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A new vehicle for urban freight? An ex-ante evaluation of electric cargo bikes in courier services

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ABSTRACT

One possible strategy to tackle the negative effects of urban freight is the substitution of cars by electric cargo bikes for inner-city courier shipments. This paper determines whether there is a potential market for electric cargo bikes, how the current market is organized, how electric cargo bikes are perceived by bike and car messengers, and what factors drive their willingness to use them. We find that in terms of cost, payload and range, electric cargo bikes lie in between two existing modes (bikes and cars) that have a largely overlapping market. Vehicle choice is commonly made by freelance messengers, as many courier companies don't operate their own fleets. Therefore they can contribute only indirectly to the dissemination of electric cargo bikes by considering them in their operational management. Despite the fact that most messengers have not used an electric cargo bike before, it was generally regarded to be suitable for courier shipments. Using a binary logit model, we find that messengers' demographics, their professional practice as well as their attitudes and values have significant impacts on their willingness to use electric cargo bikes. Critical factors for actual implementation appear to be electric range, purchase price and publically available information.

1. Introduction

Technical innovations, particularly in vehicle design, will play a very considerable role in the future in reducing emissions, especially in urban areas. In combination with new concepts in the organization of mobility and transport, they can contribute significantly to greater sustainability in transport. Comprehensive overviews of efficient and sustainable strategies for last-mile deliveries have been given by Giuliano, O'Brien, Dablanc, and Holliday (2013) and Browne, Piotrowska, Woodburn, and Allen (2007). One of these strategies is the use of electric vehicles for urban freight (van Duin, Tavasszy, & Quak, 2013). As the market for currently available electric cars, and especially larger electric vehicles, is still limited, some focus is being placed on introducing smaller electric vehicles such as electric cargo bikes (E-CBs). The use of these vehicles is currently being discussed as one interesting possibility of configuring urban transport more sustainably (Lenz & Riehle, 2012). E-CBs are seen as having particular potential here, as they enable both greater loads and larger distances than is possible with the purely human-powered cargo bikes, tackling common disadvantages of cycle freight such as range, payload and driver fatigue (Transport for London, 2009). For this reason, there is currently a whole series of projects in Europe testing whether or in what way (electric) cargo bikes can be used in a way that makes economic and ecological sense. Two fleet trials of cargo tricycles, both in combination with an urban micro-consolidation center, have proven successful in Paris (Dablanc, 2011) and London (Leonardi, Browne, & Allen, 2012).

Positive expectations are not universally shared, however. Analyzing the US situation, Giuliano et al. (2013) come to the conclusion that the use of alternative fuels and vehicles for inner-city deliveries is an urban freight strategy with only "low effectiveness" and therefore also only "medium applicability to [the] United States". The differing estimation of the potential of cargo bikes in inner-city courier services doubtless reflects the massive difference between US and European inner-city structures (Le Galès & Zagrodzki, 2006), where E-CB-suitable transport demand might only be similar in limited metropolitan core areas (Conway, Fatisson, Eickemeyer, Cheng, & Peters, 2011).

In all, however, there is hardly any knowledge regarding the potential and conditions of E-CB use in city-center commercial transport today. The European experience shows that a multitude of different conditions are to be taken into account when estimating the potential of cargo bikes. Among these, alongside the technical and infrastructural prerequisites, are the corporate structures on the supply side, the spatial and temporal demand patterns, and also the acceptance of the new transport mode on the part of companies and their drivers and riders. The latter also applies to drivers who currently use regular bicycles or cars for courier services, and thus belong to the group of potential E-CB users.

These various factors and the interactions between them will be described and discussed more closely in the following using the example of urban courier services. Courier services are seen as an appropriate

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sector for an in-depth ex-ante evaluation, as they are the most reliable, flexible and expensive segment of CEP (courier, express, parcel) services, operating with small-scale shipments in densely populated urban centers (Glaser, 2000; Maes & Vaneslander, 2012; Witte, Krichel, & Sommer, 2011). The E-CB reference model used — a competitor to the existing markets of bike and car shipments — is a 2-wheel vehicle as pictured in Fig. 1. This type of construction (so called "Long John"), with a cargo box between front wheels and handlebars, is generally favored by messengers for point-to-point shipments compared to tricycles (Riehle, 2012).

The basis for this research is the empirical study of courier companies and individual messengers, with the aim of establishing and gauging the prerequisites and possibilities for integrating E-CBs in available corporate structures and transport services provision, and understanding the role of possible decision-makers concerning vehicle choice.

The article is structured as follows: following this introduction, we describe the data that we have gathered in answering the research question, and the methods we have used in evaluating these data (chapter 2). Chapter 3 contains the initial approximation for determining the potential of E-CBs. To this end, we analyze on the one hand trip patterns which we illustrate using the example of Berlin, and on the other hand the characteristics of the shipments made by the companies studied. In Chapter 4, we consider the current organization of courier services in inner cities; vehicle costs and company organization are at the forefront here. The fifth main chapter looks at the professional background of current bike and car messengers, their awareness of and acceptance of E-CBs, as these are the people who would actually use them. In the process, we observe the influence of socio-demographic factors, current service practices, attitudes and values on the acceptance of cargo bikes. Acceptance is here defined as "willingness to use". In order to determine the strength of the influencing factors, we have used binary logit models whose results we describe in chapter 6. The article closes with remarks on the implications of this research.

2. Research questions, data and methods

This research is guided by the central question of whether there is a potential market for E-CBs (electric cargo bikes) in urban courier services. To answer this question, it is necessary on the one hand to understand the specific structure of shipments that are carried out by bike or by car; on the other we need to consider the acceptance of E-CBs by the bike and car messengers who would use this new mode. To this end, we have investigated how E-CBs are perceived by potential users (i.e. bike and car messengers), and what motives support or impede messengers' willingness to adopt this mode of transport. Against this background, we have used an approach that relies on a series of various empirical data that we analyzed with descriptive statistical methods and a binary logit model.

Eight German courier companies provided quantitative data for research. All of them are among the three biggest market players in their home cities which are (in rank of size) Berlin, Hamburg, Munich, Düsseldorf, Leipzig, Bremen, Nuremberg and Mainz. The database provided (dataset 1) contains all trip data for one year of business (May 2011 to April 2012) for all modes of transportation, except for 2 companies who applied a regional filter (metropolitan area) before transferring the data (therefore Fig. 2 shows 6 business areas only). 752,334 single shipment distances (3‰ of the German courier services market, see MRU GmbH, 2012) were used for mapping the companies' spatial extension. A core business area was defined as at least 1 pickup or 1 drop-off per week per zip code.

For an in-depth analysis of courier shipments, one company based in Berlin was selected. The sample for this research was filtered by mode of transport and shipment type. Regarding mode of transport, as an E-CB would be positioned between the markets of regular bicycle shipments and (passenger) car shipments, only these two modes were taken into consideration. Shipments by small utility vehicles (vans) or other vehicles were not considered. In terms of shipment type, like most of the courier companies, two main types of services are offered: point-to-point shipments and overnight deliveries to any national or international destination, where the first and last mile is bridged by messengers. Only point-to-point shipments were considered (84% of all bike shipments and 86% of all car shipments), as overnight trip data records didn't allow a retracing of the messengers' route. Information concerning type, volume or weight of the transported good was partly manually coded into a new variable assessing whether the specific goods are feasible for transport in a typical cargo box on top of a 2-wheel E-CB with a load rate of up to 100 kg (with no parcel more than 25 kg) and a cargo box with a volume of 78 cm × 48 cm × 47 cm (176 l) as pictured in Fig. 1. The final shipment-related data sample contained 59,501 car shipments and 88,391 bike shipments (dataset 2).

Fig. 1. Example picture of a 2-wheel electric cargo bike (E-CB) as used in the project "Ich ersetze ein Auto" by German courier companies. Photo credit: Amac Garbe for DLR.