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Reject or Embrace? Messengers and Electric Cargo Bikes

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Abstract

One of many approaches to react to the challenges faced by urban freight can be the introduction of electric cargo bikes as an environmentally friendly mode of transport for courier deliveries. Since this market consists of highly decentralized decision-making structures, it is important to characterize the individuals involved and their perceptions in order to estimate market potentials and identify barriers to market uptake. To achieve this goal, we use information from a nationwide survey to draw a picture of the messengers involved as well as to model a binary decision of innovation rejection. The results indicate a group of people close to the general population but with certain particularities regarding gender, education and work style. Their attitudes towards technology are rather positive but their actual adoption of electric cargo bikes shows a much more heterogeneous pattern based on socio-demographics, job circumstances and personal characteristics.

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Keywords: courier logistics; electric cargo bikes; technology adoption; binary logit

1. Introduction

Like every other area of passenger and goods transport, urban freight is facing the challenges of ever-growing demand and increasing scrutiny towards its negative externalities. Local and climate emissions, noise and safety are becoming the focus of a search for improvements and alternatives to “achieve essentially CO2-free city logistics in major urban centers by 2030”, as formulated by the European Commission Whitepaper (EC, 2011). In order to achieve these goals, cities need to push forward their transformation exploring new ways of organizing goods transport as well as wholly new transportation modes.

One possible contributor to more effective and environmentally friendly city logistics schemes is the use of cargo bikes for the last mile of deliveries (Holguin-Veras et al., 2014; Browne et al., 2011; Lenz & Riehle, 2012), often enhanced by electrically assisted drivetrains. Cargo bikes possess many advantages for commercial use, like low operating cost, less driver fatigue, higher payload, and environmental benefits (Transport for London, 2009),

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rendering them especially suitable for courier logistics with a high share of small-scale short distance shipments in metropolitan centers or when embedded in innovative logistics systems such as micro-consolidation centers (demonstrated in London by Leonardi et al., 2012) or mobile depots (e.g. in Brussels as shown by Verlinde et al., 2014). In Paris, an increasing number of innovative companies are starting to use cargo bikes for short-distance deliveries (Dablanc, 2011), resulting in strong growth of this currently niche market (Koning and Conway, 2014). The exact market size remains unclear, mostly due to incomplete statistics about two- or three-wheelers used for freight transport. Among the 3.8 million bicycles sold yearly in Germany, the number of electric cargo bikes can only be estimated around a 4-digit number (ZIV, 2013).

In order to explain the current market situation as well as to estimate its future potential, several assessments (Verlinde et al., 2014; Maes, 2015) have shown a repeating pattern: Cargo bikes prove to be a reliable and climate-friendly alternative to LCVs, but are little embraced by companies due to their unfavorable economics. While a total welfare approach including externalities would yield a positive net worth of electrification, a business economics perspective without including externalities shows up the well-known challenge of electric drivetrains, as their higher investment and setup expenses is not offset by the lower variable cost per kilometer. Hence, other motivations appear to be complementary in the decision to adopt electric vehicles.

This adoption process has been the focus of interest in many studies concerning electric vehicles in general. Most studies concentrate on private passenger cars (a comprehensive overview is given by Plötz et al., 2014), while commercial transport is under-represented (Globisch et al., 2013). Wolf and Seebauer (2014) investigated the adoption of electric bicycles by private households, employing the meta-theory UTAUT (unified theory of acceptance and use of technology, introduced by Venkatesh et al. (2003) for IT diffusion), which brings together 8 previous adoption theories, including the Theory of Planned Behavior (Ajzen, 1991), the Technology Acceptance Model (Davis, 1993) and the Diffusion of Innovations Theory (Rogers, 2003).

Regarding freight transport, Roumboutsos et al. (2014) apply a Systems of Innovation approach to estimate the potential of electric vehicles in city logistics and highlight the importance of well-organized local political actors and their networks. Laugesen (2013) compiled the results of 60 freight-oriented electric vehicle demonstration projects in the Baltic states. Cargo bikes are rarely the main focus of these urban freight demonstration projects, but sometimes accompanying modules (e.g. retail deliveries by cargo tricycle in Hasselt, Belgium and postal deliveries in Brussels, Belgium). Van Duin et al. (2013) focus on the simulation of electrification effects in city logistics. They apply a Fleet Size and Mix Vehicle Routing Problem with Time Windows (FSMVRPTW), finding that electric vehicles are generally capable of improving efficiency while strongly reducing externalities. Furthermore, the perspectives of different stakeholders (such as drivers, shift managers and dispatchers, customers or neighbors to costumers) are important for the assessment of innovations in courier and parcel logistics (Ehrler and Hebes, 2012).

Commercial fleets are seen as crucial for alternative vehicle uptake, as single decision-makers can impact the procurement not only of their own vehicle (as in private car markets) but large fleets comprising of many vehicles (Globisch et al., 2013). Sierzchula (2014) identified the interest in innovative vehicle technology as the main EV-adoption motivation for fleet managers, with only secondary complements seen in lowering environmental impact, receiving government grants and improving the company’s public image.

As introduced by Nesbitt and Sperling (2014), fleet decision-making processes can be distinguished alongside two main dimensions: formalization and centralization. Formalization refers to the level of rules and procedures guiding the decision process. Centralization refers to the number and independence of decision-makers involved. Based on these dimensions, the authors derive four main structures of fleet decision-making: Hierarchic (high formalization and centralization), bureaucratic (high formalization, low centralization), autocratic (low formalization, high centralization) and democratic (low formalization and centralization). In Germany, a common form of operating a courier logistics company is without employed drivers, but with freelance messengers who are contracted on a commission basis, operate their own vehicles (normally bicycles, cars, or vans). Consequently, vehicle procurement and use decisions are made in a decentralized fashion by a heterogeneous group of individual messengers (Gruber et al., 2014) and the common definition of a firm’s vehicle fleet might only be applied with caution. If done so, it would be attributed to the democratic fleet decision-making category, which according to Nesbitt and Sperling (2014) was the least common type but seen as an interesting case for alternative fuel vehicles.

In this paper, we want to contribute to the understanding of alternative vehicles adoption in city logistics by an in-depth analysis of a stakeholder group bearing high importance for the decision process but receiving limited academic attention: the individual messengers.

2. Project context, data and methods

2.1. Electric cargo bikes for courier logistics in Germany

This analysis was conducted among messengers within a two-year fleet trial of 40 electrically assisted cargo bikes, funded by the German Federal Ministry for the Environment as part of the National Climate Initiative (project name: “Ich ersetze ein Auto”, i.e. “I substitute a car”).

The project vehicles (type “iBullitt”, see Fig. 1) offer a cargo box with approximately 200 liters of storage space between handlebars and front wheel. With battery capacities between 16 and 32 Ah and a maximum payload of 90 kg, these vehicles are capable of covering usual work loads of messengers (some 100 km daily).

Fig. 1. A messenger riding one of the electric cargo bikes used in the fleet test (photo source: Amac Garbe / DLR).

The electric cargo bikes were successfully deployed in the daily routines of courier logistics providers in eight major German cities. The vehicles were used continuously and with increasing success. During the 21 months of observation, around 127,000 shipments were carried out by messengers using the project vehicles, accounting for 8% of all shipments of the participating companies. The vehicles were used for approximately half a million kilometers in operational business.

This paper uses empirical data from two surveys. The eight courier companies have sent out invitation links to all approximately 600 (mostly freelance) messengers working for them to participate in the survey. The sample contains 362 answers: The 1st wave (t0, May 2012, return=191) was conducted before vehicle dissemination, the 2nd wave (t1, April 2014, return=171) 21 months after vehicle dissemination.

In order to assess the future market potential of electric cargo bikes, we find it necessary to characterize in detail this under-examined professional group in terms of socio-demographics, job circumstances and personal characteristics, including how they differ from the general population.

2.2. Rejection analysis

A second angle of our investigation is the factors leading to the rejection or embracement of electric cargo bikes by individual messengers. Contrary to the well-known approach of modelling technology acceptance, whose intensity in our case can vary between enthusiasm and passive non-opposition (especially during the free provision of fleet test vehicles), rejection appears easier to assess. Hence, our target is to identify factors causing the rejection of electric cargo bikes for commercial use.

Table 1 shows the grouping of the rejection variable from answers in both waves to rejecters and non-rejecters. In t0, the rejecters showed no interest in participating in the fleet trial nor could they picture themselves using electric cargo bikes in the future. The latter also holds true for rejecters from t1; however, they might have tested the project bike prior to their decision.

Table 1. Building the variable "rejection of electric cargo bikes" out of the survey responses.

Wave	t0 (May 2012)			t1 (April 2014)						
n	191			171						
Participation in fleet test	Are you interested in testing the electric cargo bike "iBullitt" as part of a project?			Which degree of experience do you have with the electric cargo bike "iBullitt"?						
	Yes.	No.		I have no experience.		I have used it only for test rides.		I have used it regularly for my job, but I'm not using it anymore.		I have used it regularly for my job, and I'm still using it.
n	111	80		104		21		8		38
General interest	↓	Can you picture yourself using an electric cargo bike for your job in the future?								↓
		Yes.	No.	Yes.	No.	Yes.	No.	Yes.	No.	
n		17	63	31	73	12	9	6	2	
Rejecters	0	0	1	0	1	0	1	0	1	0

To model this binary rejection as a dependent variable, we employed a dichotomous discrete choice model (binary logit). This model has been successfully used up to the present day for many acceptance and adoption studies, in areas as diverse as energy (Liu et al., 2013), agriculture (Mariano et al., 2012), land use (Jongeneel et al., 2008) and especially transport (Holguín-Veras and Wang, 2011; Ye et al., 2012) and technology forecasting (Cheng & Yeh, 2011). Since we have applied the model in a classic and unmodified form, the reader is referred to Ben-Akiva and Lerman (1985) for details on the mathematical foundations.

Sixty-three messengers participated in both waves, resulting in two answers for each of these panel members. Our constructed dependent variable correlates with panel membership by a coefficient of only 0.034. We therefore decided for a pooled model using answers from both waves. As expected, a dummy for panel membership revealed no significance.

3. Results

3.1. Characterization of messengers in Germany

We observe that working as a freelance messenger in urban courier logistics differs considerably from an employed job as a driver in other logistics industries. External perception draws a homogenous or even stereotype picture of this professional group, especially of bike messengers (sporty, venturesome, ecologically aware, technology enthusiast). In contrast, while some attributes might be distributed homogenously, we found others to be very heterogeneous among the surveyed messengers. The detailed characterization is shown in Table 2.

Firstly, socio-demographic variables give an overview. The youngest of the 362 respondents of both survey waves was 18, the oldest 81 years old. We found a very similar age distribution (mean 42.6 years) to the German population (mean 43.9 years[1] in 2011). Half of the messengers earn a net income of between €1,001 and €2,000, while the German average is €1,685[2]. In contrast, the educational profile shows a stronger deviation compared to the whole population: While only 36% of the sample has a low (compulsory school) or medium (secondary school) level of education, the corresponding number for Germany is 68%[3]. However, the main point of distinction is gender with only 7% of the respondents being female. Courier logistics clearly is a male-dominated industry.

Secondly, several job-related variables deserve attention. On average, the respondents drive a total daily mileage of 144 km, out of which 104 km are billed to the customers as net shipment distance. Note that these numbers combine bike and car messengers of which the latter naturally tend to achieve higher total daily mileages.

Both working days per week and working hours per day show substantial difference to regular German job conditions, as only half of the respondents follow the classic working scheme of 5 days per week and 6.5 to 9 hours per day. Deviations in both directions stem from the possibility to work part-time or as an intensive temporary or seasonal job. This is also reflected by roughly a third following other professions beside the messenger job. Note that especially the bike messenger job is a viable option for students due to low entry barriers and flexible working conditions. The variety in work styles also causes a high fluctuation in part of the workforce, while on the other hand one third has 10 or more years of messenger experience.

Geographically, respondents originate mainly from 7 large German cities. Approximately following the distribution of the fleet trial vehicles to these cities, Berlin exhibits the largest share at almost 40% (17 out of 40 project vehicles), followed by the second largest German city Hamburg at 16%.

While bicycle ownership (75%) and car ownership (56%) closely follow the German figures (82% owning a bicycle[4] and around 43.4 million passengers cars[5] are registered by a population of 80.8 million[6] inhabitants), cargo bike possession (excluding project vehicles) stands out at around 8%. When asked for their preferred vehicle for courier logistics, we can see a roughly equal split between ICE and climate-friendly vehicles. About every fourth messenger stated having practical experience with cargo bikes which largely originates from testing one of the project vehicles.

Around half of the messengers visit their contracting courier company's site at least daily, e.g. in order to hand over shipments. Other messengers pass by their company's site on a more irregular basis, e.g. for administrative purposes. Courier logistics offer different types of consignments which show varying popularity among messengers. Overnight pick-up tours (milk runs) are clearly the least popular consignment type. Compared with this, half of the messengers prefer ad-hoc point-to-point consignments with shipment distances below 20 km.

Thirdly, we asked for personal attitudes. 9 out of 10 respondents expressed interest in vehicle technology. Regarding the perception of electric cargo bikes, the respondents show a very positive attitude (86% agreeing or strongly agreeing), seeing this vehicle type as suitable for city logistics, contributory for environmental goals, and attracting pedestrians' interest. While the perceived substitution potential is split between car and bike shipments, messengers are less sure about the long-term success of electric cargo bikes in courier logistics. The item with the most indecisive answer distribution is the sufficiency of available information, with roughly as many people agreeing as disagreeing and a large proportion of neutral answers.

In line with the observed patterns in working time, flexibility is the most important job-related aspect for the respondents, with which they are also highly satisfied. Further important factors include contact with clients and other people, day-to-day variety, taking exercise while working, and job income. While the latter shows average dissatisfaction, the others provide contentment. Less important job factors comprise ecological footprint, long-term

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[1] Source: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Bevoelkerung.html, reference year: 2011
[2] Source: http://de.statista.com/statistik/daten/studie/164049/umfrage/verfuegbares-einkommen-je-arbeitnehmer-in-deutschland-seit-1960/, reference year: 2013
[3] Source: http://de.statista.com/statistik/daten/studie/1988/umfrage/bildungsabschluesse-in-deutschland/, reference year: 2013
[4] Source: http://www.mobilitaet-in-deutschland.de/pdf/MiD2008_Kurzbericht_I.pdf, reference year: 2008
[5] Source: https://www.destatis.de/DE/ZahlenFakten/Wirtschaftsbereiche/TransportVerkehr/UnternehmenInfrastrukturFahrzeugbestand/Tabellen/Fahrzeugbestand.html, reference year : 2013
[6] Source: https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/Bevoelkerung/Bevoelkerung.html, reference year: 2013

job planning, being at the heart of the city, job image, and innovative technology use. The low average importance of the latter appears especially contradictory to the high interest in vehicle technology.

Table 2. Characterization of messengers in courier logistics (n=362).

SOCIO-DEMOGRAPHIC VARIABLES			
Age [years]	mean: 42.6, SD: 11.6		
Gender		*Net. income*	
Female	7.2%	Up to €1,000	36.5%
Education		€1,001 - €2,000	48.6%
Low/medium	35.9%	€2,001 and more	14.9%
JOB-RELATED VARIABLES			
Total driven daily mileage [km]	mean: 143.5, SD: 98.3		
Total daily shipment distance [km]	mean: 103.7, SD: 73.1		
City / Company		*Working days per week*	
Berlin	37.3%	1	5.0%
Hamburg	15.5%	2	6.6%
Munich	9.7%	3	11.0%
Nuremberg	9.7%	4	14.4%
Bremen	8.0%	5	54.4%
Düsseldorf	8.0%	6	6.1%
Leipzig	5.5%	7	2.5%
Other	6.4%	*Working hours per day*	
Vehicle ownerhip		up to 3 hours	2.5%
Regular bicycle	75.1%	3.5 to 6 hours	24.6%
(Electric) cargo bike	7.7%	6.5 to 9 hours	47.2%
Car or van	55.8%	9.5 to 12 hours	25.4%
Preferred vehicle for courier logistics		12.5 and more hours	0.3%
Regular bicycle	42.0%	*Profession beside messenger job*	30.4%
(Electric) cargo bike	9.7%	*Presence at courier company*	
Car or van	48.3%	several times per day	34.1%
Experience with cargo bikes	22.9%	daily	17.7%
Possibility to bundle shipments	50.0%	several times per week	29.0%
Working experience as messenger		weekly	11.8%
less than 1 year	12.7%	monthly	7.3%
1- less than 2 years	11.6%	*Preferred consignment type*	
2- less than 5 years	19.9%	Point-to-point shipments (up to 20 km)	49.7%
5- less than 10 years	20.7%	Point-to-point shipments (more than 20 km)	26.8%
10 years or more	35.1%	Overnight pickups	3.3%
		Regular tours	13.0%
		Other, e.g. value-added logistics	7.2%
PERSONAL ATTITUDE VARIABLES			
Interest in vehicle technology	90.1%		
General assessment of suitability of electric cargo bikes			
Using electric cargo bikes in my city makes sense.		*Electric cargo bikes attract pedestrians' interest.*	
Strongly agree	63.0%	Strongly agree	49.4%
Agree	23.2%	Agree	34.6%
Undecided	9.6%	Undecided	11.6%
Disagree	2.5%	Disagree	2.6%
Strongly disagree	1.7%	Strongly disagree	1.7%
Electric cargo bikes contribute towards environmental protection.		*Messengers on electric cargo bikes can take over tasks that have formerly been carried out by car messengers.*	
Strongly agree	53.3%	Strongly agree	44.7%
Agree	29.8%	Agree	31.7%
Undecided	8.9%	Undecided	12.9%
Disagree	4.6%	Disagree	5.9%
Strongly disagree	3.4%	Strongly disagree	4.8%

Messengers on electric cargo bikes can take over task that have formerly been carried out by bike messengers.		*Electric cargo bikes will generally prevail in courier logistics.*	
Strongly agree	40.7%	Strongly agree	25.2%
Agree	27.8%	Agree	29.9%
Undecided	17.7%	Undecided	28.1%
Disagree	8.7%	Disagree	12.5%
Strongly disagree	5.1%	Strongly disagree	4.3%
Sufficient information is available on electric cargo bikes and their usage.			
Strongly agree	9.4%		
Agree	23.0%		
Undecided	37.2%		
Disagree	23.6%		
Strongly disagree	6.9%		

Importance of and satisfaction with job-related aspects

Flexibility / time management				*Contact with my clients*			
Very Important	49.4%	Very satisfied	44.4%	Very Important	36.3%	Very satisfied	33.1%
Important	33.8%	Satisfied	38.2%	Important	33.0%	Satisfied	44.5%
Neutral	12.8%	Neutral	13.2%	Neutral	23.5%	Neutral	17.4%
Unimportant	2.8%	Dissatisfied	3.7%	Unimportant	5.0%	Dissatisfied	4.2%
Very Unimportant	1.1%	Very dissatisfied	0.6%	Very Unimportant	2.2%	Very dissatisfied	0.8%
Variety from day to day				*Contact with people*			
Very Important	31.7%	Very satisfied	29.5%	Very Important	29.0%	Very satisfied	31.5%
Important	36.1%	Satisfied	40.2%	Important	34.0%	Satisfied	42.7%
Neutral	26.4%	Neutral	25.8%	Ne utral	26.2%	Neutral	24.2%
Unimportant	4.4%	Dissatisfied	2.8%	Unimportant	7.7%	Dissatisfied	1.4%
Very Unimportant	1.4%	Very dissatisfied	1.7%	Very Unimportant	3.0%	Very dissatisfied	0.3%
Amount of income				*Taking exercise while working*			
Very Important	27.4%	Very satisfied	8.5%	Very Important	28.5%	Very satisfied	37.2%
Important	33.5%	Satisfied	20.9%	Important	28.8%	Satisfied	27.2%
Neutral	29.9%	Neutral	40.1%	Neutral	24.0%	Neutral	27.5%
Unimportant	7.2%	Dissatisfied	23.4%	Unimportant	14.0%	Dissatisfied	5.4%
Very Unimportant	1.9%	Very dissatisfied	7.1%	Very Unimportant	4.7%	Very dissatisfied	2.6%
Ecological footprint of job				*Long-term job planning*			
Very Important	19.2%	Very satisfied	31.4%	Very Important	21.9%	Very satisfied	10.6%
Important	29.2%	Satisfied	27.8%	Important	23.3%	Satisfied	24.7%
Neutral	31.2%	Neutral	27.2%	Neutral	24.2%	Neutral	44.1%
Unimportant	14.5%	Dissatisfied	10.4%	Unimportant	23.9%	Dissatisfied	12.9%
Very Unimportant	5.8%	Very dissatisfied	3.3%	Very Unimportant	6.7%	Very dissatisfied	7.6%
Being at the heart of the city				*Image of job*			
Very Important	13.8%	Very satisfied	24.9%	Very Important	18.0%	Very satisfied	18.6%
Important	24.3%	Satisfied	35.7%	Important	19.1%	Satisfied	32.7%
Neutral	29.7%	Neutral	34.8%	Neutral	27.5%	Neutral	37.2%
Unimportant	20.1%	Dissatisfied	3.7%	Unimportant	25.6%	Dissatisfied	10.3%
Very Unimportant	12.1%	Very dissatisfied	0.9%	Very Unimportant	9.8%	Very dissatisfied	1.2%
Using innovative technologies							
Very Important	12.7%	Very satisfied	12.0%				
Important	21.2%	Satisfied	30.2%				
Neutral	32.2%	Neutral	45.2%				
Unimportant	24.9%	Dissatisfied	10.2%				
Very Unimportant	9.%	Very dissatisfied	2.5%				

3.2. Factors influencing electric cargo bike rejection

Out of all elements of the messenger characterization, only a limited number proved to be significant in a multivariate perspective on electric cargo bike rejection. There are prominent variables that don’t shown significant influence on the likelihood of rejecting electric cargo bikes, such as both weekly and daily working hours and travel distances, company (and therefore city) effects, work style and work experience as a messenger, as well as general motivations for choosing the messenger job (such as income, flexibility, variety and contact with people). Even the motives of physical exercise and low carbon footprint did not reveal significance.

To illustrate the cumulative effects of the different types of independent variables, we present two models of electric cargo bike rejection. Table 3 lists both models and their coefficients. Positive coefficients indicate a higher probability of rejection. Lower p-values indicate a high significance of the measured effect.

Table 3. Model results (n=362).

Variable	**M1**		**M2**	
	coeff.	p	**coeff.**	p
Age	**0.056**	0.000	**0.048**	0.000
Gender: female	**1.359**	0.003	**1.428**	0.004
Net. income: >€2000	**1.036**	0.002	**1.025**	0.004
Education: low/medium	**0.628**	0.011	**0.474**	0.076
Car ownership			**0.811**	0.005
Possibility to bundle shipments			**-0.822**	0.001
Interest in vehicle technology			**-1.727**	0.000
Constant	**-3.315**	0.000	**-1.451**	0.023
Log likelihood	-214		-196	
Pseudo R^2 (McFadden)	0.125		0.199	

Model 1 contains four classic socio-demographic variables: age, gender, income, and education. Model 2 adds relevant information about messengers' job circumstances: car ownership and the possibility of bundling several shipments during ad-hoc tours as well as stated interest in vehicle technology.

Model 1 reveals the importance of classic socio-demographics on technology acceptance. Rejection probability increases with age and income, while higher education and male gender apparently result in higher likelihood of open-mindedness towards innovative vehicles. These four variables already account for an R^2 (McFadden) of 0.13.

Model 2 underlines the importance of individual work surroundings and attitudes. As we turn to consider job circumstances, we see that messengers owning cars are less likely to embrace the commercial use of electric cargo bikes. On the other hand, bundling shipments, a typical strategy of courier deliveries, plays an important role. Finally, interest in vehicle technology is the most important factor influencing the choice between rejection and embracement. The seven variables of M2 account for an R^2 (McFadden) of 0.20.

As described above, other socio-demographic and attitude variables are either insignificant or potentially endogenous for our constructed dependent variable and thus not included in the model.

In various robustness checks (not presented here), all coefficients prove quite stable and independent of the inclusion of new variables. Collinearity checks revealed a condition number of 14 and no variance inflation factor above 1.3, further strengthening these findings.

4. Interpretation

As in other studies dealing with technology adoption, we observe the importance of classic socio-economic factors such as age, income, education and gender. The clearest picture emerges for education: Messengers show an above-average educational profile and a low education increases the probability of rejection. Concerning age, our results show a wide (but quite average) range and an increasing rejection with higher age. While this is in line with some other studies (overview given by Lüthje, 2007), the inverted relation has also been observed by Wolf and Seebauer (2014) for adoption in the private e-bike market, where older people are more likely to embrace electrically assisted bicycles than their young counterparts. Similarly, the detected negative impact of high income dissents from other studies observing a positive relation between income and adoption (Hjorthol, 2013). Unlike the rather unrelated situation in private vehicle procurement, a new type of commercial vehicle can be expected to change a messenger's income situation. Those with currently high income thus appear less keen on changes of the status quo. The negative effect of female gender on EV adoption is in line with many studies (Wietschel et al., 2012), as is the interest in vehicle technology. Note again that both male gender and technology interest are each true for over 90% of our sample, rendering these aspects dependent on a low number of cases. Interestingly, using innovative technologies has been rated the least important among 11 job-related aspects.

On a more practical level, factors describing messengers' job organization proved to be of influence for technology acceptance. While professionals often solely distinguish their messengers' workforce between car and bike messengers, we found car ownership as only one among several variables leading to a rejection attitude towards electric cargo bikes. One of these variables is the possibility of bundling shipments, which is a typical strategy of messengers to improve their share of billed shipment distance compared to total driven mileage. (Electric) cargo bikes, offering a higher storage capacity than bicycles, are welcomed by messengers pursuing these bundling strategies.

Range-restricted technologies such as electric vehicles have a suitable application field in courier logistics, as a majority of messengers prefer ad-hoc consignments with shipment distances below 20 km. In combination with frequent presence at the courier company's site, (fast) charging concepts can be a facilitator to successfully implement less expensive cargo bikes with electric ranges below the daily mileage of messengers.

Messengers assess electric cargo bikes as being environmentally-friendly vehicles; however, this cannot be seen as direct driver of procurement intention, as having a low carbon footprint is only a secondary target for most members of this professional group.

The specific requirements of electric cargo bikes (possibility of charging and safe parking) must not intervene with the observed high degree of desired flexibility and heterogeneity of work styles.

It is appealing that the observed multitude of company policies and built environments reflected by the diverse sample distribution does not have any effect on the rejection probability. We can therefore hypothesize that our results have a general applicability, regardless of specific local circumstances.

The high value of 86% agreement that using electric cargo bikes makes sense has three implications: Firstly, such a high level is very promising in terms of general market potential. Secondly, electric cargo bikes do not appear to be an outlandish technological niche but rather a somehow pragmatically expected evolution of the current technology. Thirdly (and somehow disturbing however), it is in stark contrast to the share of 147 out of 362 respondents identified as rejecting the individual long-term adoption of this alternative.

One approach to tackle these rejection levels can be fleet tests in order to raise cargo bike experience.

5. Conclusion

Using a two-wave survey including 362 answers of individual messengers about themselves, their job situation and their attitude towards technology, we achieved an in-depth characterization of this seldom-portrayed professional group of decision-makers in the field of city logistics.

With the exception of a high share of males and higher level of education, their socio-demographic features are fairly aligned with the general population. We detected a plurality of working styles, due to the high degree of flexibility and the freelance working environment. While around every fourth of the respondents stated own experience with electric cargo bikes and 8% already owning this vehicle type, almost 90% see them as a viable option for courier deliveries.

In order to shape a more concrete picture of technology uptake by these individuals, we opted for the modeling of a binary variable reflecting rejection. Especially in a longitudinal study design this decision can be derived with more accuracy than its positive counterpart (adoption). We found evidence for well-known explanatory factors of innovation rejection. These factors include socio-demographic attributes such as age, gender, income and education, as well as individual perception of the technological innovation and its impact. Other important factors include specificities of the messenger job like car ownership and delivery strategy.

As a concrete policy recommendation, our results suggest a high success potential for information and adoption campaigns as well as large-scale fleet tests, all specifically aimed at the identified profile of rejecters in order to increase their awareness and acceptance of new vehicle technologies.

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