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Replacing Car Trips with a Cargo Bike Sharing Service: What Features Do Users Value Most?

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Abstract: While cargo bikes are becoming an increasingly popular alternative to larger, more polluting vehicles in both the logistics and private mobility sectors, there has been comparatively little research on their use for private mobility. The potential of shared cargo bikes to replace car trips has been examined in some studies, but no previous research has investigated the critical factors that make it a valued alternative. By studying users' willingness to pay, this paper examines the perceived value of a free cargo bike sharing service for users. The research is based on a survey of 321 users of the Fietje cargo bike sharing service in Bremen, conducted in 2022. In this sample, 38 to 55% of shared cargo bikes trips would otherwise have been performed by car. The paper identifies the transport of objects and children as critical features that provide value to users and create the potential to replace car trips. The results also draw attention to the fact that a cargo bike sharing service is likely to be a more effective tool for reducing car use if it is free. Introducing a fee would increase car trips by 14 to 18% of the total trips enabled by the service.

Keywords: cargo bikes; shared mobility; willingness to pay; users' preferences; alternative to car

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1. Introduction

Private vehicles incur significant costs on cities related to negative externalities such as emissions, (CO_2, brake dust, tire particles), congestion, noise, safety and the use of space for parking [1]. As cities attempt to address sustainability challenges related to the use of motorized vehicles, promoting forms of transport that are less polluting, quieter and require less space has drawn increased attention. While the transport of people alone can be accomplished through the use of public transport, walking, bicycling and other forms of micro-mobility [2], the movement of goods can be more challenging to address using these alternative modes. Cargo bikes and other light electric freight vehicles have therefore received increasing attention in recent years for their potential to replace larger vehicles in the logistics and service sectors [3–6], but the potential of cargo bikes to replace car trips for private citizens is less explored [7,8]. In particular, there is a lack of knowledge about the service features valued by users and needed to make it a valued alternative to cars.

This is surprising given the large potential for substitution identified by researchers such as Wrighton and Reiter [9], who find that 51% of motorised trips related to the movement of goods in urban areas could be replaced by bike or cargo bike, where 2/3rds of the replaced trips are related to private logistics (shopping and leisure). Cargo bikes, with their ability to carry everything from furniture to children and ease of travel and parking, can be a more suitable replacement to cars for short trips [10,11]. However, their uptake is hampered by their relatively higher costs, perceived safety and need for at home storage [7].

A shared cargo bike service can potentially solve some of these issues, offering users the utility of a cargo bike when needed without the additional burdens associated with ownership. This can in turn reduce short car trips and the need for car ownership. Overall, the literature on private cargo bikes is limited. It primarily consists of isolated studies with relatively small samples, making it especially important to compare and contrast these findings with similar results from other case studies. In addition, no empirical research has investigated the critical factors making shared cargo bikes a valued alternative to cars for users, even though this knowledge is needed for cities and businesses to develop long lasting services that replace more polluting and space intensive travel options.

WTP is frequently used to understand the relative importance of different factors on the level of appreciation of a service [12]. However, WTP has not yet been studied to understand the attractiveness of a shared cargo bike service, which results in limited understanding about what private people prioritize when choosing a cargo bike sharing solution. Using a logistic regression, the paper investigates the users' willingness to pay (WTP) for using a shared cargo bike service. Data were collected by means of a survey conducted in Bremen, Germany, among cargo bike sharing users as well as booking data for the stations offering the service. The paper provides insights on the attributes needed for a cargo bike sharing system to be a valued alternative to car use. We also consider the effects that implementing a fee would have on the number of car trips being replaced by the service. After a literature review, the paper presents the methodology used to carry out the study. The results are then presented and discussed before concluding on the paper's implications and limitations.

2. Literature Review

There are not many papers dedicated to private cargo bikes and even fewer when looking specifically at cargo bike sharing. The paucity of articles focused on the topic was noted in a recent literature review published on electric cargo bikes for private use, though focus on the subject is expected to grow in coming years [7]. To our knowledge the literature on cargo bike sharing is based on data collected in Austria, Germany and Switzerland. Becker and Rudolf [13] have studied a specific free cargo-bike sharing system in Germany and Austria, called Freie Lastenräder and based on a cooperative network of 46 free cargo bike sharing operators. The data used in the study was collected by a survey distributed in 2016 among their 9750 registered users, gathering responses from 931 of them. The results of this survey are also presented in a book chapter together with data collected among users of Carvelo in Switzerland. Hess and Schubert [14] conducted a study in Basel in Switzerland based on data collected in 2017 among registered members of the cargo bike sharing platform Carvelo2go as well as non-members. Dorner and Berger [15] have studied a peer-to-peer cargo bike sharing (LARA Share) based in Austria and mostly in Vienna. Data were collected between November 2017 and February 2018. A more recently published study was conducted among cargo bike sharing users registered in the Freie Lastenräder network [10]. The paper focuses on the potential of cargo bike sharing to reduce car ownership and while the characteristics of users were not the primary focus of this paper, some of them are nonetheless detailed in the sample description.

The profile of users as described in previous papers suggests they have specific mobility behaviors in common regardless of the country. Most of them are cyclists, as 71% use a bicycle as their daily means of transport [16]. They have a very low number of cars but a high number of bicycles compared to the general population [15]. Many of them do not own a car but have experience with car-sharing systems [14,16]. In terms of age, previous papers mention an average between 36.4 [15] and 39.62 years old [14]. When looking at gender, cargo bike sharing users are shown to be mostly men. Only 35% of

Freie Lastenräder users were women in 2016 [16]. Dorner and Berger [15] find even smaller proportion of women among users of the peer-to-peer cargo bike sharing, with 29.8%. Being a female has been shown to decrease the probability of being an active member of a cargo bike sharing system, where 40% of users are female [14]. A very recent study conducted by Bissel and Becker [10] on data collected in 2022 among the Freie Lastenräder users in Germany shows a much higher proportion of female users (42.8%), indicating that cargo bike sharing has spread among women in Germany. Becker and Rudolf [13] show that 31% of users are in households with children, 25% are couples without minors, 22% with roommates and 17% are one-person households. 51% of users are couples with children in the Swiss sample. Users are also characterized by a high proportion with a high level of education [14,15]. They also declare being concerned by the environment: 92% are rather or very concerned about climate change, 84% about air quality [16].

Trips made with shared cargo bikes also seem to have particularities compared with the use of privately owned cargo bikes. In their literature review, Carracedo and Mostofi [7] compare the daily distances traveled with privately owned cargo bikes in three different studies and report an average daily distance of 4.5 km [17] compared to 14.57 km using shared cargo bikes [15]. Despite being relatively close, these values could indicate that privately owned cargo bikes are used for shorter distances than shared cargo bikes. For shorter distances, the effort of booking and collecting a shared cargo bike can act as a barrier. Users must first find an available bike, make the booking, travel to the host station to pick it up, and then travel back from the station after dropping off, whereas it is much easier to use a privately owned cargo bike parked close to home.

Regarding trip purposes, previous research on shared cargo bikes showed that they are mostly used to transport things, such as groceries and bottle crates, but also hardware store/materials and furniture. Transporting children is also an important purpose [16]. In their Swiss sample, Becker and Rudolf [16] show that 50% of users have used the cargo bike sharing system for shopping/errands and 33% to transport children. Trip purposes with privately owned cargo bikes seem different, with even more trips transporting children, particularly to kindergarten and school, as well as trip to work [17,18].

When looking at studies on shared micromobility in general, results revealed that these services seldom replace car trips and mostly substitute sustainable transportation modes such as walking or taking public transportation [19,20]. In their literature review, Teixeira et al. [20] examine 19 studies and estimate that the median percentage of respondents substituting car trips with bike sharing was 10%, compared to 70% when looking at public transport and walking trips. Likewise, bike sharing appears to have little impact on car ownership, and in fact bike sharing users tend to have higher rates of car ownership on average [21]. However, cargo bikes and cargo bike sharing have a much higher potential to not only replace car trips [22] but also reduce car ownership [10,11]. In the study conducted by Becker and Rudolf [13], 45.6% of shared cargo bike users would have used a car alternatively, compared to 27.7% who would have travelled by bike, 9.6% by public transport, 3.3% on foot and 12.8% who wouldn't have made the trip. But as far as we know, no research has investigated the critical factors favoring the replacement of car trips by shared cargo bikes.

In terms of cargo bike sharing operating models, current offers rely on different principles: commons oriented (like the Free cargo bike-sharing in Germany and Austria), profit-oriented (such as Carvelo in Switzerland), public service-oriented run by municipal companies, etc. [13]. As the name suggests, the Free cargo bike sharing has no user fee, but donations are encouraged, whereas Carvelo requires booking fees (5 CHF for users without subscription and 2.50 CHF for those with subscription) and hourly rates (3.50 CHF for users without subscription and 1.75 CHF for those with subscription, free during night hours).

Halfway between sharing and owning are leasing offers, as launched by the Norwegian company Whee! with a monthly payment between 1700 and 2200 NOK [23]. Little is known about the profitability of the different operators as well as about users' willingness to pay a financial contribution for using such services.

To understand what users value in such a mobility service, and to investigate the features potentially making shared cargo bikes a valued alternative to cars, this paper adopts an original approach by modelling users' WTP. WTP has recently been studied for cargo bikes used by commercial transport operators. The WTP values "provide insights into the monetary value the respondents placed on various attributes and factors related to the choice between the cargo bike and car options" ([12], p. 11). WTP can be defined as the amount that must be subtracted from a person's income to keep utility constant when receiving a good, where utility is a function of income, quantity and price of the good (including alternative goods that can replace the good in question) and individual characteristics [24]. Song et al. [25] studied bike sharing users' WTP according to perceived value theory, where perceived value is defined as "the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" [26] (p. 14). In other words, perceived value is a trade-off between the received benefits (generally including usefulness, ease-of-use and entertainment) and perceived sacrifice (which includes the risk and costs in terms of money, time, effort and energy) [25]. To our knowledge, there is no previous research on users' WTP for private cargo bike sharing.

In light of previous research conducted, our work is driven by the following questions: what features of a cargo bike sharing service are perceived as most valuable for the users? What are the critical factors to make it an attractive alternative to car use? How would the implementation of a fee impact the number of car trips being replaced by the service?

3. Methodology

The research presented in this paper is part of the EU project Urban Logistics as an on-Demand Service (ULaaDS) and concerns one of the pilots conducted in the city of Bremen, Germany consisting of a cargo bike sharing system called Fietje. After a brief introduction of the service, the data and methods are presented.

3.1. Fietje: Bremen Cargo Bike Sharing System

Fietje is the free cargo bike project initiated by the General German Bicycle Club (ADFC) Bremen. Fietje operates 13 cargo bikes (4 electric), hosted by shops, organisations, or coffee shops located in different areas of the city. Most host stations are open 6 days a week and all of them are closed on Sundays. All persons registered on the Fietje website can book a bike online. While bike sharing networks often offer short-term rental from one station to another [19], Fietje cargo bikes can be borrowed for one to three days. Fietje cargo bikes also need to be dropped off at the station where they were picked up during opening hours. The available bikes are bakfiets models, meaning they are two-wheeled cargo bikes with a large basket in the front (cf. Figure 1). Loaning a bike is free of charge and the maximum load for the bikes is 80 kg.

Data from the booking system was collected from 13 stations over a year. 10 of the stations were in operation the entirety of 2022, whereas 3 stations started operating at different points during the analysis period. Looking at data, the Fietje bikes saw an average utilisation rate (days booked per month) of 77% across 13 stations. This figure is based only on the months in which a station was in full operation. A total of 1542 bookings were registered in 2022, corresponding to 2988 days booked.

Figure 1. Example of the type of cargo bikes used in the Fietje service. Photo: Howard Weir.

To determine the potential of the service for an entire year, we can estimate the total number of days booked if all the stations were in operation:

$$0.77 \times 365 \text{ days} \times 13 \text{ stations} = 3654 \text{ days booked}$$

The annual operating costs for the two models were reported by ADFC as being EUR 1200 and EUR 1567 for the regular bikes and e-bikes respectively. This cost includes service, repairs, advertising, insurance and staff hours. The bikes themselves cost between EUR 2000–7000, again depending on the model of bike.

3.2. The ADFC Survey

In the context of the ULaaDS project, we have access to data from a survey carried out by ADFC among all persons registered on their website in November 2022. All registered persons (2886) received the link to the online survey by e-mail. 505 users opened the survey link whereas 351 completed the survey, among which 30 respondents reported never having used a Fietje cargo bike. To conduct the analysis presented here, these respondents have been removed from the database to only consider answers from actual users of the bikes. The database was then composed of 321 respondents.

The questionnaire was designed by ADFC, and the authors of this paper were not involved in the process. It contains 18 questions: the two last questions were open-ended questions and are not analyzed in this paper, the other questions are in multiple-choice or Likert scale format and are part of the analysis. The questionnaire covers 8 categories: (1) Usage behavior (trip purpose, distance, type of parking area, frequency and location of bookings); (2) Alternative transportation mode; (3) Motivations to use the service; (4) Intention to buy a cargo bike; (5) Willingness to pay for using the service; (6) Satisfaction with using the service; (7) Preferences in terms of cargo bikes (model and motor support); and (8) Socio-demographics (gender and age). In multiple-choice questions, the possibility to answer "other" was often offered, together with an open field. The answers given in these open fields have been read carefully and recoded in one of the other options when relevant. The originality of the survey was to include a question on users' WTP, the analysis of which can provide useful insights into the key features of a cargo bike sharing service.

Based on the available demographics, the sample is consistent with the literature. Users' age appears to be quite spread among age categories, with more users aged between 30 and 40 years old (cf. Figure 2), which is similar to previous research [14–17].

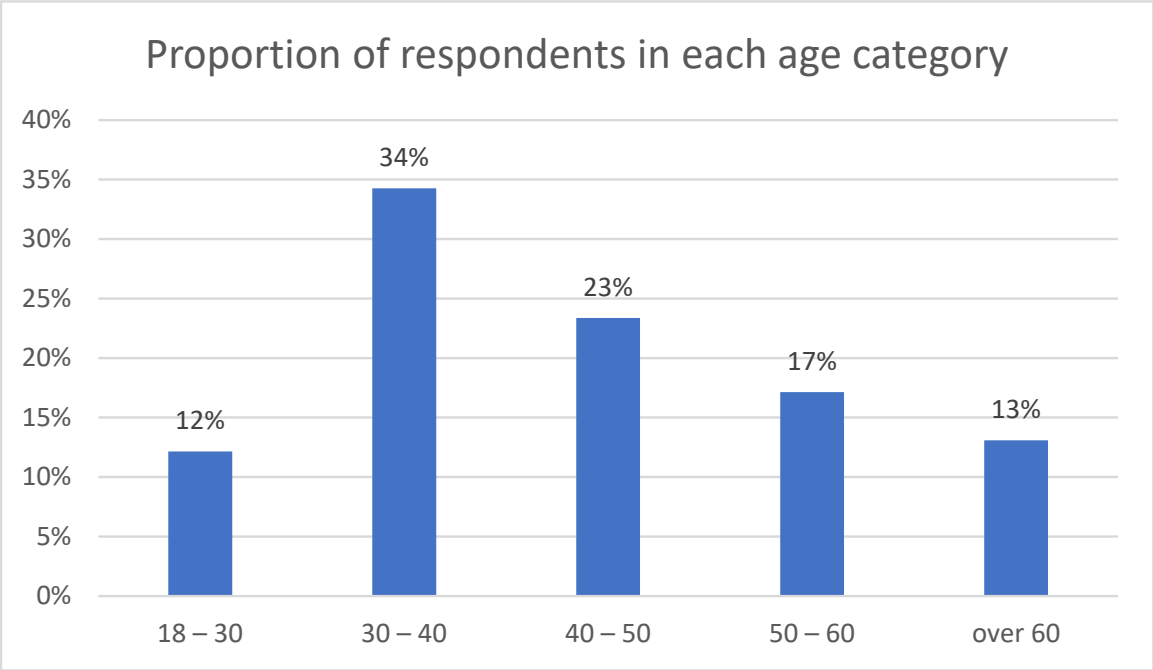

Figure 2. Age of Fietje users (source: ADFC survey, 2023).

In terms of gender, the sample shows a slightly lower percentage of women than men (45% to 51%). In comparison with previous studies, this proportion of women is the highest, confirming the tendency observed by Bissel and Becker [10] in the recent survey realized among the Free Cargo-bike sharing users, where 42.8% of users were female, indicating that cargo bike sharing is becoming increasingly popular for women. Fietje users also seem to be very much concerned by climate change since their main reported motivation to borrow cargo bikes is "because I want to make my journeys in a climate-friendly way", with 96% of respondents agreeing to it, which confirms previous observations [16].

3.3. Methods

In this paper, we are studying the factors explaining whether users were willing to pay to use the service or not. So, the variable to be explained is the "user's willingness to pay" variable (yes/no). As this variable is binary, a logistic regression was used to model it, using the software RStudio 2023.12.0+369, and the glm() tool. This statistical method makes it possible to assess which variables impact users' perceived value for the service by monitoring how one explanatory variable affects another and thus to evaluate the effect of each explanatory variable "all other things being equal". The tested explanatory variables are summarised in Table 1. To test the collinearity between explanatory variables, we calculated the variation inflation factors (VIF). They are all between 1.02 and 1.25, which shows that collinearities are limited.

Table 1. Tested explanatory variables in the WTP model.

Variable	Modality	Variable Type
User's gender	Man Woman	Categorical
User's age	18–30 years 30–40 years 40–50 years 50–60 years Over 60 years	Categorical
Trip purpose	Transport children Transport bulky items Go on a trip Weekly shopping Transport animals Try out a cargo bike	Dummy Dummy Dummy Dummy Dummy Dummy
Distance	Under 2 km 2–5 km 5–10 km 10–30 km Over 30 km	Categorical
Alternative transportation mode	Private car Public transport On foot By bike Car sharing No trip done	Dummy Dummy Dummy Dummy Dummy Dummy
Motivation to use a shared cargo bike	Because it is free Because it is near me Because I wanted to try out a cargo bike Because I want to make my journeys in a climate-friendly way Because it was the most practical means of transport for my purpose	Categorical (Likert scale) Categorical (Likert scale) Categorical (Likert scale) Categorical (Likert scale) Categorical (Likert scale)
Reasons why no intention to get a privately owned cargo bike	Because too expensive Because rarely used Because I don't have a place to put it safely Because for me the idea of sharing is crucial Because I already own one	Dummy Dummy Dummy Dummy Dummy
Satisfaction level	Related to the booking process Related to contact with the rental station Related to the ride and handling	Dummy Dummy Dummy
Regular donations	Yes/no	Dummy
Need for motor support	Yes/no	Dummy

Descriptive statistics and cross-tabulations with chi-square tests were also carried out with specific variables. The results presented in this paper are partially based on a preliminary analysis described in the ULaaDS project deliverable 5.5 [27].

4. Results and Discussion

To better understand what factors are valued by the users of the shared cargo bikes, we present the results of the WTP model in Table 2. It appears that most Fietje users (71%) are willing to pay a fee for using the service. Logically, the higher the value, the smaller share of users willing to pay:

- 55% are willing to pay up to EUR 5 per borrowing day (but not more than EUR 5);

- 14% are willing to pay up to EUR 10 per borrowing day (but not more than EUR 10);
- 2% are willing to pay up to EUR 20 per borrowing day.

Table 2. The willingness to pay for renting a shared cargo bike sharing model.

Variables		Coefficient	Standard Deviation	Z Value	Significance	% Total Sample
(Constant)		2.55	0.76	3.36	*** [1]	
Uses Fietje because it is free (ref: disagree or strongly disagree)	Strongly agree	−2.65	0.76	−3.47	***	54%
	Agree	−1.53	0.78	−1.96	*	35%
Alternatively, would have used his/her private car (ref: no)	Yes	−0.56	0.27	−2.03	*	36%
Has no intention to buy a cargo bike because rarely use it (ref: no)	Yes	1.03	0.40	2.60	**	20%
Has no intention to buy a cargo bike because the idea of sharing is crucial (ref: no)	Yes	−0.92	0.47	−1.96	*	8%
Used Fietje to transport animals (ref: no)	Yes	1.41	0.82	1.73	·	4%
Used Fietje to transport children (ref: no)	Yes	0.73	0.31	2.36	*	37%
Used Fietje to transport bulky items (ref: no)	Yes	0.71	0.31	2.31	*	39%
N	321					
ρ^2	0.14 [2]					

[1] The asterisks indicate the significance level: · corresponds to a p-value $\leq$ 10%; * to a p-value $\leq$ 5%; ** to a p-value $\leq$ 1%; *** to a p-value $\leq$ 0.1%. [2] "ρ^2 is the empirical proportion of information in the choice data (as defined by the benchmark null case) that is explained by the model" [28] (p. 61).

The completed logistic regression shows that for a user, the probability of being willing to pay is higher if:

- the purpose of the cargo bike trip is to transport bulky items, children or animals.
- the user has no intention to buy a cargo bike because of infrequent use.

And it also shows that the probability of being willing to pay is lower if:

- the user would have used a private car alternatively to the cargo bike.
- the user has no intention to buy a cargo bike because the idea of sharing is crucial.
- the user agrees or strongly agrees with the fact that a motivation to use the service is because it is free.

Gender and age were not significantly correlated to the WTP in the model. Unfortunately, other sociodemographic characteristics such as education level or professional category were not available in the database but could be interesting to test. Users who do not intend to buy a cargo bike "because the idea of sharing is crucial" have a lower probability of being willing to pay to use the service. We can interpret this result as meaning that these users consider that sharing goes together with free service and do not want to pay to use a shared mobility service.

When it comes to motivations, the only one to have a significant correlation with the WTP in the model is "because it is free", which seems rather evident. Other motivations do not appear to be correlated to the WTP "all other things being equal". When looking at users answering that they use the service to make journeys in a climate-friendly way, their willingness to pay is similar to that of users who disagree with the statement. This motivation is not characteristic of users who are willing to pay, which explains why it does

not appear as statistically significant in the model. The motivation "because it was the most practical means of transport for my purpose" does not appear to be correlated to WTP in the model but the cross tabulation still shows some correlation. Because of a low response rate for the answer "strongly disagree", it is not possible to evaluate the statistical significance of the relation. However, the figures still indicate that the more users agree that a shared cargo bike was the most convenient solution, the more willing they are to pay (cf. Table 3).

Table 3. Level of agreement to the affirmation "I used Fietje because it was the most practical means of transport".

	Strongly Agree	Agree	Disagree	Strongly Disagree
Willing to pay	74%	72%	66%	30%
Not willing to pay	26%	28%	34%	70%
Total	100%	100%	100%	100%
N	148	123	50	10

We see two primary explanations for as to why this variable does not appear in the WTP model: the low response rate for the answer "strongly disagree" is the first one. The second reason lies in the fact that the variable has some collinearity with other variables in the model, such as the use of use a private car as an alternative for some trip purposes. Given the fact that previous studies [29,30] show that shared mobility services are valued by users because of their convenience, we can suppose that with a bigger sample and/or with a survey design where respondents would have to choose only their main motivation, we could better isolate the effect of the convenience motivation on WTP in the model.

Moreover, our results show that shared cargo bikes have a strong potential to reduce car trips. Indeed, among the alternative transportation modes tested in the model, only private car is correlated with WTP: users who would have used their private car instead of the shared cargo bike are less willing to pay than others. This is an important result because it implies that establishing user fees would result in less participation from users substituting private car trips with cargo bikes. The fact that cargo bike sharing is free is key in its potential to replace car trips.

When looking at what users report when asked about the transportation mode the cargo bike replaced (cf. Figure 3), 36% answered they would have used a private car and 21% answered they would have used car sharing, with some choosing both and some answering other reasons in addition, as respondents could choose several answers. Using the above, we obtain a range of car trips avoided for between:

- 38% of respondents who answered that they would have used the car (private or shared) and do not answer any other possible alternative.
- 55% of respondents choosing "private car" or "car sharing" and possibly other reasons (among them those who would not have necessarily used a car if they had not used the cargo-bike because they might have answered another possible alternative transportation mode such as public transport).

This means that, as reported by users, between 38–55% of Fietje cargo bikes trips have replaced car trips. This result is in line with what Becker and Rudolf [16] found (45.6%) in their survey (where only one answer was possible) and generally adds to the evidence that shared cargo bike services are effective at replacing car trips.

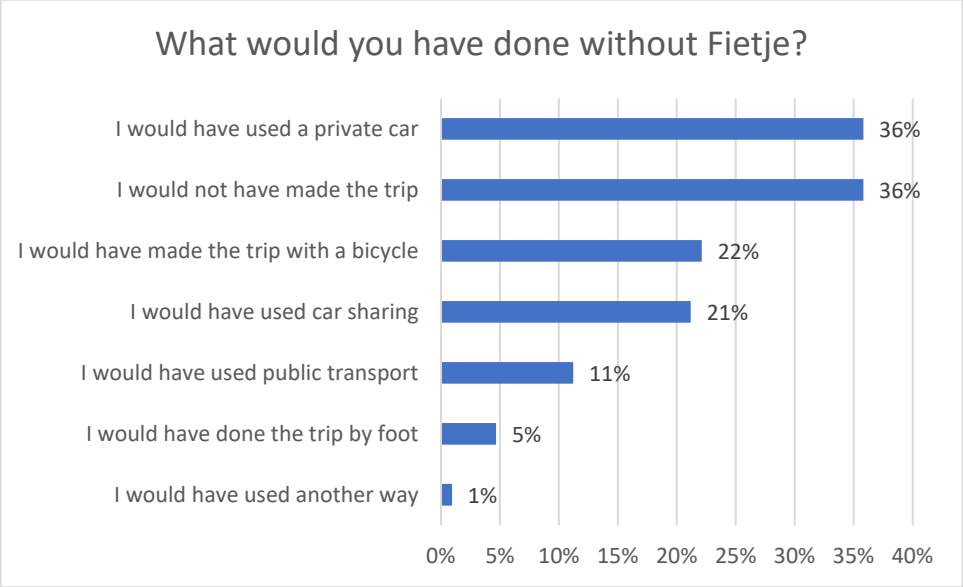

Figure 3. Proportion of respondents choosing each alternative transportation if not cargo-bike (source: ADFC survey, 2023; several answers possible).

In addition to being valued by those who would have otherwise used their car, the use of shared cargo bike is also appreciated by users for some specific trip purposes for which the use of a car is typically convenient. Trips purposes correlated to the WTP correspond to the transport of bulky items, children or animals. Other purposes (trying out a cargo bike, go on a trip, weekly shopping) are not correlated to users' WTP "all other things being equal". Users value the use of a shared cargo bike the most when they need to transport things and show a greater willingness to pay for a service that facilitates this type of trip. Transporting bulky items and children are reported as two of the most common reasons to use the Fietje service (cf. Figure 4), and according to the WTP model, show the greatest potential for reducing car trips.

These results need to be put in perspective with the fact that Fietje cargo bikes can only be borrowed for a minimum of one day and a maximum of three days, so neither for short periods nor for long-term bookings. In addition, some stations had very high utilisation rates (up to 92% of days booked), causing a lack of availability and that users anticipate their need for a bike in advance. This suggests that "transporting children", which is an important trip purpose for Fietje users, probably doesn't cover the daily trip to school, but other kinds of trips that are more occasional. Similarly, shopping trips made with the shared cargo bikes are probably occasional trips, maybe to a special shop further away than the usual one. In the same vein, leisure trips made with Fietje bikes are possibly occasional and do not cover routine household activities. Unlike private cargo bikes that are used for daily trips to work or kindergarten [17], shared cargo bikes are mostly used for occasional purposes, meeting different mobility needs for users. The figures reported by the Norwegian leasing company Whee! support this result, since 88.7% of their users use the cargo bikes daily [31].

This is also sustained by the distances travelled reported by Fietje users: most of them (37%) answered between 5 and 10 km. 32% answered between 10 and 30 km and 19% between 2 and 5 km. Cargo bikes are rarely borrowed to travel very short or very long distances: only 3% travelled less than 2 km, and only 9% of respondents travelled more than 30 km. With privately owned cargo bikes, users likely take more short trips as they can more easily use them for daily trips to school or work [17].

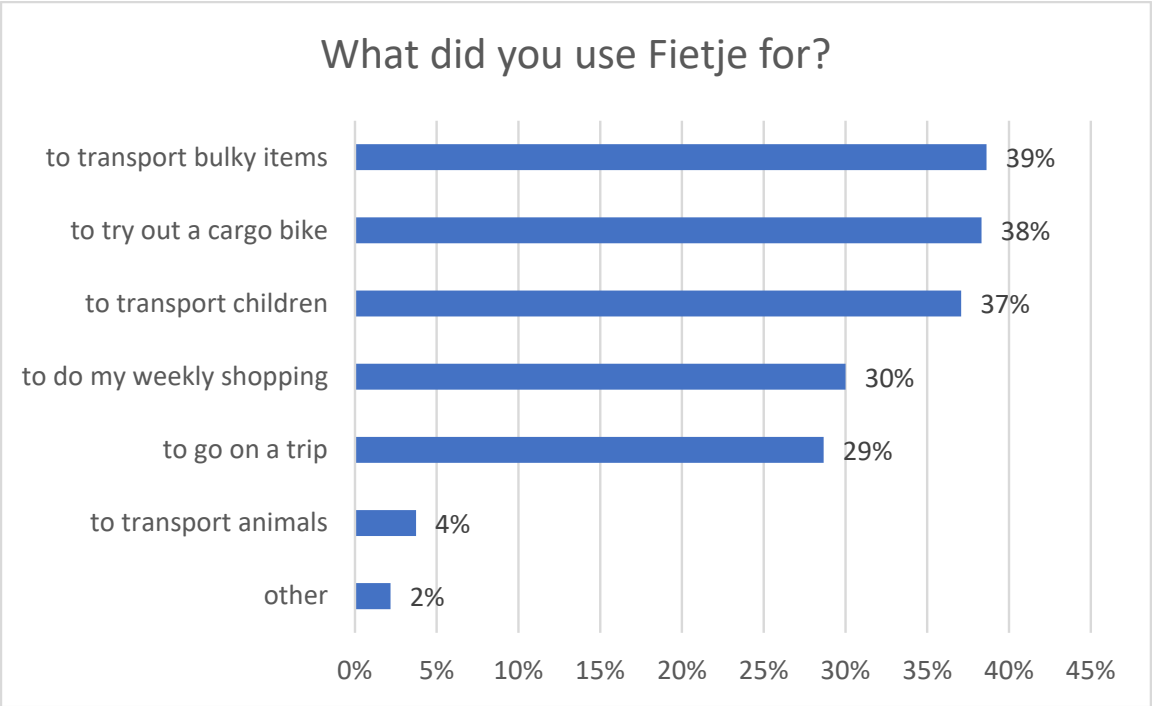

Figure 4. Proportion of respondents choosing each trip purpose (source: ADFC survey, 2023; several answers possible) Note about the figure: When asked about the trips' purposes using the shared cargo bikes, Fietje users could choose several answers. In total, the 321 respondents gave 572 purposes, indicating that users borrowed a bike for more than one reason. Due to the lack of precision of the survey questions, it is not possible to determine whether different trip purposes were associated in one booking or correspond to several bookings. As it was possible to keep the bikes up to three days, several purposes were most probably associated with one booking, which is consistent with previous research [13].

The model confirms the relatively low frequency of use for the shared cargo bikes. The correlation between the WTP and the variable "Has no intention to buy a cargo bike because rarely use it" shows that the shared cargo bikes are valued for occasional transportation needs. Otherwise, users would invest in their own cargo bike rather than paying for using a shared vehicle.

Among the cargo bike sharing users, 30% are planning to buy their own (cf. Figure 5), which is similar to the 35% found by Becker and Rudolf [13], on their sample. It represents a significant share of Fietje users, but it also means that borrowing a shared cargo bike as a temporary solution before buying their own does not concern most users. On the contrary, a large share (67%) of users do not plan on buying their own cargo bike. The main reasons are the price (21%), infrequent use (20%) and the lack of suitable storage (17%). Cargo bike sharing is a solution for those who cannot afford buying or storing one. But what is interesting is that it is also a mobility service useful to some households for occasional use, indicating that cargo bike sharing is expanding the range of mobility options households have. Our results show that 36% of users would not have made the trip if they had not borrowed a cargo bike (cf. Figure 3). Cargo bike sharing increases the travelling possibilities for users and makes possible trips that would not have been made otherwise which means that this mobility offer is complementary to other mobility options available to people.

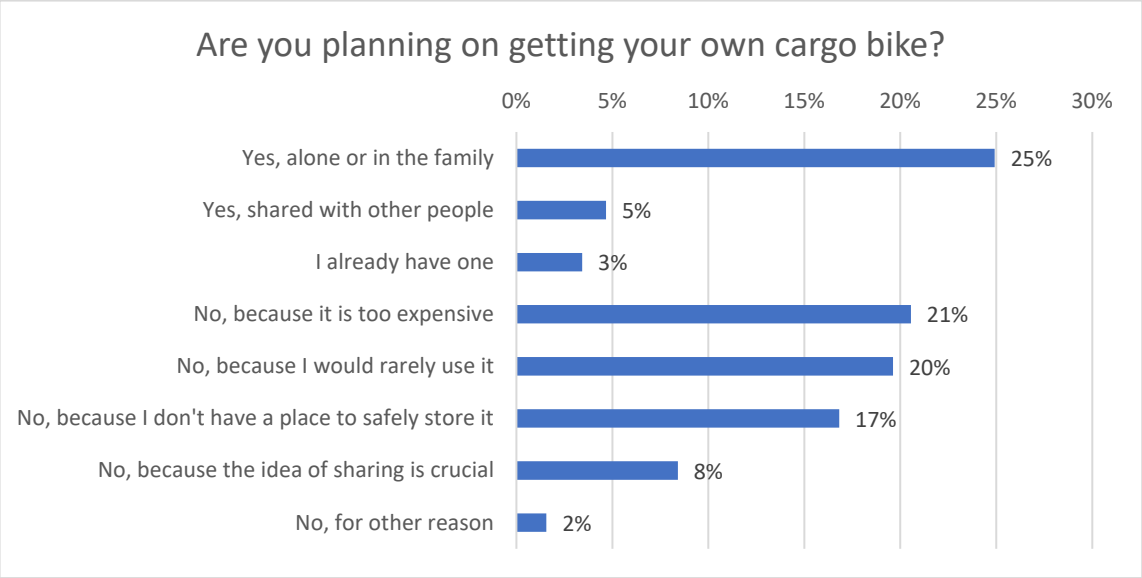

Figure 5. Users' intention to buy a cargo bike (source: ADFC survey, 2023) Note about the figure: The answer "I already have one" was not offered in the questionnaire and has been created and recoded based respondents who answered "no, for other reason" and added an open comment saying that they already had their own private cargo bike.

Considering the stated WTP of survey respondents, the service in its current incarnation could almost cover its costs if a daily fee were to be introduced. If we apply the average booking rate of 77%, we get 281 days booked per station annually. Assuming a fee was collected from all users that reported a WTP, at the maximum level they were willing to do so, then it would be possible to collect EUR 1278.55 per station. This is just shy of ADFC's reported operating costs of EUR 1286 for normal bikes but falls a bit further short of the EUR 1567 reported for the electric bikes. However, implementing a fee would also reduce the number of car trips avoided, since users not willing to pay would stop using the shared cargo bikes and would instead use their alternative transportation mode or not travel at all.

30% of current users are not willing to pay and would stop using the service were a fee to be introduced. Among them:

- 47% would use a car (private or shared) and do not have any other possible alternative.
- 60% would use a car (private or shared) or possibly other alternative transportation mode.

This would result in additional car trips corresponding to between 14 and 18% of the total number of trips provided by the sharing service. In the case of Fietje, implementing a fee would result in 515 to 658 additional car trips per year, if we consider that the service is booked 3654 days a year and that each booked day corresponds to a trip.

In addition, among users who are not willing to pay, 32% would not make the trip at all.

5. Conclusions

This paper aims at better understanding cargo bike sharing users' preferences through an original approach. By modelling users' WTP with a logistic regression, the results provide insights on the shared cargo bikes features valued by users "all other things being equal". The results help better understand the potential of cargo bike sharing services for replacing car trips and further supports the findings of existing research that have considered shared cargo bike services in other cities. In the case of this study, between 38–55% of trips carried out using the shared service would otherwise have been performed by cars. An important result is that users who would alternatively have travelled with their

private car are less likely to be willing to pay to use the service. This highlights the fact that the gratuity of the service is a critical factor for making people replace car trips with shared cargo bikes. The paper provides insights into the trip purposes where the use of a cargo bike is particularly appreciated by users. Indeed, for transporting bulky items, children and pets, users are willing to pay a fee, showing the value the service has for accomplishing these specific trips. Our results indicate that these trips are most likely occasional and not part of users' daily routines. Users would otherwise prefer to buy their own cargo bike instead of sharing one. As a car is a reasonable alternative to perform these types of trips, the results show that the availability of shared cargo bikes can be an effective tool to reduce car trips by giving additional options to those with access to a private vehicle. These usage patterns can also be interpreted as a preference of car owners to use cargo bikes for certain tasks, since they are making an active choice to use a cargo bike when they have a suitable alternative available.

Our conclusions are particularly useful for cities who want to implement a cargo bike sharing scheme. If the policy goal is to substitute car trips, for example for transporting things occasionally, offering a low-cost or free service is crucial to attract users who already have a car at their disposal. Cities should explore different funding mechanisms and business models to encourage the expansion of cargo bike sharing services. We see that reported operational costs (EUR 1200–1567) are a significant proportion of the bike's overall costs (EUR 2000–7000), which suggests that subsidies or funding mechanisms to support the expanded use of cargo bikes should not only target purchase price, but also support their continued use. For example, supporting leasing of cargo bikes with service agreements could potentially lower barriers for use related to initial costs and maintenance.

From a city planning perspective, shared cargo bikes also have the potential to reduce the need for more parking spaces adapted to cargo bikes, which is also relevant for users as finding suitable parking spaces for cargo bikes has been reported to be difficult [32]. More generally our results provide useful insights to cargo bike sharing operators: knowing that users value the service mostly for transporting things, it can help them choose cargo bikes models best suited to these purposes and adapt their business models to users' preferences.

With regard to limitations and areas of future research, our paper would have benefited from integrating more demographics in the analysis. Education level, professional category, and household structure would have been particularly interesting. In addition, it would have been interesting to have some location data about where the cargo bikes were travelling when in use during the trial which would have provided more detailed information about number of trips, distances, stops, etc. There is also a limited understanding about the types of car trips that are being replaced and the overall societal value that the replacement of those trips provides for city residents. Looking at different models for implementing the service, booking times, fee structures, etc., could also yield interesting results. As all papers on cargo bike sharing rely on data collected in Germany, Austria and Switzerland, other contexts should be investigated in future research.

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