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Pedaling towards a sustainable future

Lessons Learned from Cargo Bike Pool Operators in Sweden.

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Abstract

This study examines the impact and potential of cargo bikes as socio-economically and ecologically beneficial modes of transportation. It focuses on the perspectives of cargo bike pool members and the challenges faced by pool operators. Three interviews were conducted with cargo bike pool operators in Sweden to understand the challenges and considerations involved in establishing and operating a pooling service, as well as their opinions on its financial future. Additionally, a user survey targeting pool members from one of the interviewed operators was conducted in 2020. The survey investigated user barriers, motivations, opinions towards the pooling service, and its effect on user mobility habits before and after joining.

Although the acceptance and utilization of these services depend on factors such as proximity, pricing, availability, quality, and convenience of the service. The findings show that pooling services increase member interest in owning and using cargo bikes as a replacement for cars. However, concerns regarding the marketability of cargo-bike pools alone are raised in this study, thus, to enhance the attractiveness of cargo-bike pools, this study suggests incorporating additional modes of transportation, offering supplementary value propositions, and ensuring a user-friendly experience. On the operator side, this study highlights the importance of stakeholder collaboration in maximizing the potential of cargo bike pools for sustainable transportation enabling resource sharing, and marketing efforts, and improving the overall service by leveraging financial, spatial, and logistical benefits.

Finally, this study finds that the current state of cargo bike pools necessitates collaboration and subsidies from municipalities and stakeholders. Suggesting innovations in business models and increased marketing strategies that capture a broader demographic through an enhanced value proposition that includes other forms of modality and benefits in their services, are vital for the growth of cargo biking through pooling systems.

The research provides insights for prospective operators in establishing and operating cargo bike pools, emphasizing considerations related to the physical layout, financial aspects, marketing, and value proposition of the service and has broader implications in how to encourage more sustainable mobility practices.

Keywords; cargo bikes, sharing services, cargo-bike pools, sustainable mobility, mobility

Nyckelord; lastcyklar, delningstjänster, lastcykelpooler, hållbar mobilitet, mobilitet

1. Introduction

As sustainable transportation becomes even more important, pan-European strategies call for more sustainable transportation options in both private and commercial transport. In Sweden, the goal is to achieve a net-zero domestic transport emission by 2045 (Environment, 2020), necessitating a shift from fossil fuels to more sustainable alternatives, in part by promoting other modes of transportation such as cycling and electric vehicles over cars. Road traffic accounted for 91% of Sweden's carbon emissions in 2018, with cars contributing to 67% of these emissions. Considering that the average car-based journey in Sweden is between 3-4 km (Energikontor, 2020), cargo bikes have been identified as a potential substitute for some of those trips (Carracedo & Mostofi, 2022; Riggs, 2016).

Cargo bikes have a rich history that can be traced back to the late 19th century (Cox, 2015). Initially serving as a cost-effective delivery solution, their usage diminished due to the rise of self-service shopping and the increasing popularity of cars. These bikes re-emerged in the 1970s as symbols of environmental responsibility and critique against car-centric societies, with technological innovations such as electrically assisted cargo bikes seeing a rise in use in urban freight and logistics (Lenz & Riehle, 2013). However, current literature has identified that while cycling is on the rise, thanks in large part to electrically assisted bikes, the carrying capacity of a car is still lacking in many areas, as some of the main uses of a car would indeed be to transport larger cargo (Carracedo & Mostofi, 2022; Castro et al., 2019; Umeå kommun, n.d.).

The potential of using cargo bikes in private transportation mobilities for their social, economical, and ecological benefits, use cases, and carrying capacity has been identified and studied in prior literature, with a variety of policies across Europe to encourage this mode of transportation (Becker & Rudolf, 2018; Hess & Schubert, 2019; Riggs, 2016) for both businesses, municipalities, and various stakeholders. Yet, it is not widespread for private transportation, and for individuals seeking to live a car-free lifestyle, barriers do remain (Carracedo & Mostofi, 2022). Barriers from individuals to replace and own their cars with cargo bikes are mainly the perceived initial purchase costs and often purchased by those with higher incomes, and lacking the space to store them (Irala, 2017).

To solve these barriers and increase adaptation to a broader audience, Product-Service Systems (PSS) have been identified as a viable solution, encompassing a variety such as carpooling and bike-sharing services, where similar solutions have been applied to cargo bikes (Becker & Rudolf, 2018; DeMaio, 2009; Hess & Schubert, 2019; Irala, 2017). However, studies on operator barriers and challenges in establishing and running cargo bike pools remain relatively unexplored in current literature.

2. Study Purpose And Research Questions

The purpose of this study is to investigate cargo bike pools in Sweden, their motivations, benefits, challenges, and impact on sustainable mobility habits. The research questions guiding this study are as follows:

1. What role does the cargo bike play in urban transportation?
2. How do sharing services promote increased cargo bike usage? What are their motivations, benefits, and potential user segments?
3. What challenges do cargo bike pool operators face when planning and operating a pool?

By addressing these research questions and incorporating theoretical foundations, this study aims to contribute to a further understanding of cargo bike pools and their potential for sustainable urban mobility. Simultaneously, it aims to offer perspectives for prospective cargo bike operators.

3. Background

a. Re-emergence of Cargo Bikes as Eco-Friendly Freight

Understanding the role of cargo bikes in urban transportation requires an understanding of their historical context. Cargo bikes first appeared in the mid-1880s and quickly gained popularity as a cost-efficient solution for various businesses, including butchers, bakers, and more, to deliver their goods. From the 1920s to the 1950s, cargo bikes were highly favored in the retail and postal sectors due to their efficiency. However, with the advent of private motorized transport in the 1950s and 1960s, cargo bike popularity among businesses declined. The changing dynamics of retail, particularly the introduction of self-service shopping, made cargo bikes obsolete. As the role of retailers as intermediaries between customers and goods diminished, the need for delivery services decreased, and cargo bikes became symbols of a bygone era (Cox, 2015).

The trend reversed in the 1970s when cargo bikes regained interest alongside the rise of environmental activism, transforming from a mere logistics innovation to a critique of car-centric mobility cultures. European cities restricted access to their core areas during certain times. This, coupled with digital systems and changes in the retail sector, made cargo bikes economically competitive for efficient inner-city deliveries. Logistics operators worldwide started replacing delivery vans with cargo bikes, resulting in significant cost savings (Cox, 2015; Gruber & Narayanan, 2019).

On the broader economic impact, Studies indicate that cargo bikes have the potential to replace over half (51%) of last-mile deliveries, leading to a substantial reduction of approximately 18-20 million tons of CO2 emissions annually (Schliwa et al., 2015; Wrighton & Reiter, 2016).

The increased popularity of cargo bikes can be largely attributed to the introduction of electric motors and new models that have significantly improved carrying capacity, speed, and range. Modern-day cargo bikes can carry weights ranging from 50 to 250 kg, with a

battery range of 50 to 80 km, making them ideal for last-mile deliveries (Gruber & Narayanan, 2019; Lenz & Riehle, 2013; Schliwa et al., 2015; Wrighton & Reiter, 2016).

According to Gruber and Narayanan (2019): modern cargo bike models can be classified into various typologies, including delivery bikes, long john bikes, longtail bikes, front-load tricycles, and heavy-load tricycles, as depicted in *Figure 1*.

Figure 1. Examples of types of cargo bikes
First row from left to right; delivery bike, long john bike, longtail bike,
Second row: front-load tricycle, and heavy-load tricycle.
Source; Gruber and Narayanan (2019)

b. Theoretical Framework

In this section the joined theoretical frameworks of mobility cultures and diffusion of innovations, permeating throughout this study are explained.

i. Mobility Cultures

Understanding mobility cultures is pivotal in understanding why individuals or a collective prefer one mode of mobility over another, encompassing both cultural and practical aspects. Mobility cultures encompass individual and collective attitudes, beliefs, and practices that shape transportation habits; influenced by a combination of hard and soft factors (Klinger & Lanzendorf, 2016). Hard factors refer to the physical infrastructure, laws, and policies that either facilitate or discourage specific modes of transportation. On the other hand, soft factors encompass values, norms, and practices both negative and positive perceptions associated with various transportation choices.

To illustrate this, consider a scenario where cars define a city's mobility culture, and people tend to favor cars over cycling. Promoting the usage, and a culture of cycling would require a multi-faceted approach. This approach would involve tackling the hard factors, such as constructing infrastructure that facilitates cycling, such as separated bike lanes, and prioritizing the needs and considerations of cyclists in urban and spatial planning policies. Additionally, addressing soft factors can be achieved through education and awareness-raising initiatives, as well as creating more socio-economically accessible ways to encourage the use of cycling as a transportation mode.

Understanding the underlying reasons behind people's mode choices is essential, as it provides insights into mode preferences based on a combination of objective and subjective factors. Thus, changing the mobility culture of a group requires a comprehensive approach that addresses both the hard and soft factors within that specific mobility culture.

ii. Diffusion of Innovations

Another theoretical framework that will be employed in this study is Everett Rogers' (2003) theory of "Diffusion of Innovations," which explains how innovations and ideas are spread and adapted through society. Rogers identifies five user segments and their motivations for adopting an innovation *(Table 1),* as well as five influential factors in the adoption process: relative advantage, compatibility, complexity, trialability, and observability. These factors offer valuable insights into the considerations that shape individuals' decisions to adopt an innovation (Rodgers, 2003). Analyzing these factors allows for a comprehensive understanding of the adoption process and its implications for successful implementation *(Table 2).*

Moore (2014) identified a gap in Rogers' model: a chasm between early adopters and the early majority, which arises due to differing expectations. Early adopters are drawn to revolutionary innovations, while the early majority prefers evolutionary improvements. Bridging this gap requires a niche market approach that caters to the demands of the early majority, particularly in the consumer market.

To successfully reach the early majority, Rogers (2003) emphasizes the importance of ensuring the reliability, performance, and cost-effectiveness of the innovation, such as the cargo bike. Strategies for crossing the chasm include identifying a target market, comprehensively understanding the product's concept, effectively positioning it in the market, developing a holistic marketing strategy, selecting appropriate distribution channels, and determining suitable pricing strategies (Moore, 2014). This approach allows innovations to bridge the chasm and transition to a broader audience. This theory has implications for expanding the adoption of cargo bikes among a wider customer base, considering their environmental, economic, and social benefits.

Combining these theoretical frameworks provides a comprehensive framework for investigating the link between mobility cultures and the diffusion of innovations. Using mobility cultures to understand the social and cultural dynamics involved in the choice of transportation, and using Moore's framework to understand the increased adoption of new mobility technologies.

Table 1. Adopter groups explained by Rodgers (2003)	
Adopter group	Characteristics
Innovators	Enthusiasts who are among the first to adopt new technology
Early Adopters	Visionaries who look for innovations that cover their needs, without relying on external opinions
Early Majority	Seek practicality in innovations and rely on the opinions of others before adopting
Late Majority	More conservative, adopting innovations only once they've become a standard in the market
Laggards	The last to adopt, often skeptical and sometimes adopting under social pressure

Table 2. Key Factors Influencing Adoption Rodgers (2003)	
Factor	Explanation
Relative Advantage	Refers to how much better the innovation is compared to existing alternatives.
Compatibility	The innovation should fit well with the values and needs of the potential users.
Complexity	The innovation should be simple and user-friendly to increase willingness to try it.
Trialability	Adopters should have the opportunity to experiment with the innovation before committing fully.
Observability	The results or benefits of the innovation should be visible and noticeable to others.

4. Literature Review

Building off the background section, this section investigates the role and challenges of cargo bikes in urban private transportation. Through a review of existing literature, it offers insights into their role, benefits, and adoption barriers for cargo bikes and presents the role of PSS in promoting this mode of transportation.

a. Benefits of Cargo Bike Substitution in Private Mobility

While the advantages of cargo bikes in urban freight logistics in terms of the environmental and economical are evident, the adoption of cargo bikes in private usage remains limited and uncommon (Carracedo & Mostofi, 2022). Electric-assisted cargo bikes offer a compelling alternative for individual transportation when conventional bicycles are insufficient, particularly in terms of carrying capacity (Carracedo & Mostofi, 2022). Studies indicate that a majority of trips in European cities, typically done with cars, are under 7 km, and 85% of shopping trips could easily be replaced with cargo bikes (Schliwa et al., 2015; Wrighton & Reiter, 2016). In Sweden, half of the car journeys are shorter than five kilometers, presenting an opportunity for cargo bikes to replace some trips (Energikontor, 2020).

Recent literature suggests that up to four private car trips per week, specifically for daily errands, could be substituted with cargo bikes. By replacing these trips with climate-neutral alternatives, significant social, economic, and ecological benefits can be achieved. These benefits stem from the nature of cycling, such as reducing noise pollution in cities, mitigating climate impact, and promoting overall social well-being through cycling (Becker & Rudolf, 2018; Carracedo & Mostofi, 2022; Energikontor, 2020; Riggs, 2016; Rivera & Henriksson, 2014).

Benefits are not only on a societal scale but also on an individual scale. A cargo bike, costing between 2000€ and 5000€ for an electrically assisted cargo bike, offers a considerably lower total cost of ownership than cars, and the number of cargo bikes available on the second-hand market is steadily increasing (Carracedo & Mostofi, 2022). The cost-per-kilometer for cargo bikes ranges between 0.08€ and 0.213€, while for combustion cars it is 0.35€-0.62€/km (Carracedo & Mostofi, 2022). Economic and ecological benefits aside, cargo bikes also enable individuals without a driver's license or car access to transport heavy goods and cargo. Considering the lower cost and increased accessibility, cargo bikes promote social and economic inclusivity in the transportation system, benefiting a wide range of demographic groups. Despite the outlined benefits, existing literature notes that adaptation remains minimal, especially in private transportation (Carracedo & Mostofi, 2022). The question is then, why is this the case?

b. Barriers In Adapting Cargo Bikes In Private Transport.

Despite their benefits, cargo bikes are not widely adopted throughout society. Although certain outliers exist, such as 24% of families with children in Copenhagen, Denmark, owning a cargo bike (Carracedo & Mostofi, 2022; Colville-Andersen, n.d.; Hess & Schubert, 2019).

Understanding differences between cities and mobility cultures becomes crucial, as both social and economic factors play significant roles *(see section 3a).*

As with any form of cycling, the city's design is important in promoting cycling. Perceived safety on the roads is a major concern, requiring a well-developed and interconnected network of cycling lanes that prioritize rider safety and comfort (Félix et al., 2019, 2020). Adequate parking infrastructure for bikes, especially for cargo bikes with bigger size requirements, is also important in public and private spaces. Parking a cargo bike at home can be particularly bothersome (Becker & Rudolf, 2018; Irala, 2017). Geographical factors such as terrain, topography, and climate also play a role. In areas where the city is extensively spread out and cycling infrastructure is inadequate, long distances combined with these barriers can discourage the adoption of cycling as a viable option for daily transport. However, electrically assisted bikes can partially decrease these perceived barriers (Bourne et al., 2020; Félix et al., 2019, 2020).

On the other hand, soft factors such as the lack of recognition of cargo bikes as viable car substitutes pose challenges. Cargo bikes are commonly associated exclusively with logistics rather than private mobility (Carracedo & Mostofi, 2022). Perceptions of cargo bikes being more expensive and less versatile — compared to cars, may also contribute to the reluctance to adopt them as car substitutes, despite contrary evidence in terms of total cost of ownership (Carracedo & Mostofi, 2022).

Negative price perceptions of cargo bikes can be counteracted through two main methods: subsidies to promote purchases and sharing services. Subsidies have proven effective in promoting adaptation for electrical bikes as they previously have shared a negative price perception, with users finding them far too expensive to purchase themselves (Naturvårdsverket, 2019). For example, in Sweden, a subsidy program implemented between February and October 2018 encouraged the adoption of electric bikes. Individuals were eligible for a subsidy that covered 25% of the purchase price, up to a maximum value of 10,000 SEK. A total of 96,869 payments were made, with 61% of beneficiaries citing the subsidy alone as a motivating factor for purchasing a cargo bike (Naturvårdsverket, 2019).

Similar subsidies exist across European countries to promote cargo bike adaptation for individuals, businesses, and municipalities, ranging from 100€ to 2000€ (Becker & Rudolf, 2018; Carracedo & Mostofi, 2022). However, there is concern about fairness, as the current design of many subsidy programs leads to unequal outcomes that primarily benefit wealthier households. These programs do not consider income levels or set limits on the price of the vehicles. As a result, higher-income households have an advantage, while lower-income households may face challenges in accessing the subsidies (Carracedo & Mostofi, 2022).

c. Sharing Services as a Solution to Overcome Adaptation Barriers

To create a more economically accessible form of using cargo bikes, product-sharing systems (PSS) may hold the key to increasing adaptation for those lacking the interest and means to

purchase a cargo bike outright. PSS provides convenient and affordable access without the barriers associated with bike ownership itself, as shown by prior literature.

Three distinct approaches exist to facilitate access to products and services: pools, sharing, and leasing. Pools entail the collective ownership and shared use of a common pool of resources among a group of individuals or organizations. Sharing, on the other hand, involves the temporary transfer of ownership or usage rights of a product or service between individuals or entities, often facilitated through peer-to-peer platforms. Leasing, also known as renting or hiring, revolves around the payment for the usage of a product over a specific period while the ownership remains with the provider (Irala, 2017; Tukker, 2004; Vezzoli et al., 2018).

PSS' earliest history traces back to bike-sharing services. Originating from the 1960s in the Netherlands through the bike-sharing program "Witte Fietsenplan" (White Bicycle Plan), an experimental initiative in Amsterdam involved placing free-to-use white bicycles throughout the city for public use. However, due to vandalism, theft, and general negligence, the initiative was short-lived (DeMaio, 2009). The concept re-emerged in the mid-2000s when bike-sharing services grew rapidly due to urbanization, technological advancements, sustainability concerns, policy support, and shifting attitudes toward shared resources. A modern-day example of the success of PSS and bike-sharing services in promoting cycling in an otherwise car-dominated mobility culture can be found in Prague. A public-private partnership between the city, a transport company, and bike-sharing companies offered free rides to monthly public transportation pass holders. This initiative attracted around 7,200 passengers, resulting in approximately 72,000 individual bike rides over three months, demonstrating the importance of sharing services in promoting bike adoption (expats.cz, 2022).

Other studies have also highlighted the significance of PSS (Product-Service System) services in facilitating reduced car usage. Becker & Rudolf (2018), through interviews with members of various cargo-bike-focused sharing services, discovered that in the absence of such services, many individuals would prefer to use a car instead and opt for conducting their trips with a cargo bike through a sharing service. Similar findings have been observed in both the German and Swiss contexts (Becker & Rudolf, 2018).

Understanding the requirements for acceptance and adoption of a cultural shift from ownership-based mobility to sharing-based mobility becomes important, especially when considering a transition from car to cargo bikes; and that the mobility culture of many contemporary societies are based around cars and private ownership (Chen et al., 2021; Félix et al., 2019; Klinger & Lanzendorf, 2016).

Regarding sharing mobilities, leasing requires a lower cultural shift as it is closer to traditional ownership. However, it still faces ownership-related barriers, such as finding parking spaces at home (Irala, 2017). Sharing services, as exemplified by Prague, prioritize reliability but encounter challenges due to limited research on user behaviors, specifically in the context of cargo bikes (Irala, 2017).

Among the three modes mentioned, pooling was identified as the most efficient Product-Service System (PSS) to promote cargo bike usage, according to stakeholders interviewed by Irala, especially when a cargo bike pool is offered through a larger sharing mobility system, consisting of scooters, carpools, and traditional bikes (Irala, 2017).

Cargo bike pools can be established in existing areas or new buildings dedicated to shared mobility services, and the associated challenges and opportunities differ, as identified by Irala (2017). In existing areas, often managed by housing associations, challenges arise due to limited insurance coverage for cargo bikes, concerns about parking and charging infrastructure, and dependence on housing associations for finances, cost, and revenue structures. To address these challenges, there is an opportunity to standardize cargo bike pool solutions that are not tied to specific areas or associations. Additionally, exploring the possibility of external actors funding the bikes through local advertising can generate revenue (Irala, 2017). Developing integrated systems for booking and locking cargo bikes can enhance the overall user experience since the success of sharing cargo bike services relies on factors such as accessibility, availability, competitive pricing, financial viability, positive quality perception, and a seamless user experience from start to end (Hess & Schubert, 2019; Irala, 2017).

In the case of newly built shared-mobility pools, challenges primarily involve policies, municipal support, and securing a long-term commitment from the operator. However, these shared-mobility pools offer advantages such as convenient parking and storage options, access to electricity — often due to being newly built areas, user fees as a revenue stream, and seamless integration with other shared mobility solutions. Identifying cost-saving strategies is viewed as a significant opportunity for ensuring the financial sustainability of cargo bike pools (Irala, 2017).

5. Methodology

To address the purpose of this study and the corresponding research questions, a method incorporating qualitative interviews with three pool operators across Sweden, a user survey provided by one of the interviewed pools, and a review of relevant literature was employed. While not a systematic review or formal analysis, it served as a basis for guiding the research and setting up a framework for the interview guide used during the operator interviews *(See Appendix 1 and 2)*.

a. Interview Methodology

After conducting the literature review and creating an interview guide, a local cargo bike pool operator hosted by Umeå Municipality was contacted. The interviewee and the supervisor for this study recommended reaching out to other interested cargo bike pool operators throughout Sweden to include a variety of experiences, leading to an interview with a pool hosted by a cargo bike pool operated by a municipal housing company and a Consulting firm that has provided turnkey-solutions for municipally owned pools and housing-association owned pools around Sweden. For clarity's sake, while Pilot was reached out to first, the actual interview happened after the other ones due to scheduling differences.

This form of respondent sampling is best described as a form of snowball selection (Berg, 2006), where a small number of respondents filling criteria for the study are contacted, which in turn refer you through other respondents. For future reference, the respondents will be referred to by identifiers to uphold anonymity as shown in *Table 3* (Creswell & Creswell, 2023).

Table 3. Interviewed CBP-operators and their involvement with CBPs

Operator identifier	**Summary of their involvement with Cargo Bike Pools**	**Date of Contact**
Consultant	Swedish consulting & Turnkey company for cargo bike pools with experience in 10 projects	20/04/2023
Manager	A municipal property manager in Umeå, Sweden established a residential CBP.	27/04/2023
Pilot	A CBP- pilot initiative was done by Umeå municipality, which has been running since 2017 with two garages in the city.	28/04/2023

Furthermore, the interview with Pilot yielded access to a user survey conducted between December 3rd and December 15th, 2020, encompassing 107 members from their cargo bike pool. This survey provided valuable insights into user satisfaction, opinions of the service, and the demographic characteristics of pooling members, including their mobility habits before and after becoming members (Pilot, 2020).

b. Analysis Methodology

Unlike a structured interview approach, which follows a predefined set of questions, a semi-structured approach was taken using the interview as a general guideline. This flexible approach allows for unexpected and in-depth insights to appear. However, it can lead to potential information gaps due to time constraints and questioning techniques. To address this, an interview guide was followed (Creswell & Creswell, 2023).

The interviews were recorded, transcribed, and analyzed thematically using a deductive-inductive approach (Braun & Clarke, 2022). The deductive aspect involved drawing conclusions or predictions from existing theories, findings, or hypotheses. The inductive approach allowed for the refinement or creation of new theories or hypotheses based on the gathered data. Combining these approaches, the deductive interview provided a framework for investigating specific research questions, while the inductive approach facilitated the exploration of new perspectives (Braun & Clarke, 2022).

Thematic analysis was used to organize and interpret patterns within the interviews, finding and analyzing significant emergent themes. The data were coded to identify meaningful units, which were then organized into potential themes (Braun & Clarke, 2022). These themes were further refined and defined, and the resulting emerged themes will be presented in the results chapter.

c. Ethics, Validity and Reflexibility Of The Study.

Ensuring credibility and objectivity in the research requires acknowledging the researcher's personal values and beliefs, which can influence the study's design, data collection methods, interpretations, and overall conclusions (Denscombe, 2007). Reflexivity, therefore, involves reflecting on the researcher's positionality, assumptions, biases, and existing knowledge within the field. Objectivity extends to the interview respondents, as their information must be objectively interpreted and accurately represented (Denscombe, 2007).

Another fundamental aspect of research is validity, encompassing multiple dimensions. Construct validity involves linking the theoretical framework to the research findings, ensuring alignment between the studied concepts and the collected data (Creswell & Creswell, 2023). Internal validity means accurately representing the causal effects of the variables within the study, ensuring that the observed relationships are not confounded by other factors (Creswell & Creswell, 2023). Finally, external validity, or generalizability, determines the extent to which the findings can be applied beyond the specific study context (Creswell & Creswell, 2023).

i. Research Ethics

Ethical considerations played a crucial role in this study, including informed consent, participant rights, privacy, well-being, and anonymity (Denscombe, 2007). To safeguard confidentiality, practical measures were implemented, including the use of informed consent forms and data anonymization. By taking these steps, the aim was to protect the privacy and identities of the participants. Additionally, both the researcher and the participants remained aware of potential conflicts of interest, ensuring that bias was mitigated, and ethical academic standards were upheld throughout the study. The ethical considerations also guided the development of the interview guide: designed to promote neutral, balanced, and ethical data collection practices (Denscombe, 2007). To protect anonymity and privacy, the names of the interviewees and their affiliated companies were withheld.

d. Limitations

This study acknowledges limitations in terms of scope and depth, recognizing the potential for future investigations to explore other questions beyond the initial scope. Time constraints during the interviews hindered in-depth exploration of certain topics, limiting the comprehensiveness of the analysis and ultimately resulting in knowledge gaps through the limitations of the interview.

Appendix 3 offers insights into the demographics of Pilot's (2020) participants, including their housing, socioeconomic status, car access, and possession of a driver's license. However, the analysis's limitation prevents in-depth correlations between variables.

Considering that the findings are constrained to a specific geographical and demographic context, it has limited generalizability due to the small sample size and the specificity of the research questions. It is important to note that the findings may not readily apply to the broader industry, given the contextual constraints of this study's scope.

6. Results

In this section, the main findings will be presented related to past sections and the interview guide *(See appendix 1 and 2)* along with the information gained from the interviews and the user survey by Pilot (2020). First, context and background information will be provided about the operators' pools and their motivations for creating them *(Section 6.a)*. Second, the user perspective will be presented, discussing their motivations, barriers, and changes in mobility habits as a result of joining a pool have been *(Section 6.b)*. Finally, the challenges operators have faced in operating and setting up their pools will be presented *(Section 6.c).*

a. Factors Influencing the Establishment of Cargo Bike Pools: a socio-ecological Motivation

Discussing the findings from the conducted interviews, it was revealed that the creation of Cargo Bike Pools (CBPs) was primarily driven by the intention to provide social and ecological benefits to users, rather than solely focusing on potential economic gains of operating one. This section delves into the factors that influenced the establishment of these cargo bike pools, addressing the aspects of where, why, and when they were created.

One of the interviewees, referred to as "Manager," acted as a representative for a municipal housing company that established a CBP in the Ålidhem residential district. The decision to create the pool was prompted by the relocation of a car garage, which was caused by ongoing densification in the area. This presented an opportunity to establish a CBP close to the new garage (Manager, personal communication, April 27, 2023). The planning phase for the pool started in 2020 and is currently in a testing phase, where a select number of residents have been allowed to try out the service. However, it has not yet been opened to the wider district. The purpose of this testing phase is to gauge the level of interest and optimize the offerings of the CBP, while also gathering valuable feedback from the initial users (Manager, personal communication, April 27, 2023).

Apart from the opportunity that arose, another significant motivation behind establishing CBPs, particularly in this area, was the socio-economic demographic. As a public housing company in Sweden, prioritizing the provision of affordable housing to the public, the focus was on social objectives and delivering on the socio-ecological benefits of PSS, rather than profiting from establishing a cargo bike pool. The interviewee emphasized the social benefits of such a service, particularly in enabling individuals without the means to own or use a car.

“[...] because it's our largest area with the highest number of tenants. [...] and many of them don't own a car. This provides a different kind of freedom. [...] Additionally, for example, if you're a student coming here and not interested in buying a car, it can be beneficial to have the option to do big grocery shopping or carry heavy loads without the need for a car or relying on people who own one. [...]“ - (personal communication, April 27, 2023)

The motivation to provide a CBP on socio-ecological grounds seems to be evident throughout all the projects that the Consultant worked with, as they worked with both

implementing cargo bike pools on behalf of various municipalities and housing associations (Consultant, personal communication, April 23, 2023), though further details were not discussed in the interview.

Pilot's initiative presents an intriguing opportunity to create a cargo bike pool for a broader audience beyond specific housing associations. The decision to introduce the Cargo Bike Pool (CBP) stems from the city's rapid densification and the demand for sustainable transportation options. The municipality aims to achieve a target of 65% of all trips within urban areas being made using sustainable modes of transportation by 2025 (Umeå kommun, 2016). In 2014, 62% of shopping-related trips in the city were made via car. The proposal for the cargo bike pool, presented to the city's technical board in 2016, aimed to lower the percentage of car trips. By finding a correlation between age and car usage, especially in pick-up-drop-off activities, they aimed to introduce cargo bikes within an age range where families are common and often rely on cars. Additionally, they aimed to motivate the use of the already well-developed cycling infrastructure in Umeå that can be utilized all year round (Umeå kommun, 2016).

The project was launched to the public in 2017 within a garage at the Umeå University campus, free of charge, through a collaboration with another housing company to test the cargo bike pooling concept at a larger scale, in an area where it would see frequent use (Pilot, personal communication, April 28, 2023). A year later, in 2018, a custom-built garage was constructed in the center of Umeå's city center. Currently, the service offers a total of 18 bikes, divided between three-wheeled and two-wheeled cargo bikes *(see Figure 1).* Membership costs 100 SEK (Swedish crowns) per year, with the first 2 hours of use being free, and added costs of 10 SEK per hour afterward, with a maximum limit of 270 concurrent members.

The pilot noted that a motivator for undertaking this as a municipally funded endeavor was to further promote this mode of transportation, acting as an innovator and testbed role model for future interested cargo bike pool operators. As cargo bike pools operated at this scale are not yet widespread, though similar initiatives have been carried out across Sweden (Pilot, personal communication, April 28, 2023).

Concluding this section, the main motivation to promote cargo bike pools is to encourage the adoption of sustainable modes of transportation and to highlight the socio-ecological benefits before the financial gains.

b. Assessing The Impacts, Motivations, and Barriers Of Cargo Bike Pools

The interview with Pilot and their provided user survey (2020) serves as an insight into understanding the user motivations, barriers, and shifts in mobility patterns following joining a cargo bike pool, compared with prior literature.

i. Factors Influencing Participation and Usage of Cargo Bike Pools

Cargo bikes have appeared as a viable alternative to cars for individuals without access to personal vehicles or those embracing a car-free lifestyle, as mentioned in prior literature. Therefore, understanding who joins a pool is important. In Pilot's survey (2020), 41% of the respondents lacked access to a car, while 53% had access to one, and the remaining had access through a carpooling service (107 respondents).

According to the survey findings *(see Appendix 3)*, it was observed that a significant portion of the respondents (16%) did not possess a driver's license. Moreover, many of them (60%) resided in apartments. Additionally, the employment status of these individuals indicated a correlation with the obstacles associated with not owning a cargo bike, such as limitations in terms of ability, space, or income (Irala, 2017).

Use cases for the bikes align with existing literature, as seen in Figure 2, where use cases include grocery shopping, transporting children, and outings. Most of the use cases seem to be for specific purposes and not as a general transportation option.

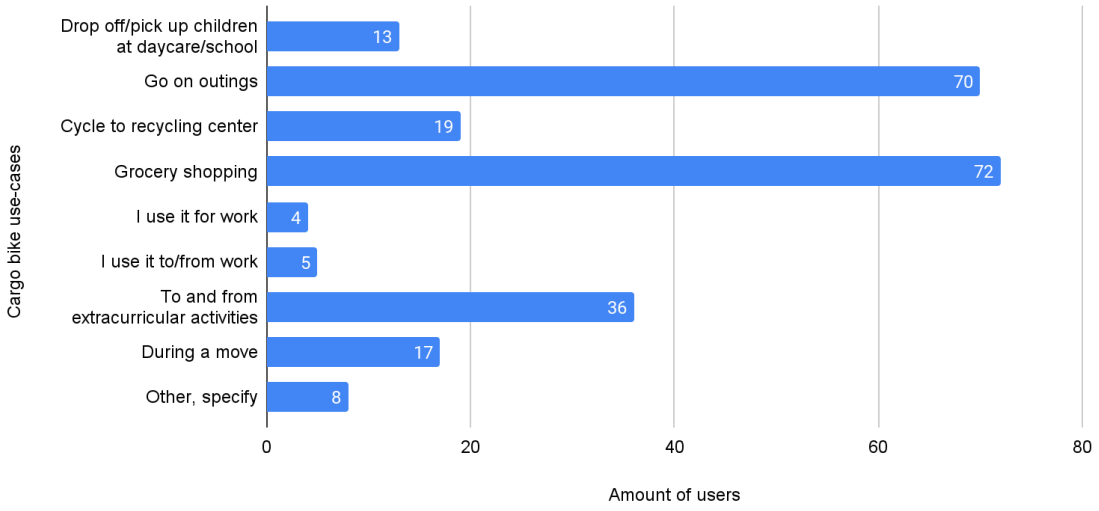

Figure 2. Uses for a cargo bike
"Other" includes similar reasons as mentioned above.
Source; (Pilot, 2020)

Although the user survey did not delve into the frequency of service usage, user anecdotes shed light on the relative advantages of participating in a sharing service (Pilot, 2020). One user with a physical disability mentioned the suitability of tricycle cargo bikes as an enabler to biking. Another user emphasized the effectiveness of cargo bikes, particularly during the COVID-19 pandemic, for transporting children and avoiding crowded public transportation.

Two motivations are particularly significant for joining and using the pooling service: the economic and ecological advantages. Respondents often cited the cost-effectiveness of the service compared to buying a cargo bike. They emphasized the affordability of joining the pool, the two-hour free-use window, and the economic benefits associated with sharing and using cargo bikes as key factors influencing their increased usage of the service.

"[...] it's way cheaper than buying a cargo bike" - (Pilot, 2020)

Analyzing these motivations within Moore's framework (2014) suggests that cargo bikes, as well as sharing services, offer distinct relative advantages over other transportation modes, both in the economical domain and in users' association with a sustainable mode of transport.

However, inconveniences ranging from minor issues, such as needing to privately buy extra helmets for their children when using the cargo bikes, to being unable to book at all, can severely hinder a user's experience and opinion of the service. The former consideration was addressed in Manager's pool by providing free helmets as part of their pool (personal communication, April 27, 2023) to decrease the users' financial burden, providing extra value and positioning using the cargo bike pool as a more attractive, family-friendly mode of transportation.

Sharing services like cargo bike pools introduce new practices and challenges, such as specific locking procedures and advance bookings. In Pilot's pool, users register and book bikes through a website, accessing a key from a garage with a 24-hour advance booking. Users are responsible for both charging the bikes and confirming their condition and availability when returning them, although this is done in the garages.

The inconveniences related to booking, locking, and sharing bikes also contribute to users' preference for car ownership instead of using these services (Pilot, 2020). The sharing nature of a pool risks overbooking and non-availability when needed. Out of 101 people, a total of 70 reported that all available cargo bikes were occupied, with varying frequencies from 1-5 booking attempts in a year to being overbooked (54 people) and 16 more than five times. Among those who experienced it, 42.6% of respondents reported it to be a problem (Pilot, 2020). It is important to note that Pilot's pool only allows same-day/advance booking. Although issues like this cannot solely be attributed to the booking system, but rather lie in the pool's finances and spatial constraints of the garage. According to the Consultant (personal communication, April 23, 2023), these issues are uncommon, calling for pools to introduce a real-time digital booking system through both apps and websites. This would allow users to view available bikes and reserve units several days in advance, with ease of use and predictability in mind. However, solving spatial and financial issues that could increase the number of cargo bikes still is a more challenging question.

“[...] The usage and interest of a CBP is contingent upon the availability of bikes, as users lose interest if bikes are not readily available [...]” (Manager, personal communication, April 27, 2023)

One advantage of owning a car is the convenience of having it close to one's home. Compared to a cargo bike pool, this can be seen as a barrier, as making an advanced booking and traveling to a distant location to access a bike may be less appealing. Factors such as living far from the city, long-distance commuting, the need to transport multiple passengers or larger items, and the desire for spontaneous travel were among the reasons cited for choosing private cars. *Table 4* outlines a summary of user feedback on Pilot's pool and improvement points.

Table 4. What users would choose to improve on (Pilot, 2020)

Category	Suggested measures from the survey
Enhanced user experience	- Mobile applications for booking, return and repair reporting processes instead of via a website - Improved booking procedure through the website - Longer reservation window and pre-booking slots - Ensuring that the bicycles are available when needed
Accessibility	- More cargo bikes in general, an ensuring that cargo bikes are fully - Cheaper hourly rates and longer rental periods beyond having to return the bike by midnight - More pick-up and drop off locations - Servicing more areas in the city and establish new garages
Improvements in the value proposition of the pool	- Supplying helmets, especially for children - Carpooling in conjunction with cargo bike pools to reduce car reliance

ii. Impacts on mobility patterns and habits

The creation of cargo bike pools (CBPs) by the interviewed parties has been driven by the desire to provide services that offer social and ecological benefits. The aim is to promote sustainable mobility practices and increase acceptance of cargo bike usage and shared mobility services. According to Pilot's survey data (2020), there has been significant success in fostering this shift, with 50% of respondents acknowledging a preference for using cargo bikes for errands more often than cars. However, it is important to note that the survey analyzed data for only one year, and continuous data is lacking.

Figure 3 displays user data on the belief of cargo bike sharing as a viable substitute for car ownership. Among the participants, 39.3% expressed that a nearby CBP could potentially replace car ownership, while an additional 23.4% would consider this option if a carpool service was available. This suggests that a combination of multi-modal pools offering both cars and cargo bikes is an attractive alternative for many individuals seeking to reduce car dependency. It is worth noting that not all respondents viewed cargo bikes as a suitable replacement, citing reasons such as distance from pool locations and the impracticality of

using cargo bikes during colder months. Highlighting the importance of implementing a multimodal approach within pools and sharing services.

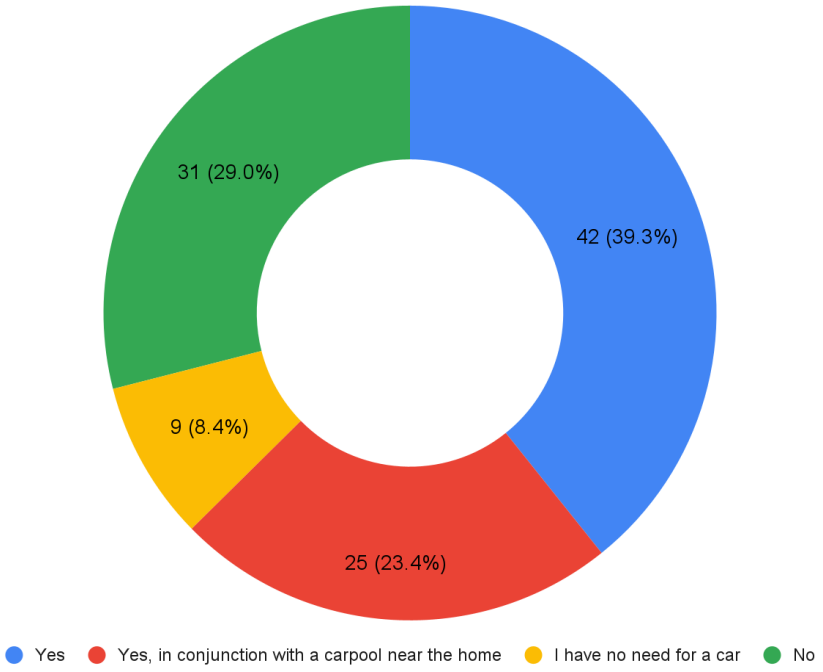

Figure 3. Would a cargo bike sharing pool near your home replace car ownership? Source; (Pilot, 2020)

The data reveals an interesting finding about the adaptation process of "trialability" in the context of the cargo bike pool. The Pilot's goal of encouraging adoption through trialability, allowing individuals to experience cargo bikes firsthand, is supported by the survey results. While most of the respondents did not own a cargo bike, 32.7% expressed an inclination to purchase one themselves after using the service. This phenomenon was also highlighted during the interview with the Consultant, emphasizing the importance of cargo bikes in increasing knowledge, acceptance, and interest in personal ownership.

The results suggest that CBP operators like Pilot, Manager, and Consultant are making progress in bridging the gap and functioning as a test drive for potential cargo bike owners. However, while the survey does not provide information on why respondents chose not to purchase a cargo bike for personal use, it is reasonable to assume that barriers identified in previous studies on obstacles to purchasing cargo bikes may also apply in this context (Irala, 2017).

"Many feel that they want to try and see how it works in their everyday life before making a purchase." - (Pilot, personal communication, April 28, 2023)

Another notable gap in Pilot's survey is the absence of information on user perceptions of the relative advantages of cargo bike pools compared to other affordable and non-ownership services like bike pools, car-pools, and public transport. Exploring this topic in future investigations would be necessary to gain a better understanding of how CBPs specifically affect an individual's relationship with mobility.

Figure 4 presents data on whether respondents have purchased their own cargo bike, sourced from Pilot (2020). These findings align with existing literature, which supports the effectiveness of PSS (Product-Service Systems) in substituting car trips with cargo bikes and the observation that private purchases increase as a result of trying cargo bikes (Becker & Rudolf, 2018; Hess & Schubert, 2019; Irala, 2017).

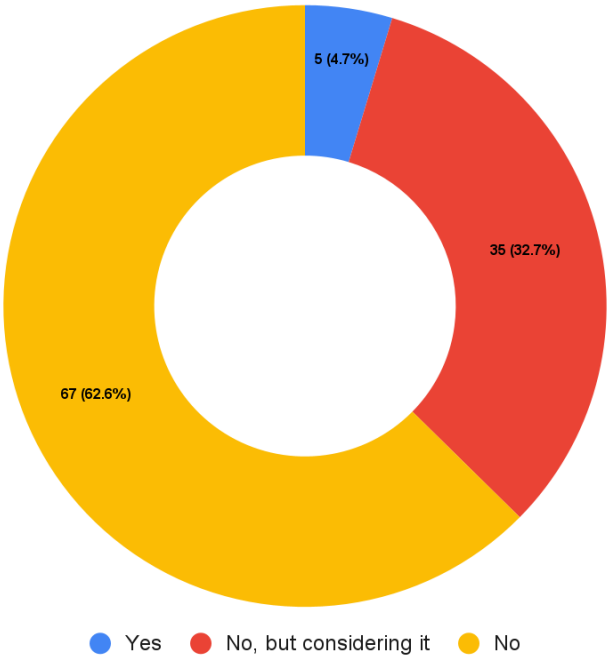

Figure 4. Have you bought your own cargo bike?
Source; (Pilot, 2020)

c. Financial, Spatial, Planning and Marketing Considerations in Cargo Bike Pool Establishment

The research and interviews uncovered overlooked dimensions in the planning and operational phases of establishing a cargo bike pool. These oversights encompassed aspects such as the physical layout of the pool and the allocation of operational responsibilities for bike repair and servicing. The root causes of these problems can be attributed to limited initial, direct investment and inadequate resources overall allocated to the pooling service.

This theme can be further examined through three subsections: planning considerations for a successful cargo bike pool service, marketing issues, and financial challenges.

i. Planning, Spatial and Operational Oversights Necessitate Creation Of New Dedicated Spaces

Planning and operating oversights, along with financial constraints, present significant challenges in creating cargo bike pools—often small in scale and typically initiated by neighborhood associations or commercial entities. In Sweden, grassroots initiatives take the lead in creating these pools(Consultant, personal communication, April 23, 2023). However, optimizing the spaces for bike pools can be challenging due to factors like location, proximity, and physical features. These pools are often located in converted and retrofitted spaces like old bicycle garages or parking areas, which can pose challenges such as affecting service quality and increasing theft risks (Consultant, personal communication, April 23, 2023). Hosting pools in established spaces adds complexity to the equation, considering differences in parking infrastructure and funding of housing associations, aligning with Irala's (2017) findings.

Noting the positive initiatives of smaller-scale pools, there are oversights and constraints when hosting a pool in an already built areas. For instance, the doors: When hosting a pool in a retrofitted space, doors are often traditional and manually opened/closed, requiring a key to open. This poses both an overlooked security risk and an inconvenience for users. If a key is lost, the entire locking mechanism needs to be replaced. The Manager reported instances of two cargo bike thefts in their pool, possibly due to doors that failed to close properly (personal communication, April 27, 2023). It stays unclear whether these issues were caused by door malfunctions or user errors. Moreover, manually opening the door and holding it open while maneuvering a cargo bike can be a significant hassle for users, adding unnecessary effort and inconvenience to the process.

It seems that many of these pools are ill-equipped and expect to manage the risks of theft. Instead of investing in security measures upfront, operators prefer to test the concept and evaluate its success before committing substantial financial resources to scale up their services. It also extends to not committing to hosting a pool in a new, custom-built space as it would require significant amounts of resources and collaboration (Consultant, personal communication, April 23, 2023). This hesitancy also extends to the implementation of adequate security measures, as emphasized by the consultant's observations.

"[...] We have had problems with vandalism and theft in our bike pools. It's common to only think about security measures after something has happened [...] Often, stakeholders want to test the concept before investing in security. [...]" - (Consultant, personal communication, April 23, 2023)

The manager’s experiences align with the consultant's observations. Only after experiencing the theft, was security tightened, surveillance cameras in the pool and GPS trackers, alarm boxes, and robust and user-friendly locking mechanisms.Security should be a proactive priority rather than a reactive measure, given the high cost associated with stolen cargo

bikes. Striking the right balance between robust security measures and user accessibility is critical (Manager, personal communication, April 27, 2023) .

"[...] if people want to steal a cargo bike, they will [...], while we try not to create a "Fort Knox" we should at least try our best to deter theft" -(Manager, personal communication, April 27, 2023)

Spatial limitations in retrofitted areas also hinder the expansion of bike pool capacity. Operators, eager to expand the bike pool's capacity, face challenges in retrofitted areas due to spatial limitations. Often exhibiting hesitation in investing or creating dedicated spaces specifically tailored for this purpose, though the consultant notes that this a wider issue than will, but connected between partnerships and financial and spatial opportunities (Consultant, personal communication, April 23, 2023). By fostering outreach initiatives and encouraging collaboration between stakeholders, cargo bike usage can increase and achieve more economic efficiency for a pooling service.

Multiple stakeholders can pool their resources to procure a shared cargo bike pool, allowing for standardized maintenance procedures and booking systems smaller scale initiatives, such as housing associations and neighborhood associations, often lack collaboration among interested operators, resulting in limitations in the establishment, operation, and maintenance of bike pools (Consultant, personal communication, April 23, 2023).

Operating cargo bike pools involves a learning process through trial and error. Key considerations emphasized by the interviewees include operational responsibility, bike sourcing, and repair plans. A robust maintenance and repair strategy is essential due to the inevitable wear and tear on bikes caused by high usage rates. Outsourcing repairs lead to extended downtime and added costs, both financially and environmentally. Operators should maintain an inventory of repair parts and establish an in-house repair system to minimize downtime and reduce the ecological impact (Pilot, personal communication, April 28, 2023). Pilot emphasizes the importance of co-locating and co-operating these pools for these benefits and to make addressing these challenges easier (Consultant, personal communication, April 23, 2023; Pilot, personal communication, April 28, 2023).

The consultant also notes that hosting a pool in a custom-built area might be the optimal option, even if costly and more difficult (Consultant, personal communication, April 23, 2023). In the context of the Manager's pool, spatial constraints of the pools were considered, allowing optimization of available space (Manager, personal communication, April 27, 2023). Conversely, Pilot's pool became more visible and accessible with the establishment of a custom-built garage located in the city center. In part by building a glass building specifically designed to meet their requirements. By adopting this approach, the Pilot's pool improved public visibility while mitigating the risk of theft; this was accomplished by incorporating custom charging solutions directly into the walls, eliminating the need for external locking and charging mechanisms (Pilot, 2020, personal communication, April 28, 2023). Consequently, streamlining the process enhances convenience and security.

ii. Marketing Strategy And Value Proposition Limiting Potential User Base.

The consultant noted inadequate marketing strategies in small-scale Cargo Bike Pools (CBPs), specifically in targeting local potential users. Primary modes of promotion rely on word-of-mouth recommendations, and active outreach initiatives are minimal. This absence of proactive marketing is concerning, given that CBPs often aim to serve families with children, and the benefits of cargo bike service are under-promoted. The consultant theorized that the lack of alternative mobility options, such as bikes or e-scooters, to complement the pool may contribute to a narrow target market (personal communication, April 23, 2023). However, the consultant also suggests that due to the relative niche of cargo bikes, those interested would already know about the service, making outreach initiatives redundant. In line with their theory, the Manager includes electric bikes, traditional bicycles, and a workshop facility as an expanded value proposition, currently in the testing phase, which has generated significant interest (Manager, personal communication, April 27, 2023).

The consultant suggests that the lack of outreach initiatives and correct marketing strategies are hindering the growth of cargo bike pool users. Interviews revealed that growth and increased membership are primarily driven by the unique offerings of the service and positive reputation, promoting user referrals through word of mouth (Manager, personal communication, April 27, 2023).

The consultant's theory aligns with Pilot's marketing approach, which was limited to two direct marketing initiatives: an inauguration party per garage and the opening of each garage. Interestingly, these events proved effective as promotional instruments, generating initial interest in the pool. In subsequent years, brand recognition and word-of-mouth referrals played a pivotal role in expanding the service's reach, ultimately reaching its maximum member capacity in 2019 (Pilot, personal communication, April 28, 2023). Pilot's survey indicated that 95.3% of users recommended the service to others (Pilot, 2020).

The pilot emphasized the importance of branding in increasing awareness of the municipal cargo bike pool. During the planning phase, it was crucial to create a strong brand identity that was specifically associated with the pool, rather than cargo bikes in general. Considering that Pilot's Cargo Bike Pool was a municipally owned endeavor, considerations were made to label the bikes as "the municipality's service," which was seen as important. In the planning phase, discussions were held about how the bikes should be presented to the public, including the possibility of allowing sponsored logos or displaying other company affiliations, such as the manufacturer, to lower the unit price.

These lessons should be considered by operators, as the current promotion of CBP services relies more on word-of-mouth and existing knowledge, rather than extensive mass marketing and value proposition. This has effects in limiting the future growth of the customer base.

iii. Partnerships, Subsidies and Business Models: Promoting Financial Viability

Financial considerations appear as a central theme in our interviews, permeating various discussion points. The cost associated with creating and operating a Cargo Bike Pool (CBP) was identified as a significant challenge. Factors such as deciding the value proposition, forging suitable partnerships, and fostering inter-stakeholder collaborations all revolved around the financial aspect. The interviewees emphasized the need for financial support and subsidies to address these challenges.

The consultant highlighted the prevalence of subsidies in the projects they were involved in, with stakeholders such as neighborhood associations, housing associations, and municipalities providing substantial funding or full support for CBPs (personal communication, April 23, 2023). The need for subsidies was echoed in the interviews with the manager and pilot as well. In the manager's case, the public housing company funded the establishment and operation of the pool. Similarly, the pilot mentioned that their cargo bike pooling service is currently subsidized by the municipality for its socio-ecological benefits.

“The project is extended on an annual basis, which is fantastic because it aligns perfectly with the Umeå Municipality’s and the technical board's environmental goals. It is highly regarded by the citizens. However, it is currently subsidized by the municipality since it does not generate sufficient revenue to cover its expenses.” (Pilot, personal communication, April 28, 2023).

Subsidies for CBP initiatives can go beyond financial contributions and may include subsidized leases or the provision of space at no cost, lowering the barriers for interested operators and stakeholders to create a pool, especially when done as a collaboration between stakeholders.

For example, Pilot mentioned that their initial garage near the university campus was made available for free to assess the socio-ecological impact and benefits of the cargo bike pool (personal communication, April 28, 2023). Engaging property managers is vital for obtaining partial funding, as they share a focus on socio-ecological benefits and creating a desirable living environment. Collaboration and more cargo bike pools bring value to the municipality and benefit property owners with socio-economic benefits, enhanced appeal, a progressive image, and reduced parking demand.

Regarding the responsibility of subsidizing and ensuring the financial viability of CBPs, different perspectives were seen. The consultant emphasized the role of municipalities in guiding property companies toward establishing CBPs, suggesting the replacement of parking spaces and co-financing of public CBPs, similar to subsidies provided for public transport (Consultant, personal communication, April 23, 2023).

"[...] municipalities have a great responsibility in how they steer property companies in that direction. Such as replacing parking spaces with these kinds of opportunities. But I still see that municipalities and the state also take greater responsibility in one way or another for

the issue. For example, through co-financing of public cargo bike pools. For example, they subsidize public transport, one could do something similar for pooling services" (Consultant, personal communication, April 23, 2023)

However, Pilot suggests an alternative approach, proposing that the key to promoting financial viability lies in the business model and value proposition of these pools. Instead of solely relying on municipality subsidies, they propose that external actors should create practical business models that offer a large value proposition that entices users to join and use these services.

"[...] It does not have to be the municipality that operates this exclusively. Another option is to have an external actor who has a concept and a business model, along with a variety of other features like car sharing and cycling pools[...]." -(Pilot, personal communication, April 28, 2023).

Concluding the operators' statements, financial support and subsidies play a vital role in addressing the financial obstacles associated with CBPs and promoting their long-term sustainability.

7. Discussion

Preluding the discussion, it is first important to address the limitations of the study and how they affected the boundaries and constraints of the research. A notable limitation was the small number of interviews conducted, which focused on subsidized pools. This limited the understanding of commercially viable business models. Additionally, the focus on interviewing operator experiences and the survey targeting current and existing pool members limited the understanding of the barriers and motivations for joining or leaving a pool. These gaps resulted from time and resource limitations, as well as an oversight in including a broader range of participants. Future studies should address these limitations by exploring motivations, barriers, and operator experiences from diverse perspectives, as well as investigating the role of municipalities in supporting cargo bike pool initiatives.

Framing the discussion around the initial research questions, cargo bikes, and subsequently cargo bike pools that cater to those without the ability or desire to use a car for short-distance urban areas, is crucial. Joining a cargo bike pool is motivated by sustainability concerns, convenience, and cost efficiency and addresses barriers highlighted in previous literature and interviews (Becker & Rudolf, 2018; Hess & Schubert, 2019; Irala, 2017). For those user segments with a spatial or monetary inability to own a cargo bike for themselves, PSS services may be a key enabler in using them in their mobility habits, as shown throughout this study.

However, these services face inherent challenges due to their sharing nature. Users need to compete for bike access and face various inconveniences and considerations on value, proximity, ease of use, and reliability. Positioning sharing services as a superior option to owning and using a car becomes paramount in attracting users, increasing cargo bike usage, and shifting the acceptance of sharing mobility and cultures through substituting cars with

cargo bikes. In this research, the impact of cargo bike services to foster such a shift has been discussed.

The chasm identified by Rodgers (2003) and Moore (2014) is demonstrated in this study, emphasizing the importance of cargo bike pools in bridging this gap through the adaptation processes. Pools allow the early majority to try cargo bikes without making significant investments in purchasing one themselves, opening them to the possibility of ownership through pool trials. As 50% of Pilot's survey respondents preferred cargo bikes over their cars for various trips (Pilot, 2020), pools also highlight the *trialability* factor; after trying the Pilot's pool increased to around 32.7%, around 35 respondents, and with five respondents responding that they bought one after joining and trying the cargo bikes (Pilot, 2020).

For this trend to continue in cargo-bike pooling, several challenges have been highlighted by the interviewees in terms of planning, marketing, financial considerations, and the business model itself. Based on the interviews, building custom-built garages with innovative solutions that enhance safety, capacity, and ease of use for CBPs is important for their success, even though it is not always feasible. The findings suggest that future policy and financial changes in the business models are crucial factors for the success of cargo bike pool operators. Additionally, offering additional services such as workshops or diverse offerings in shared mobility pools can improve the viability of CBPs. Improving the value proposition and ensuring user-friendliness are key factors in attracting users and competing with other transportation options, intending to minimize reliance on subsidized funding, which aligns with earlier literature.

In terms of marketing and attracting new potential users, CBPs' niche nature might limit their reach. Further work to increase attractiveness would require a more comprehensive strategy beyond word of mouth and targeting a customer base already "compatible and interested" with such services, offering cargo bike pools. Perhaps offering it as a larger broader sustainability strategy like Irala (2017) found, or the opposite; adding value propositions may be the key.

Moreover, collaborating and co-locating pools among different stakeholders might be beneficial for future operators. Until a value proposition and user rates for cargo bike pools have been established, acceptance and intrigue regarding such systems need to increase in the future. Subsidies and collaboration may be essential moving forward, although the political implications, causes, effects, and potential conflicts of such subsidies have not been addressed in this study. This area could be explored in future research.

8. Conclusions

In conclusion, this research aimed to examine the benefits of cargo bikes, the perceived value of cargo bike pool members in using such a service, and the challenges faced by pool operators in setting up and running these services, thereby contributing to the field of sustainable mobility. Existing literature supports cargo bikes as socially, economically, and ecologically favorable modes of transportation due to their lower cost, environmental friendliness, and health benefits (Becker & Rudolf, 2018; Hess & Schubert, 2019; Riggs, 2016;

Rivera & Henriksson, 2014). However, the slow adoption rate has been linked to financial costs and parking constraints. Thus, product-as-service systems (PSS) such as cargo bike pools offer a socio-economically accessible way to integrate cargo bikes into daily mobility patterns (Carracedo & Mostofi, 2022; Irala, 2017).

Through interviews with three cargo bike pool operators in Sweden, a recurring theme could be observed: the primary goal of these pools is to generate social and ecological advantages rather than financial gains associated with operating a cargo bike-focused PSS. User surveys provided by one of the interviewees align with existing literature, indicating a growing interest and shift towards using cargo bikes as a substitute for car usage in various contexts, including grocery shopping, outings, transporting heavy goods, and traveling with children. This increased interest has resulted in a higher likelihood of individuals purchasing cargo bikes after trying them through pooling services. Approximately 32.7% of the 107 respondents expressed interest in buying a cargo bike, which corresponds to around 35 individuals. Moreover, the survey revealed that 4.7% of the respondents (5 people) had bought a cargo bike after participating in the survey.

The research also identified challenges faced by pool operators in establishing and operating cargo bike pools, including physical location and space constraints, financial aspects, marketing strategies, and the value proposition of the service. The study suggests that cargo bike pools themselves are not financially sustainable and require collaboration with stakeholders to subsidize costs, optimize marketing outreach initiatives, allocate resources for maintenance responsibilities, and find more suitable locations for hosting these pools. Perspectives on subsidization and financial viability vary, ranging from increased municipal subsidies to finding the right business model for sustainability.

To enhance the attractiveness of cargo bike pools, the findings suggest incorporating additional transportation modes such as regular and electric bikes into a cargo bike pool, alternatively integrating cargo bikes into a larger mobility offering that includes car-pooling, and providing supplementary services like tool rental options and complementary equipment such as helmets. These measures can help attract various user segments to join a pool. Understanding user motivations, barriers, and considerations for pool establishment and operation is crucial in creating financially viable and appealing services that promote sustainable transportation choices.

Addressing this knowledge gap will contribute to the development of a correct business model, fostering cargo bike substitution of cars and promoting a more sustainable transportation culture.

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10. Appendix

Appendix 1. Interview guide	
Category	Question
Planning phase, motivations and considerations?	- What factors influenced the creation of the cargo bike pool? - What are some of the challenges associated with starting a cargo pool? Were there any spatial, planning constraints, restrictions or otherwise? - What role do public-private partnerships, with a municipality or other stakeholder play in the development and implementation of cargo bike pools? - In hindsight, were there any insights over oversights that could have been solved or changed earlier in the process? - What are some things that should be considered or are overseen when establishing a pool in already built spaces? - How has the support been in terms of finances and resources to establish the pool?
Challenges and and operating the services	- Any considerations, challenges or opinions about the bike sourcing procedure? Where there any considerations on which manufacturer to buy? - On the economical side, how are cargo bike pools run, financed and logistically maintained? - How much have the cargo bikes been used since their introduction into your pool/sharing system? Can you describe some of the feedback and general impressions of the people using them? - To what extent have the cargo bike pools you've worked with affected user mobility habits and car usage? Any differences?
Usage and overall impact thanks to pooling service	- To what extent have the cargo bike pools affected user mobility habits and car usage? Any differences? - In your experience, who use the pools? What have target audiences been for your CB-pool? - How have you worked with advertisements, to spread the the services?

Appendix 2; Identified themes from the literature		
Category	**Key takeaways**	**Related Sources**
Why Cargo Bikes?	- Variety of social, economical and ecological benefits on societal and individual levels, - Electrical Cargo Bikes make car replacement feasible - Several daily car trips are short-distanced and can be substituted with cargo bikes - Cargo bikes as car substitutes in private transportation remains uncommon in most mobility cultures, despite adaptation in freight	(Carracedo & Mostofi, 2022), (Energikontor, 2020), (Wrighton & Reiter, 2016), (Schliwa et al., 2015), (Riggs, 2016), (Colville-Andersen, n.d.), (Hess & Schubert, 2019), (Félix et al., 2019, 2020), (Cox, 2015),
Barriers in adapting cargo bikes in private transport.	- Subsidies are not enough, other barriers remain - Spatial barriers and geophysical barriers to private adaptation of cycling - Cultural and infrastructural barriers in car-focused mobility cultures	(Klinger & Lanzendorf, 2016), (Félix et al., 2019, 2020),(Bourne et al., 2020),(Naturvårdsverket, 2019). (Carracedo & Mostofi, 2022), (Becker & Rudolf, 2018), (Rivera & Henriksson, 2014)
Sharing services to meet those barriers.	- PSS Identified as crucial for increasing adaptation through a socio-economically accessible service - Pooling systems identified as most efficient at promoting cargo bikes Transitioning to a sharing-based mobility culture is hard - Operational variations and challenges vary between pools in new and old host areas	(Klinger & Lanzendorf, 2016), (Rodgers, 2003), (Moore, 2014), (Hess & Schubert, 2019), (Irala, 2017), (Tukker, 2004), (Vezzoli et al., 2018), (Umeå kommun, 2016), (DeMaio, 2009), (Chen et al., 2021)

Appendix 3. Demographic insights

Question	Number of individuals	Label	%
Employment status	77	Employed	71.96%
	19	Student	17.76%
	4	Retirees	3.74%
	7	Other (Sick leave, parental leave, unemployed, self-employed)	6.54%
Housing Type	34	Townhouse/Villa	35.05%
	59	Apartment	60.82%
	4	Collective Housing/Condo	4.12%
Children in the household	56	Yes	52.34%
	51	No	47.66%
Drivers license	90	Yes	84.11%
	17	No	15.89%
Car access	57	Yes	53.27%
	6	Carpool	5.61%
	44	No	41.12%