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Exploring the choice of battery electric vehicles in city logistics: A conjoint-based choice analysis

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ABSTRACT

Adoption of electric vehicles by transport companies remains limited although major European cities should reach CO_2-free city logistics by 2030. This paper explores therefore the vehicle choice behaviour of transport companies through a conjoint-based choice analysis.

The results showed that the benefits of battery electric vehicles are less valued than their disadvantages. However, a majority of respondents agrees that authorities should encourage the use of battery electric vehicles. Based on the preferences of transporters, we conclude that the most important measures are to develop a larger charging infrastructure and implement financial incentives through subsidies or tax exemption.

1. Introduction

City logistics faces a major challenge. According the European Commission (EC, 2011), freight transport should become CO_2-free in major urban centres by 2030. However, it is currently responsible for 25% of CO_2 emissions in cities (Dablanc, 2011), and forecasts project an increasing number of freight vehicles in city traffic (Zanni and Bristow, 2010). In that context, battery electric vehicles (BEVs) could represent an interesting solution. If electricity is generated from renewable energy sources, BEVs' operations could contribute to decarbonising city logistics (Browne et al., 2011). But, electrifying city logistics brings also benefits at a more local level. Because the electric motor does not emit exhaust gas emissions, BEVs can contribute to a better air quality in cities (Soret et al., 2014). This solution has therefore attracted the attention from local authorities (Litschke and Knitschky, 2012).

That notwithstanding, the perceptions of freight transport companies regarding BEVs seem to be less enthusiastic than that of authorities. Sales of electric freight vehicles remains indeed limited. However, city logistics is considered a suitable environment for BEVs (Lebeau, 2013; Van Mierlo and Maggetto, 2007). Greater attention must therefore be devoted to transport companies, particularly with respect to how they value BEVs.

Conjoint-based choice analysis offers an interesting approach in this context. It is a stated preference technique that simulates a choice situation involving a set of competing alternatives. By observing the alternatives that the respondents prefer, it estimates the trade-offs that respondents make among various attributes. Conjoint-based choice is a traditional approach to investigating the choice behaviour of respondents in the context of BEVs (Lebeau et al., 2012). However, analyses have been limited to the passenger car segment. This paper will therefore extend these analyses to the preferences of urban transport operators for electric freight vehicles. That represents an original contribution given the state of the art in city logistics. As next section will show, the literature is mostly limited to identifying the barriers and drivers of BEVs. Van Amburg and

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Pitkanen (2012) have provided some additional insights through a survey in the logistics industry where respondents were asked to rate the importance of the different BEVs attributes. But we still find a gap in understanding how these attributes interact between each other and how they influence the final choice. The objective of this paper is therefore to assess the trade-offs that urban freight transporters make between BEVs' attributes. Based on their preference structure, we will highlight the most effective policies that can stimulate their adoption.

This paper will first present the main factors that influence the value of BEVs based on a review of various experiences using BEVs in logistics. That review will be used in the subsequent section to select the most relevant attributes to consider in the design of the conjoint-based choice analysis. Their influence on choice behaviour is assessed through a survey conducted among freight transport operators in Brussels, and the results are presented in Section 4. The respondents' attitudes regarding these attributes are estimated in the subsequent Section 5. A discussion will compare the results of Sections 4 and 5 with the findings of the literature review in order to identify the most effective policies that can stimulate the introduction of BEVs into city logistics.

2. Drivers and barriers to BEV adoption

Given the interest expressed by authorities, numerous research projects have been conducted in Europe to explore the feasibility of BEVs in city logistics. They include projects such as EVD-POST (2001), ELCIDIS (2002), ENCLOSE (2014), STRAIGHTSOL (2015) and the current FREVUE (2013). Based on the literature and on the lessons learnt from the various demonstrations, this section reviews the different drivers and barriers experienced in the context of BEVs in city logistics.

2.1. Compatibility with the logistics

The limited range of BEVs is often considered the most important barrier to BEV adoption. That perception might be reinforced by the ranges advertised by manufacturers that are often not achieved under everyday conditions (FREVUE, 2013). Ranges are indeed usually assessed based on the NEDC which assumes a more energy efficient driving cycle than in real conditions (Pelkmans and Debal, 2006). Still, the limited range of BEVs can be compatible with specific applications in city logistics. Indeed, the last mile in urban areas is characterised by small distances: it has been estimated that more than 80% of freight trips in European cities are shorter than 80 km, which is compatible with the limited range of BEVs (BESTUFS II, 2008a). That constraint is then no longer perceived as a barrier. This can be the case in a hub-and-spoke structure such as an intermodal chain in which BEVs can operate the last miles (Macharis et al., 2007). Urban consolidation centres are also commonly identified as a suitable logistics concept in which BEVs can achieve city-centre deliveries (ELCIDIS, 2002). Other experiments, however, have been using BEVs in more traditional concepts of urban distribution (E-Mobility NSR, 2013). These various experiments often share a common characteristic: BEVs depend on a home base at which they can be recharged during their inactive period (usually at night). In that logistics environment, the lack of a public charging infrastructure and the long charging time become less important (ELCIDIS, 2002). The possibility of charging at "home" is even considered a benefit. The operator saves time and fuel by not driving to the pump to refuel a conventional vehicle. Moreover, BEV daily range can be increased by charging during the loading/unloading period at the depot (E-Mobility NSR, 2013).

2.2. Good performance

In a test of electric light commercial vehicles (LCVs) in Osaka, 73% of users reported that the vehicles' performance was the same or better than that of conventional vehicles (Taniguchi et al., 2000). The review of BEV best practices conducted by FREVUE (2013) also shows that feedback from private operators and demonstrators was mainly positive. Drivers are the most surprised by the benefits of BEVs. They are the most reluctant to change, but they recognise after testing that BEVs improve their working conditions and make driving more comfortable (ADEME, 2004; BESTUFS II, 2006; SUGAR, 2011). They appreciate BEVs' good acceleration, smoothness when driving and quietness in the driver's cabin (ELCIDIS, 2002). These aspects are particularly convenient for deliveries in urban areas (ADEME, 2004). However, some experiences indicated a lack of comfort caused by the effort required to reduce electric consumption from auxiliaries (ELCIDIS, 2002). Nevertheless, experiencing a BEV can be considered an important step towards their adoption in logistics. This observation is also true for the management staff: those who had tested BEVs were satisfied with their performance, whereas those who had not remained reluctant because their perception of BEVs was still limited to cost considerations (BESTUFS II, 2008b).

The most important performance of BEVs for companies is however their **low environmental impact**. For transport operators, BEVs can contribute to a corporate strategy of reducing CO_2 emissions (E-Mobility NSR, 2013). BEVs can also be used as a marketing tool. Experience has shown that companies highly value a positive attitude on the part of the general public and customers. In some cases, companies even received media coverage or environmental awards. These benefits can help the organisation to create a positive corporate image, which is argued to attract new customers (E-Mobility NSR, 2013). It can also provide a solution for potential customers seeking to reduce their environmental footprint.

2.3. Ambiguous costs

Logistics projects that show environmental benefits are however difficult to implement if they do not demonstrate in advance their ability to generate profits (Melo and Costa, 2011). **High purchase cost** is therefore perceived by transport