that cargo bike owners with children shower a higher degree of agreement with the need to travel long distances as a reason for not using their bikes.
4.1.2 Interviews with potential users of a cargo bike

The empirical study on the “user perspective” was completed with two in depth face-to-face interviews of potential cargo bike users (User A and User B) chosen from the survey sample (they specified that they did not own a cargo bike). The main sociodemographic differences between user A and user B is that user A was a man and lived in a villa, while User B was a woman living in a condominium. As stated in the methodology, these interviews focused on awareness, potential use of cargo bikes, change in their current transport habits, barriers of adoption, and potential of PSS solutions to support answering RQ1 and RQ2.

Awareness of the Cargo Bike
Both User A and User B declared to be enthusiasts of achieving a car-free way of living as they proactively chose and seek alternative transportation modes to the car. User A was an enthusiast of bikes, while User B was introduced to cargo bikes at her workplace.

Potential usage and change on transport behaviours
While User B considered that having access to a cargo bike could potentially supress her needs for a car, User A still believed some of his needs depended on car usage (and thus not all car trips could be converted to the cargo bike). Nevertheless, both users believed they would use a cargo bike on an everyday basis, with the main purpose of transportation of children for User A, and transportation of heavy loads and shopping for user B.

The main change both users considered that would affect their current mobility habits was a change in the mode of transport; User A already owned a trailer for his bike, and the cargo bike would be substitute of it, while User B would start using the cargo bike for trips which at the moment were mainly performed by public transport.

Barriers of adoption
For both User A and User B, the high price of the cargo bike was the main reason for not one. For User B, lacking of parking space was also a big impediment, while User A considered this problem to be a minor issue. User B also identified the high risk of theft of the bike (related to a lack of a safe locking mechanism) as a barrier for adoption.

PSS as an enabler
Though both users agreed that a PSS could potentially push them to start using a cargo bike, they also highlighted that the main elements of the value proposition of a service were price, availability and accessibility. Next, the three main different possibilities of a use-oriented PSS alternative were discussed:

Lease was the preferred option for User A, as it would break the main barrier (economic situation) and enable him to cover his transport needs in the most suitable way, as it would grant total accessibility and availability to the cargo bike. For this option, User A considered that the offer should include the maintenance of the bike and the pricing strategy should be a monthly subscription fee that could let him pay-off the cargo bike in 2 years (200 SEK/month). User B was less attracted to this option since it still wouldn’t solve parking and safety barriers.

Pool was the preferred alternative for User B, since it would tackle her two main concerns: financial constraints and lack of parking space. She associated the pool to a service that would be provided by her housing association and considered that the bikes included in the pool should be of good quality.
She also believed that with this type of service would have the potential of involve the community in taking care of the bikes, as it would create a shared responsibility. She considers the best pricing option to be a monthly fee subscription plus a fee per unit of time used, and that long sessions of usage would work best for her. User A, however, considered that this option would affect the availability of the bikes and would require more planning and preparing in the everyday lifestyle, thus having a negative effect in his transportation behaviour.

Both User A and User B considered the sharing option to be the less appealing of the three, as it would affect both availability and accessibility of the bikes. However, they differed in the acceptable distance to the nearest station, as User A consider it to be 200m, while User B would be willing to walk up to 1km. User B also stated her concerns that a big bike sharing system (such as City Bikes in Stockholm) would possibly mean a lower quality of the cargo bikes together with a lower involvement of the users in sharing responsibility.

4.2 Stakeholder perspective

In order to answer RQ2 and RQ3, four interviews were performed. These interviews targeted stakeholders of the three use-oriented PSS identified in the literature: lease, pool and share. The literature covered in the previous chapter regarding product-service systems and its implication in business models will serve as the framework to analyse the results obtained in this section.

The results are presented by use-oriented service type and sorted thematically following Osterwalder’s Business Model framework (Osterwalder and Pigneur, 2009).

4.2.1 Pool

Value proposition
The Operator and the Architect agreed that the value of a cargo bike pool lay on its ability to cover freight transport needs of a closed community without the ownership obstacles for the members of high purchase price, storage and maintenance requirements. The Operator considered this PSS alternative as the most convenient for an improved user experience, although remarked the inefficiencies of long periods of usage in an A-A service.

Customer segments
The Operator and the Architect had two different approaches regarding customer segments. While the Operator opened the pool to be available to all residents of the district (so their segmentation was based on area of residence), the Architect considered the pool to benefit exclusively the residents of the building complex, planning for a customer segmentation in which they targeted potential residents that particularly lacked access to a car or that aimed for a car-free way of living (and thus, were not interested in “the bigger mainstream crowd”). This type of profile was also identified by the Operator as the most interested in the pool, especially at the beginning. The Architect also remarked a special interest in women and families (as they studied that these groups would benefit the most from shared mobility), at the same time that the Operator identified a predominance of car-free lifestyle enthusiasts between the members of the pool, and found in user gender a main challenge, as 90% of their users were men. The Provider added to the differences of these two approaches the importance of the relationships between the users that share the scheme, as based from experience, bicycle sharing between people that do not know each other was more challenging than a shared system between people that do.
**Customer Relationships and Channels**
The Operator found of extreme importance the awareness and pre-evaluation phase of the pool for attracting new users. From experience, the visibility of the cargo bikes when they were being used as well as the periodical free trials offered resulted in an increase of residents’ interest and subscription of members, since the cargo bikes weren’t visible when parked. He also considered the pre-evaluation phase of relevance since the incremental difficulty of a cargo bike from a regular bicycle deterred some potential users from becoming members. For existing customers, both the Operator and the Provider contemplated as an important area of improvement for the success of the pools the involvement of the users, particularly that they keep an active participation in taking care of the bikes.

**Key Resources and Activities**
All of the stakeholders interviewed considered locking, booking and storage of the cargo bikes as key elements for the performance of the pool.

- Solution for Booking: For the Operator, the preferred booking system was an IT solution via website/app, easily accessible for all the members, where they could check the availability status of the cargo bikes and book them for their desired time to use. The Architect, although was still considering the most suitable alternative, stated it would be integrated with the rest of the service offered in the community in one single system. The Provider considered that the booking solution should be flexible in its access.

- Locking: The risk of theft of the cargo bikes was a major issue mentioned by all. The Provider was a keen supporter of a keyless solution, with the Operator having already implemented this recently, which he considered to have had a significant improvement in the service offered, both for new member subscriptions and user satisfaction.

- Parking/storage of the bikes: this was a major concern for all the parts, who considered that its solution still remained as a main drawback affecting the overall performance of the service. The Operator and the Provider associated this issue to the dimensions of the cargo bikes, since they are longer, wider and heavier than regular bicycles. The Operator also discussed that the particularities of each area or district often required the pooling solution to adjust to their own specific situation (most of the time involving key partnerships). The Architect, on the other hand, raised the potential benefits to solving this issue in planning cargo bike parking spaces in the garage of the buildings; this would also have an important effect on key partnerships and cost structure. The Provider furtherly mentioned the possibility of dealing with these storage concerns with a free-floating approach (in which the bikes wouldn’t need to be parked in dedicated areas but rather have a designated area available for users to park them), but considered that the risk of theft of the bikes was elevated and that current technology solutions were very rudimental, such as the location of the bike.

- Access point to electricity for electric cargo bikes: electric cargo bikes were considered by everyone as the product with the most potential for satisfying users’ needs and maximize membership to the pool. This, of course, added new obstacles, such as the access point for electricity and the charging of the bikes, which, for the Operator, highly depended on the parking solution implemented, which remained a challenge for his pool. The Architect, though, considered it as a minor issue, since these accessing points can be included in the design of
the pool. All the stakeholders agreed that charging points would also help solving the problem of locking.

• The maintenance of the bikes was an important activity that all the stakeholders considered in the cargo bike pool. The Architect remarked that including a pool service solution in new buildings legally required to provide a maintenance solution, and was considering to include a workshop in the basement. Meanwhile, the Operator relied on external agents to provide maintenance (for whom the location of these providers was crucial), and was at that moment highly dependent on the involvement of the users of the pool for performing this activity.

**Key Partnerships**

In their responses regarding key activities and resources, the stakeholders identified the importance of the involvement of different partners for successfully operate a cargo bike pool.

• Municipality: In order to offer shared mobility services for the residents of the building, the Architect would reduce parking spaces traditionally assigned to cars in the garage, and thus creating an area dedicated for a cargo bike pool. However, this reduction of car parking spaces can’t be completely determined by construction companies, as they need to satisfy the requirements and regulations settled by municipalities regarding the number of parking spaces per inhabitant of the building, an indicator known as the parkeringstal (p-tal). The main purpose of this index is to ensure that residents of these buildings have their mobility needs covered, and thus that the right number of parking spaces is provided (Stockholms Stad, 2015). The 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 by proving that they cover the full range of mobility needs of future owners, including the offering of a cargo bike pool. At the moment, both the Architect and the Municipality considered this to be a main challenge in policies, which was mainly determined by current postures and strategies towards a car-free lifestyle. This concept of shared mobility was still being considered to be deterring towards car usage, instead of encouraging towards a possible sustainable solution to mobility.

• Property Owners (Housing association): both the Operator and the Architect agreed on the relevant role that housing associations have in providing a cargo bike pool. For the Operator, property owners were essential in providing funding, parking space and members; for the Architect and the Municipality, the property owners of a shared mobility building would require a long-term commitment with these services for their success and viability. This commitment was also identified by the Municipality as a main issue to be discussed in further policies.

• Insurance: The main challenge for operating a cargo bike pool, according to the Operator, was the insurance of the cargo bikes since, at the moment, the cargo bikes offered in pools lacked of insurance options, making it difficult to operate an economical sustainable pool without economical compensation for theft.
Cost Structure

The Operator and the Provider distinguished between capital and operational costs:

- Capital costs: According to the Provider, cargo bikes have limitations in the reduction of its manufacturing costs (as opposed to regular bicycles), as they need to guarantee transportation for heavy loads, which requires high quality materials and construction. This was the main challenge according to the Provider for cargo bike pools to be financially sustainable. The Operator agreed on this major element in the cost structure; on the other hand, considered that the cargo bikes, due to its quality (and lower frequency of usage) have the potential to uphold a longer lifespan, with a current estimation of their amortization in 5 years. However, both agreed that currently in the market the cargo bikes available were designed for private usage.

- Operational costs: Maintenance was identified by both the Provider and the Operator as the main operational cost of a cargo bike pool. Moreover, the Provider highlighted that cargo bikes can incur in less maintenance costs than regular bicycles due to their higher quality, and suggested that cargo bikes should aim for simplicity in their design, as from experience bikes with advanced components needed to be repaired up to ten times more, and thus increase the maintenance cost. The Operator estimated that maintenance of the cargo bike can be up to 500kr/bike per year.

The Provider suggested that, for a cargo bike pool to be economically feasible, the strategy followed should be based on saving costs. He remarked the potential of integrating cargo bike pools in buildings of new construction, as they can reduce the costs associated to car parking spaces. This is, in fact, the strategy that the Architect was pursing: the costs associated to parking spaces in the garage are carried by all the residents of the building and they are quite substantial, as each place costs between SEK 28-40K. Dedicating these places instead for a cargo bike pool could have the potential of overcoming the high capital costs of the cargo bikes and allow the financial feasibility of the pool. The Provider doubted that the same impact could be achieved on existing residential buildings.

Revenue Streams

Three main sources of income were identified by the Operator: funding, user subscriptions and advertising. The Operator, as stated in key partnerships, relies on funding from the property owner to operate, as it is the main sponsor for the purchase of the bikes. This funding is supported by the rent paid by all the residents of the housing association. This fact, together with the openness of the pool to other residents in the area (and not just the inhabitants of the property owner’s buildings), made the Operator distinguished between two types of memberships: those residents under the housing association could access the pool without additional cost, while the preferred solution for the rest of residents of the covered area was a yearly membership subscription (of 400 SEK). The Architect agreed on the convenience of including all of the shared mobility services (the cargo bike pool being among them) as part of the rent of the building residents. For both types of users, it was agreed that the usage of the bike should be also priced taking an hour basis (10SEK/h). The Operator struggled to cover their current cost structure with only user subscriptions. On the other hand, the Operator considered that local advertising held the biggest potential source of revenue.
4.2.2 Lease

Value proposition
The Provider identified in the saved costs from purchasing a cargo bike, the covering of its maintenance and the personal and unlimited access to the bike the main value elements offered in the lease alternative for the customers.

Customer Segments, Customer Relationships and Channels
The profile of the customers of this alternative predominately showed a prior enthusiasm towards cycling. These customers were involved in long-term contracts over periods between twelve and eighteen months that, by the end of them, assured a complete pay-off of the cargo bike by the customer.

Key Resources and Activities
The maintenance of the cargo bike was the main activity performed by the Provider, which also required key resources such as bicycle components, workshop and tools, and personnel.

Key Partnerships
The key partnerships identified in the lease option included bicycle and component providers, but were mainly focused on financial solutions that could support the cost structure of the service provided.

Cost Structure
The resources and activities identified, together with the fact that the ownership of the cargo bikes stayed with the provider during the leasing period (which are valued in the range of 3,000 – 5,000 SEK), conformed a challenging cost structure that required high capital power to support.

Revenue Streams
This cost structure, apart from the financial solutions identified as key partnerships, was also sustained with the revenue streams from the lease of the cargo bikes, which came in the form of monthly payments by the customers in the range of 200-300 SEK.

4.2.3 Share

Value proposition
Although the current bike-sharing scheme offered by the Municipality did not include cargo bikes in its fleet, the access to these bikes and subsequent creation of new urban mobility possibilities for the citizens of the Municipality was the main value proposition identified.

Customer Segments, Customer Relationships and Channels
Generally, a public bike-sharing scheme targets multiple customer segments: from tourists to commuters (both casual and regular users); these schemes have shown different degrees of success in the cities that have been implemented, and the transport behaviour of these users has been widely researched (as it was investigated in the literature). However, the Municipality considered the challenge of including a cargo bike as part of the bike-sharing scheme to be tough, specially due to the little research available around cargo bike users’ profiles and behaviours and the consequent difficulties of guaranteeing the success of its adoption by the citizens.
Key Resources, Activities and Partnerships

The Municipality declared that the City did not have the ability to operate a sharing bicycle system by its own, relying its operation in a private actor. This way, the city provided public space for the stations letting the operator obtain revenues from advertising concessions. Thus, the key element in this relationship is the contract between the Municipality and the operator, with a main focus in infrastructure ownership. The implementation of a bicycle share solution was considered as a long-term commitment relationship from the Municipality. Other relevant factors considered that discouraged the implementation of this alternative were the design of the station network (currently not conceived for including a cargo bike) and key activities such as redistribution and maintenance (as cargo bikes cannot be handled with the current solution).

Cost Structure and Revenue Streams

There are two different points of view regarding cost structure and revenue streams: from the operator side, the major costs are those associate with infrastructure and implementation (including the cargo bikes, the terminals and docks, as well as the set-up and the ground work) and running costs (such as maintenance, re-distribution and system operation); from the Municipality perspective, the cost is linked to the contract. As it was stated by the Provider, while regular bicycles could be manufactured to reduce costs (which was the strategy followed by the sharing scheme offered in the Municipality), cargo bikes are limited in this cost reduction. This issue was considered key by the Municipality for the impediments of including the cargo bike as part of the offering, as external actors were not interesting in assuming the risk of ownership of the bikes. Current revenue streams in the scheme offered in the Municipality came from user fees (registration and usage, as shown in the previous chapter) but mainly from advertising partnerships.

4.2.4 General Comments

Overall, the stakeholders interviewed agreed that the most suitable product-service system solution for the cargo bike was the cargo bike pool. Moreover, they considered that a PSS for the cargo bike should be offered as part of a bigger sharing mobility system. In fact, the Municipality was already exploring the possibilities of developing a concept of Mobility as a Service (MaaS) for the city that could include a solution around cargo bikes.
5. ANALYSIS AND DISCUSSION

In this chapter, the literature and theories studied in chapter 3 will serve as the framework to analyse the empirical results obtained in chapter 4. This chapter will treat the adoption of the cargo bike, relevant factors related to product-service systems, product-service systems as enablers for the diffusion of cargo bikes and challenges and opportunities in the business models of cargo bike product-service systems.

5.1 Framework of the analysis

Following the methodology described in chapter 2, diffusion of innovation theories (3.3) will be used to describe the adoption phenomenon of the cargo bike, while product-service systems (3.4) and business models (3.5) literature will serve as the framework to analyse the potential, challenges and opportunities of the different schemes studied in this research:

- The section 5.2 studies the diffusion and adoption of the cargo bike. The official statistics of transportation in Sweden (3.1) will be used as a reference to compare the urban transportation habits from the survey sample (4.1.1). Cargo bike usage and car substitution from the survey and user interviews (4.1) will be analysed according to the literature related to cargo bikes (3.2). Next, the groups of adopters of innovations studied in 3.3 will be used to categorize the sample of the survey (4.1.1) using also the user interviews (4.1.2) as empirical support. Finally, the barriers of adoption of the cargo bike mentioned in 4.1 will be analysed.

- The section 5.3 studies relevant factors related to product-service systems. From the literature (3.4 and 3.5), four major categories (product ownership, user perceptions, lowering barriers and cultural shift) will be the base to analyse key factors related to the PSS included in this research from the users’ (4.1) and stakeholders’ (4.2) perspective.

- The section 5.4 studies the potential of product-service systems as enablers for the diffusion of the cargo bike. To do so, the concept of the chasm (3.3) will serve as the base for the analysis of the barriers of adoption raised in 5.2, and the stakeholders’ insights (4.2) will be used to analyse the potential of the three different schemes, also supported by the theories studied in 3.3. Finally, the literature related to policies (3.1, 3.2 and 3.3) and its relevance in the adoption of the cargo bike will lead a discussion supported by the empirics of chapter 4.

- The section 5.5 studies the challenges and opportunities of the business models of the PSS schemes studied. This will be achieved by analysing the empirics from 4.2 with the applied literature collected in 3.5.

5.2 Adoption of the cargo bike

Urban mobility habits of the sample

The most common activities performed by the survey’s sample on a weekly basis were shopping (93%), going to work (88%), dropping children (68%), leisure/other (61%) and sport related (50%). Comparing the results with the official statistics of urban mobility in Sweden, the frequencies of the weekly trips performed by the sample for each activity were overall similar to the average of the population as reported by Sveriges Officiella Statistik (2016). However, the sample travelled in general smaller distances than the average, with a majority of trips under ten kilometres. For these trips, and
unlike the average, the sample used as their main mean of transport the bicycle (for going to work, sports related, travels within work, leisure and other activities) and the cargo bike (for shopping, dropping children and going to school), as opposed to the car which, while it was the main mean of transport for all the activities for the general public (Sveriges Officiella Statistik, 2016), it was not the preferred option for the sample of this research in any of the activities.

As Forward (1998) noted, this choice of cycling as the main transportation mode can be related to the lifestyle of the individual making this adoption. The survey results regarding car ownership, with 78% of the respondents stating to have access to a car, together with the low use of the car as a main mean of transport suggest that the sample had a proactive attitude towards using alternative transport modes (the bicycle) to the car. This statement is furtherly supported by the in-depth interviews, with both User A and User B declaring themselves to be enthusiasts of a car-free lifestyle.

Sample’s profile: cargo bike enthusiasts
The results of the survey showed a user profile predominately composed by men (67%) in the group age of 35-50, employed, with an annual income of 300,000 – 500,000 SEK and living in homes with children (83%). This last characteristic resembles the cargo bike user profile of adopters in Copenhagen (Cyclelogistics, 2011) and indicates its relevance in the definition of the market of the cargo bike (Moore, 1999). Although the survey had generalizability limitations, the majority of male respondents in the sample together with the issues raised by the Operator (with 90% of the users of the cargo bike pool being men) suggests the consideration of gender as relevant factor in current profiles of cargo bike users (although more research is needed).

The cargo bike was mostly used by cargo bike owners for transporting children and shopping, and for the two activities connected to these purposes (shopping and dropping children) it was also their main transport mode. The two in-depth interviews with potential users also identified the performance of these two activities as the main reason of usage of the cargo bike. These findings support the observations in the literature about the potential of the cargo bike in private logistics such as shopping (Wrighton and Reiter, 2015) and carrying children (Harris et al., 2011; Lovejoy et al., 2012; Powell and Tanz, 2000). However, a comparison of the results of the survey with the study of Citylogistics (2013) show less optimistic proportions of trips covered by the cargo bike in these activities.

The group of respondents who did not own a cargo bike showed higher dependency on the car for the performance of weekly activities, although the bicycle remained as the main mean of transport in most of them. This fact, together with the insights from the in-depth interviews showed a predominant profile of existing cyclists among potential cargo bike users (La Ferla, 2010; O’Coomor, 2011) over individuals that do not use bicycles (Riggs, 2016). These results from the empirical study also partially agree with the expectations in the literature of the potential of the cargo bike to substitute car trips for this group of users (Piatkowski, Krizek and Handy, 2015), as the interviews reflected that the cargo bike would actually replace primarily other means of transport such as the bicycle or public transport. Moreover, these interviews suggested that there was still a dependency on the car for certain trips that could not be converted to the cargo bike.

Groups of adopters
Next, the sample of respondents will be analysed with the approach of the groups of adopters of an innovation proposed by Rogers (2003). The aim here is to identify to which of these groups the sample would belong according to this theory.
Innovators are presented by Rogers (2003) to be enthusiasts of the innovation who consider being the first ones adopting of a major relevance. Although the cargo bike is not a recent invention (as studied in the literature, it has been around for more than a century), it is important to notice that most of the cargo bike owners surveyed (68%) became adopters less than three years before conducting this study and, additionally, the cargo bike has become a major mode in their transport habits.

This recent adoption of the cargo bike as a “new” transport mode that can satisfy the sample needs could, following Rogers’ (2003) definition of innovation, support the idea of the cargo bike being perceived as an innovation for this group of users.

Moreover, the responses of this group in regard of the benefits of using the cargo bike over other means of transport for moving freight showed a great enthusiasm towards the cargo bike. This group, then, perceived a great relative advantage in this innovation compared to other modes which, according to Rogers (2003), can potentiate its rate of adoption.

According to Rogers (2003), early adopters seek potential benefits, and only become adopters when there is prove that the innovation can cover their needs appropriately. The group of respondents that did not own a cargo bike greatly rejected the idea that cargo bikes were not a suitable solution for their freight transport needs. Both from the survey and the interviews it is also possible to relate the perceived compatibility of the cargo bike (Rogers, 2003) for this group with their values of a car-free way of living. However, a smaller part of this group stated that the potential benefits of the cargo bike were not enough for them to adopt the innovation.

Additionally, this group of potential users claimed that they were informed of the existence of the cargo bikes as a transport alternative, thus moving away from being considered as part of the big majority of users according to the theory (Gruber et al., 2014; Lenz and Riehle, 2013; Reiter, 2013).

Moore (1999) also identified in user behaviour a main characteristic from which the user perceives an innovation (either continuous when the innovation does not require a shift in the behaviour and discontinuous when it does). This group of users, who already showed tendencies towards a car-free lifestyle, would expectedly experience less behavioural changes if adopting the cargo bike as opposed to the general public who, as studied in the literature, are more car dependent. This motivates the consideration that the cargo bike could be seen by this group of users as a continuous innovation, whereas it would be perceived as discontinuous by the general public.

It is difficult to conclude which of the respondents belonged to which group, but this analysis can suggest that among the respondents who owned a cargo bike there were innovators, and among the group that did not there were potential early adopters. The characteristics studied before regarding respondents’ lifestyles and the comparison with the general public’s characteristics researched in the literature are encouraging factors to consider that the early majority, late majority and laggards did not have a large representation in the sample.

**Barriers of adoption of the cargo bike**

Financial constraints of purchasing a cargo bikes and lacking of parking/storage space were the two main barriers of adoption identified among the respondents who did not own a cargo bike, which match with the factors observed by Börjesson and Henriksson (2014) and Heinrich et al. (2016). These two main barriers were also studied together with two socio-demographic characteristics: annual revenue and type of household. All of the respondents who identified their annual revenue as a barrier
had an income of less than 500,000 SEK per year while, in contrast, cargo bike owners inside the range of 300,000-500,000 SEK per year were the largest group among cargo bike owners (74%). In the same way, although all of the respondents that identified lacking of parking space as a barrier lived in condominiums or tenancies, the majority of cargo bike owners also lived in these types of households (55%). The analysis of this could suggest that main differences between owners and potential owners of the sample were their perception, priorities and willingness to purchase a cargo bike, supporting Rogers’ (2003) diffusion theory, in which the perception of the characteristics of the innovation by the adopter is claimed to influence the process of adoption for the different groups, and thus reinforcing the identification of innovators and early adopters in the sample. However, the limitations of generalizability and the exploratory nature of the survey do not allow a complete affirmation of these claims.

5.3 Relevant product-service systems factors

Product service systems have the capacity to introduce innovations into the market faster (Tukker, 2004). The group of users surveyed recognised that a PSS solution would be an enabler for them to overcome these barriers of adoption. The three proposed types of use-oriented services from the literature will be analysed according to the main factors identified both in the literature and the empirical study.

**Product Ownership**

The in-depth user and stakeholder interviews (within the category of *value proposition*) identified accessibility, availability and price as the main value conditioners in the offering of the cargo bike from a product-service system approach, also proposed by the theory regarding use-oriented services studied (Tukker, 2004).

- **Accessibility and availability**: the characteristics most valued for the lease option were private access and unlimited availability to the cargo bike (as it resembled best private product ownership) while, for the pooling alternative, local sharing limited the availability of the bikes, having negative effects in the user behaviour (*tangible sacrifice*). For the share option, the public access to the cargo bikes was perceived with a negative attitude, with distance to the nearest station being the main concern; this characteristic was also identified in the literature as a barrier for regular bicycle sharing schemes (Fuller et al., 2001; Ricci, 2015; Shaheen et al., 2012).

- **Price**: a monthly subscription fee was the desired pricing strategy for both the user and the provider. In pooling, while the user considered a monthly subscription fee together with a time fee as the best price configuration, the operator preferred a yearly subscription. For the offering of the pool for the residents of the housing association, included as part of the rent, plus time fee. For the sharing solution, necessity to adapt to current scheme, thus a casual or seasonal subscription fee. The periodic subscription fees in the pooling and sharing schemes can guarantee a revenue stream to the provider of the service with independence of availability of the product, partially solving this concerned raised by Tukker (2004).

**Lowering barriers**

Financial constraints and lacking of storage/parking space were identified as the main barriers of adoption both in the survey and the in depth-interviews; these two limitations are related to the *tangible market value* offered by use-oriented services (Tukker, 2004) of capital and resources saved,
respectively. However, the three schemes proposed showed different capabilities of addressing these concerns.

- Financial constraints: all the schemes (lease, pool and share) were considered to solve this barrier of adoption.

- Storage constraints: the lease alternative did not have the capacity to overcome this barrier (as the user assumes this part of product ownership); however, in the pool and share options this ownership issue is assumed by the provider, and thus can be considered to lower this barrier.

**User perceptions**

Two other main value elements identified were perceived quality of the cargo bike and responsibility assumed by the users of the service, relatable to intangible market value of the PSS offered (Tukker, 2004).

- Perceived quality: the lease alternative had the biggest potential of quality perception by the users due to the resemblance to privately owned product. This was also a requirement from the User B perspective for the pool. However, this perception in the share option was conceived as negative.

- Perceived responsibility: the private access to the product in the lease option could reflect a concentration of responsibility of the product in a single user. In pooling, the closed access to the product was considered by User A as a facilitator to involve a shared responsibility between the members of the pool, and the Provider remarked the importance of the relationships between these members. The share alternative was perceived to have a lower perception of user responsibility by the User B.

**Cultural shift**

As stated in the literature, the change in the offering of a product as a service requires a behavioural shift in the users towards the new offer that is considered to be a barrier for their adoption of the PSS (Goedkoop et al., 1999; Mont, 2002). Therefore, the offering of the cargo bike as a service would imply a different degree (depending on the solution) of change in transport habits for the users (as it was supported by the in-depth interviews).

The lease option, due to its similarities of owning a product (Goedkoop et al., 1999; Mont, 2002), would have low cultural shift requirements, while pool and share would have bigger demands in cultural shift due to the sharing of the product with other users (Tukker, 2004).

**5.4 Product-service systems as enablers for the diffusion of the cargo bike**

**Crossing the gaps from innovators to early adopters and majority**

The identification of innovators and early adopters in the sample can suggest that the barriers of adoption that they identified (financial and storage constraints) could correspond to the first “crack” observed by Moore (1999) in the adoption of innovations. PSS have been considered to reduce in different extends these barriers, and thus a PSS around cargo bikes could have the potential to promote its diffusion between innovators and early adopters.
The nature of these barriers could incite to suggest that they could also be present “chasms” between early adopters and early majority, although more research around early majority is needed to support this claim. The cargo bike was considered in the literature to be a niche product (Böjersson and Henriksson, 2014) that lacked recognition as a suitable transportation alternative among general users (Gruber et al., 2014; Lenz and Riehle, 2013; Reiter, 2013; Heinrich et al., 2016). Innovators and early adopters are the first ones in detecting the benefits and advantages of the innovation, and the results from the sample support the identification of benefits in using the cargo bike for transporting freight in a large extent. However, as stated by Moore (1999), the general public would be difficult to be influenced by current cargo bike users’ opinions and, following the logic of this analysis in which cargo bikes could be considered discontinuous innovations for this group, their adoption would also be challenging.

Potential of the different use-oriented services

Next, the potential of the different PSS alternatives considered will be studied using the approach of the niche market strategy proposed by Moore (1999). For this, the insights collected from the stakeholders regarding the categories of value proposition, customer segments, customer relationships and channels will be used in the analysis.

The leasing alternative has the capacity to attract car-free lifestyle enthusiasts as sustained by the empirical study. However, the resemblance of this PSS to private ownership (Tukker, 2004) could suggest a limited potential of this type of PSS to reach the general public.

Pools allow access to the cargo bikes to a close group of individuals (residents of an area or a building, as suggested by the empirics). This way, pools could have the potential to perform the niche market approach suggested by Moore (1999) as an effective strategy for crossing “the chasm”. According to the results (Operator), a cargo bike pool would attract in the beginning predominately car-free lifestyle enthusiasts, but the usage of the pool by these members could promote the usage by the “general public”, as the interactions and recommendations between these two groups could happen within a community approach. The trialability and observability of the cargo bike, as commented by the Operator of the pool and suggested in the theory by Rogers (2003), could have a positive impact in the process of adoption of the cargo bike by these users. The two options covered in the empirical research (a pool for an existing area and a pool for a new building offering shared mobility solutions), however, showed different potential to achieve crossing “the chasm”. While the cargo bike pool for a general area included in their niche market all of the residents (and so representation of different groups of adopters), the pool proposed by the Architect had a strategy of approaching what was identified in this study as current innovators and early adopters, limiting its capacity of diffusion to other groups.

For the sharing alternative, the previous existence of a bicycle scheme would allow the accessibility (Rogers, 2003) to the cargo bikes (if included in the offer) for current customers of the service, as well as the general public. However, these schemes tend to show and involvement from users who already had a cyclist profile (Shaheen, 2014). In this case, the niche market approach would have the potential to involve a big base of potential users, due to its advantages of trialability and observability (Rogers, 2003).

Policies and their effect in citizens’ transport behaviour

Policies were considered in the literature among the most effective influencers of transport behaviour (Wrighton and Reiter, 2015). The most relevant characteristic identified in the research regarding
transport behaviour of cargo bike users was the willingness towards a car-free lifestyle. Thus, policies that promote this characteristic among its citizens have the potential to help with the adoption of the cargo bike. As studied in the literature, the case of positive diffusion of the cargo bike in the city of Copenhagen, was a result of implementing encouraging policies in benefit of cycling that helped reshape the behaviour of its citizens (Gössling, 2013).

Transport policies are related to the city visions and objectives for future mobility. These visions have the capacity to show the level of commitment of municipalities towards the promotion of different transport behaviours. While the city of Copenhagen already was aiming for a 50% of commuter trips to be made by bicycle by 2015 (City of Copenhagen, 2007), Stockholm City is currently aiming for the 15% by 2030 (Stockholms Stad, 2012). This difference between both cities in their visions could limit the achievement of an effect of policies towards the change in the behaviour of the general public in Stockholm similar to the one accomplished in the city of Copenhagen.

Moreover, the empirical study showed a lower agreement with of the ease of the cargo bike to move around in town as a benefit compared to other statements, as well as a wide majority agreeing in different degree with the statement of the city infrastructure to be a discouraging factor for using the cargo bike.

It can be concluded then that policies play a major role in shaping citizen’s transport behaviour and, from the perspective of diffusion of innovations’ theories, have the potential to support crossing the “chasm” for the cargo bike. The current perceptions from the users and efforts from the municipality studied suggest a big room for improvement in this area, particularly if Copenhagen was to be taken as a reference in the adoption of the cargo bike in urban transportation.

5.5 Challenges and opportunities in the business models of cargo bike PSS

The empirical study with the business model canvas approach (Osterwalder and Pigneur, 2009) helped identify a set of main challenges that PSS of cargo bikes need to face, as well as key elements and opportunities for the success of their performance. The categories of value proposition, customer segments, customer relationships and channels have already been covered and compared between the schemes in 5.2 and 5.3, and thus this section will focus on the remaining ones (key resources and activities, key partnerships, cost structure and revenue streams).

A common opportunity for improving the performance of all of the schemes studied proposed by all the stakeholders was the integration of a cargo bike service solution with other mobility options. The literature studied also agreed with this fact, affirming that diffusion of innovations in mobility requires this integration with other multimodal alternatives (Sochor, Strömberg and Karlsson, 2014). Although the three schemes shared some common challenges such as the cost structure associated to the expensiveness of the cargo bikes and key elements like activities related to the customer such as the maintenance of the bikes (key activities) (McAloone, 2006), the comparison of the majority of challenges and opportunities identified by the stakeholders interviewed showed major differences between the schemes studied.
Lease
The main challenge identified by the Provider was the cost structure of this scheme; as stated in the literature, the provider absorbs the ownership costs of the cargo bike during lease period (Mont, 2002). Due to the challenging cost structure mentioned, two main opportunities of improvement of this scheme are the financial support (in terms of partnerships), and the long-term user relationships (Mont, 2004).

Pool
The pool alternative was considered the most suitable solution for offering a cargo bike as a service by all of the stakeholders interviewed. However, there were major differences between pools for existing areas and pools for new shared-mobility buildings.

- **Pool (existing area):** The main challenge identified was the limitation of insurance of the cargo bikes (in terms of key partnerships), a “hidden production cost” related to the risks supported by the operator of this service (Tukker, 2004). Parking and charging were also a major concern (key activities and resources), as the convenience of the cargo bike pool was highly dependent on the particularities of the area. The current cost and revenue structure was another challenge identified, as it showed a dependency on housing associations (key partnerships) as user fees were not enough. The main opportunity identified in relation to parking and charging is the standardization of a cargo bike pool solution that is more independent from the area it is being implemented. The opportunity considered in the area of cost structure and revenue streams was local advertising (need of financial partners as stated by Mont (2002)). Locking and booking showed an opportunity of development: as stated by Tukker (2004) and studied in the empirics, the operator did not take part in the design process of the element of the pool; however, the literature affirmed that the development of IT solutions has a great influence in the diffusion of innovations in mobility (Sochor, Strömberg and Karlsson, 2014). Thus, the opportunity identified in this of developing an integrated solution for both booking and locking of the cargo bikes.

- **Pool (shared mobility):** The main challenges faced by this solution were related to policies and the role of the Municipality in supporting and developing practices that encourage shared mobility and car-free lifestyles, as well as to ensuring the commitment of the operator of the pool in the long-term to these shared mobility solutions (key partnerships). The main advantages from which this solution could benefit if it was finally carried out include parking, storage, access to electricity, booking and locking (key activities and resources), as well as user fees (revenue streams) and easy integration with other shared mobility solutions. The possibilities of the cost saving strategies of this alternative were identified to be the main opportunities for the financial feasibility of a cargo bike pool.

Share
The cost of the cargo bikes together with the risk ownership (cost structure and key partnerships with the operator of the scheme) and the need of redesigning the current scheme (key activities and resources) were considered by the Municipality to be significant challenges for the viability of this alternative. The main opportunities that this alternative could benefit from are the existing revenue stream mechanisms of the current bike-sharing service provided in the municipality and its easy integration with other existing shared mobility solutions.
6. CONCLUSIONS AND FUTURE RESEARCH

This chapter presents the answers to the research questions of this thesis. Then, it provides a discussion around the implications of the research and the quality of the methods used. Finally, this chapter concludes with the suggestions of future research.

6.1 Answering the research questions

The purpose of this master thesis was to study the possibilities of increasing the adoption of cargo bikes in private urban mobility in Sweden with a product-service system solution and identify the key elements for its success. The goal was to make a contribution for understanding cargo bike users’ behaviours and attitudes. In order to do so, a literature review regarding diffusion of innovations, product service systems and business models was carried out to set a framework for the analysis. Then, an empirical research was conducted involving the perspective from both cargo bike users and stakeholders through semi-structured interviews and a survey. The posterior analysis of the empirics using the literature framework allowed the achievement of the goal of this thesis as well as it allowed the answering in this chapter of the research questions that support the accomplishment of the purpose.

RQ1: What are the barriers of adoption of the cargo bike?

The transportation behaviours of the cargo bike enthusiasts studied manifested a willingness towards a car-free lifestyle, with a predominant profile of cyclists. The analysis of the empirical research with the diffusion of innovation theories studied allowed the identification of innovators and early adopters in this sample, having this behavioural characteristic as a representative quality for these two groups of adopters, for whom the cargo bike could be considered a continuous innovation. For these groups of users, the main barriers of adoption identified were financial constraints and lack of parking space of the cargo bike.

Despite not being included in the empirical research, the analysis of the literature showed a general profile of the Swedish population with a car-dependent behaviour, for whom the cargo bike could be considered as a discontinuous innovation. For this majority then, a transportation behavioural change was hinted to be an additional adoption barrier of the cargo bike.

RQ2: How do the different PSS solutions support the adoption of the cargo bike?

Four factors were identified to be relevant in the adoption of a cargo bike product-service system: product ownership (accessibility, availability and price), lowering barriers (financial constraints and storage constraints), user perceptions (perceived quality and perceived responsibility) and cultural shifts related to the change from product to service usage. The three alternatives studied in this thesis (lease, pool and share) showed differences in relation to these factors. Lease had the best response in product ownership and showed the capacity of lowering the adoption barrier of financial constraints, but not the lacking of parking space; this option also had the biggest potential in user perceptions and lower cultural shift. Pool could lower the two barriers identified but, however, it raised concerns about its product ownership. This alternative also showed high user perceptions and required a cultural shift. Share showed the capacity of lowering both deterring barriers defined by early adopters; however, it received negative insights in its product ownership and user perceptions and also required a cultural shift.
The possibility of considering these PSS as enablers for the diffusion of the cargo bike was also studied to be dependent on its capacity to lower the transportation behavioural barrier of the general public. The analysis showed that the lease alternative had limitations to reach the general public. Pool, on the other hand, had the capacity to reach the general majority through community recommendations and its advantages of trialability and observability (shared mobility pools, however, showed lower ability to diffuse the cargo bike to the general majority than pools for existing areas). Share also had great capabilities of trialability and observability for promoting the diffusion of cargo bikes.

**RQ3: What are the main challenges and opportunities for a successful performance of these schemes?**

All three schemes studied shared some common elements such as the opportunity of integration of the cargo bike service with other mobility solutions and the challenge of the cost associated to the cargo bikes. Lease showed a challenging cost structure that required significate financial support and long-term relationships with the users. Pool for an existing area identified in the insurance of the cargo bikes a main challenge; parking and charging depended on the particularities of the area, and an opportunity of designing a standard system was identified. The challenge of booking and locking creates an opportunity for the developing an integrated solution (product + service), while local advertising can overcome the challenges associated to the cost structure. Pool in shared mobility had as a main challenge the development of policies that support car-free lifestyles, while also showed the best conditions for achieving financial feasibility. Finally, the share alternative identified as the main challenges for being considered as a viable option the high cost of the cargo bikes and the lack of ownership will by the operation partnerships; the main opportunity of this alternative was the implementation of revenue mechanism as well as its integration with public mobility alternatives.

**GRQ: What is the potential of increasing the adoption of the cargo bike in private logistics by offering it as a service?**

The cargo bike is associated to the concept of “car-free” lifestyle. The barriers identified by the users who showed this pattern in their transport behaviours could be lowered if the cargo bike was offered as a service, and thus promote its adoption by these users. Offering cargo bikes in a pool scheme overall showed the biggest potential of all the options considered in terms of lowering the barriers identified, user perception and opportunities of financial feasibility, as well as the capacity of reaching a general public that, currently, is more dependent on the car. However, offering the cargo bike in a PSS is dependent on the changes in transport behaviour required for the consideration of the cargo bike by the general public as a favourable mobility mode. The result of the empirical study showed that current cargo bike users find cargo bikes as a beneficial alternative for moving freight compared to other modes, and thus these benefits could also have the potential to be perceived by the general public. For maximizing the potential of adoption, policies have been found to be of great relevance, as they shape citizens’ transport behaviours.

### 6.2 Implications

**Contribution of the research**

The existing literature on transport habits in Sweden reviewed showed a scarcity of knowledge specifically related to the mobility behaviours associated to the cargo bike. The study on urban transport behaviours of Swedish cargo bike users conducted in this research aims to provide an empirical contribution to this gap as well as furtherly expand it with the attitudes and opinions of
these users towards this mean of transport. Also, this research can be considered to contribute with an empirical implementation of PSS and business models literature in the cargo bikes context.

**Competition in the mobility scene**

This thesis has only focused on cargo bikes. However, the cargo bike is just one of the many mobility alternatives (both private and shared) that can be offered and adopted in urban transportation. In fact, the traditional mobility industry (including cars, regular bicycles, motorcycles or public transport, to name some of the most relevant) has welcomed over the last decades a variety of new successful transport solutions, mostly in the form of shared schemes such as the bike-sharing systems (studied in the literature) or electric-car pools. As it has been investigated, the cargo bike is not yet a popular transportation option in Sweden. Its potential adoption cannot be studied isolated, as it must also be considered as a part of this mobility system, with the need to co-exist with the rest of the alternatives available. Not every transportation alternative can satisfy all the mobility demands of the users; thus, the cargo bike would compete in the market of urban transportation of freight (mostly children and shopping) with sounded alternatives such as public transport, light electric vehicles or, most notably, cars. However, as it has been investigated both in the literature and the empirical research, the cargo bike cannot be the answer to every mobility need in this market. Therefore, the importance of the balance between all the alternatives mentioned before must be taken into account when introducing the cargo bike in the urban mobility scene, as its correct adoption will depend on its integration with these alternatives. This issue was also supported by the empirical research conducted.

**Sustainability implications of product-service systems and cargo bikes**

Product-service systems have at its core the promotion of sustainability (Manzini et al., 2001). Sustainability can be analysed according to social, economic and environmental aspects.

As it has been investigated through the literature and empirical research, a product-service system solution for the cargo bike has the capacity of lowering barriers that could be associated to different socio-economic characteristics of the population and thus, enable its accessibility to social groups with different backgrounds. Offering the cargo bike as a service could also have a positive impact for those individuals who have the needs of transporting freight but don’t have access to other transportation alternatives such as the car. Moreover, cargo bikes represent a transportation alternative that has numerous health and safety benefits for its users (supported also by this empirical research), as opposed to other motorized available options.

Despite its limitations in the replacement of fossil-fuel vehicle trips and adoption, the cargo bike can still contribute in the reduction of urban mobility related emissions, as they represent an alternative with zero (or very low, for its electric version) emission of contaminants. Given the relevance that urban transportation has in these emissions and the objectives of the cities of becoming fossil-fuel vehicle free, cargo bikes can position themselves as a winning alternative in the urban mobility scene.

A product-service system solution for cargo bikes has the capacity to reduce household transport expenses related to other more expensive alternatives as well as to those related to product ownership. In fact, PSS for shared mobility have the ability to have a positive economic effect not only on the private level, but also on the communities they are being offered; sharing economies allow the optimization of the usage of the products being shared while maintaining the satisfaction of the community’s needs and reducing product consumption.
Policy implications: What should Stockholm do?
As it has been reiterated through this thesis, policies play a major role in shaping urban transportation behaviours. The empirical research showed that the success of the cargo bike PSS schemes studied deeply rely on the involvement of the municipality and the development of encouraging measures for alternative transport modes to the car. As it has been concluded, the city of Stockholm still has a lot to do if it wanted to reach cargo bike cycling levels of cities like Copenhagen. To do so, the city would need to develop and improve the current cycling infrastructure (which, at the same time, is less expensive to maintain than the infrastructure dedicated to motorized vehicles) as well as support the introduction of these PSS schemes and policies in favour of car-free lifestyles.

6.3 Discussion of methods
The empirical study on the user perspective (with the survey and in-depth interviews) targeted a sample in which there was a predominant representation of specific socio-demographic profiles that needs to be taken into consideration in the interpretation of the analysis and the conclusions of this research. These individuals already showed a predisposition toward cargo bikes, and although they shared some common transport habits with the Swedish average (such as frequency and purposes of trips), the results can be considered to provide low validity and generalizability in favour of its empirical contribution commented before. Nevertheless, this limitation is acknowledged, and further user studies are needed.

This research was also limited by the lack of existing cargo bike PSS schemes in Stockholm, that did not allow the performance of more interviews with stakeholders; this is also acknowledged to be a weakness of this study. However, the perspective and experiences collected are considered to be a very valuable source of empirical contribution.

Therefore, the generalizability of the answers to the research questions (barriers of adoption identified, PSS factors, diffusion of innovation enablers and business opportunities and challenges) is open to be questioned; however, with this limitation in mind, the analysis of the results has been thoroughly performed with a strong support on the literature review to add validity to the claims of the empirics. Although I believe that the barriers, factors, enablers and business opportunities and challenges identified are among the most relevant, I also acknowledge that, due to this fact, some elements might have not been identified.
6.4 Future research

The empirical study targeted users who showed a behaviour of car-free lifestyle. It is important to further study the profile and behaviour of a general majority towards the cargo bike, their barriers of adoption, and perceptions of the different product service systems proposed to improve the generalizability of this research. The same recommendation is considered for the stakeholders’ perspective, as more interviews are needed.

The integration of a cargo bike service with other multimodal transport solutions was considered to be of relevance for the performance and diffusion of the service offered. A deeper study of these integrations and Mobility as a Service is therefore proposed for a future research.

City infrastructure was a main issue found in the empirical research affecting the perception of the cargo bikes. Since these bikes have different characteristics as regular bikes, it is convenient to study the infrastructure requirements and its adaptability to the cargo bike.

Policies and regulations played a major role in the feasibility of the schemes proposed and the change in the transport behaviour required for the adoption of the cargo bike. It is considered of relevance to study in more detail the current state of these policies and how they should be developed to accommodate the diffusion of cargo bikes.
7. REFERENCES


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Osterwalder, A.; Pigneur, Y. (2009), "Business Model Generation." Amsterdam: Self Published


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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 en oval.
   - Female
   - Male
   - I prefer not to say

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

4. What is your current occupation?
   Markera 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>
</tr>
<tr>
<td>Going to school</td>
<td></td>
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<td></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>
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</tr>
<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>
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 1 km</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>
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<td>Going to school</td>
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<tr>
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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>
</tr>
<tr>
<td>Going to school</td>
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</tr>
<tr>
<td>Go shopping</td>
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<tr>
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<tr>
<td>Dropping off children</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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</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 val.
☐ Yes    Fortsätt till frågan 16.
☐ 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
☐ Övrigt: ____________________________

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

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Fortsätt till frågan 28.

**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>
<td></td>
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<td></td>
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<tr>
<td>Long distances</td>
<td></td>
<td></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>
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<tr>
<td>Safety</td>
<td></td>
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<tr>
<td>City infrastructure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Puncture / need of repair / maintenance</td>
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</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>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It's quicker to arrive at your destination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It's less stressful to drive</td>
<td></td>
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<tr>
<td>It makes the trips more enjoyable</td>
<td></td>
<td></td>
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<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>
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<td></td>
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<tr>
<td>It's a healthier option</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>It's a safer option</td>
<td></td>
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