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Using Structural Equations Modeling to explore perceived urban freight deliveries parking issues

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ABSTRACT

This paper explores the relations between perceived urban freight delivery parking issues and commercial establishment characteristics, their associated distribution channels, delivery operation patterns and local land use patterns using a structural equations modeling framework. The main motivation is to test hypothesized relations between urban freight delivery parking issues and the aforementioned factors as a way to perform an indirect, but informative, freight infrastructure adequacy assessment. The hypothesized model structure makes it possible to examine, for example, if the distribution channel characteristics (e.g., the most frequently used delivery vehicle type) can be linked to a certain type of parking behavior/preference, due to operation requirements, which could result in perceived urban freight delivery parking issues.

The chosen variables are assembled from a plethora of sources. Establishment characteristics include size, number of employees and weekly deliveries, with this data being gathered using an establishment-based freight survey. Distribution channels are characterized by the predominant delivery agent and vehicle type. Delivery operations are represented by the most common parking location. Finally, the perceived issues include vehicles blocking other vehicles, lack of loading/unloading bays and illegal parking in loading/unloading bays. The land use data is obtained from parking records, the OpenStreetMap repository, the Portuguese National Statistics Institute (e.g., information on residents) and the City Council's retail establishments' census.

The results show that, in general, the hypothesized relationships hold true. Perceived urban freight delivery parking issues are a function of the establishment characteristics, their distribution channels and delivery operations patterns. Weekly deliveries are dependent on distribution channels and establishment characteristics. Finally, weekly deliveries' frequency did not seem to influence the perceived urban freight delivery parking issues. This supports the hypothesis that the retailers' judgement is not biased by the frequency of said operations.

1. Introduction

The increasing concentration of population in urban centers generates a strong and growing demand for goods. In responding to this growing demand, urban freight operations are frequently associated with negative externalities

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(i.e., noise, pollution, poor parking practices) which can result from infrastructure inefficiencies. Parking problems (e.g., illegal and double parking, cruising for parking) rank among the most important of such inefficiencies. Double parking can be a result of scarce or poorly located loading/unloading (l/u) bays – curb-based, public, freight-dedicated parking places (Dezi et al., 2010) - or of the undue occupation of l/u bays by non-freight vehicles (Dezi et al., 2010; Muñuzuri et al., 2012). Poorly dimensioned l/u bays (Alho and de Abreu e Silva, 2014a) can also result in inefficiencies in the delivery process, for example by causing delays in parking operations. Even the road network characteristics can contribute to increased freight movements, particularly elements such as lane structure or street directionality (Merchán et al., 2015).

Assessing the existing freight parking problems at a city-wide level, or even in smaller zones (e.g., neighborhoods), can be a time-consuming undertaking requiring extended observation periods and significant data collection efforts. This paper adds to the existing body of research by focusing on the relations between perceived urban freight delivery parking issues, from the perspective of retailers, commercial establishment characteristics, their associated distribution channels, delivery operation patterns and land use patterns surrounding the establishments. The main objective is to test a set of hypothesized relations between urban freight delivery parking issues (i.e., retailers' perceptions) and the aforementioned factors as means of carrying out an indirect, but informative, freight infrastructure adequacy assessment. Ultimately, the aim is to provide relevant information to decision makers (e.g., the city council) in relation to the most pressing issues for retailers whilst also accurately reflecting the carriers' concerns.

Despite parking difficulties (e.g., lack of dedicated parking spaces, non-freight vehicles parking in l/u bays) being primarily experienced by delivery agents (drivers; helpers), this study focused on the receivers' perceptions/opinions, as it leverages acquired information about perceived urban freight delivery parking issues using an establishment-based freight survey (Alho and de Abreu e Silva, 2015a). It can be argued that these perceptions may not adequately reflect the experiences of the delivery agents. However, receivers have a close relationship with drivers and helpers. For example, research has shown that a drawback to the implementation of urban consolidation centers is the potential loss of the direct interface between suppliers and customers (Browne et al., 2005). Thus, retailers were assumed to have adequate knowledge of the problems that drivers and driver helpers face.

The remainder of this paper is structured as follows. The following section contains a literature review covering urban freight delivery parking issues and the application of SEM models to study the perceptions of problems, as a proxy for direct observation, and to freight and supply chain research. After, follows a description of the case study, the data and the methodology applied. The results obtained are presented and discussed in the penultimate section. Finally, in the conclusions, the key findings are recapitulated and the model implications are highlighted.

2. Literature review

Urban freight parking issues are predominantly evidenced by the frequent sight of double parked or in-lane parked freight vehicles close to their pickup/delivery destination (Dezi et al., 2010; Aiura and Taniguchi, 2006). With regard to the impact of these activities, Han et al. (2005) advance the following estimates: (a) under normal/random parking enforcement, illegal parking accounts for between 20% and 25% of all deliveries; (b) illegal parking of freight vehicles is the third leading cause of non-recurring urban congestion (i.e., not caused by traffic volume); and (c) the impact of double-parking freight vehicles in large urban areas of the United States can amount to 500 million vehicle-hours/$10 billion in lost time annually.

Traffic-obstructing parking practices are recurrent in zones with limited parking supply, as drivers tend to avoid cruising for parking spaces. Cruising would result in an increase of expenditures[1] due to delays in deliveries, additional fuel consumption and driving stress (Marcucci et al., 2015). Double parking can also derive from cargo security concerns (Han et al., 2005; Morris et al., 1998). The reasons for parking difficulties are not limited to inadequate supply, as Jaller et al. (2015) assessed through surveys/interviews to retailers. The challenges identified were classified thusly: restrictions, infrastructure issues, traffic and other conditions. Nonetheless, the most important issues affecting freight transportation in the city were identified as: lack of parking space, inappropriate parking and congestion; with the first of these factors being the most important one for small receivers.

Fortunately, urban freight delivery parking issues can be alleviated by public policies; e.g., by providing an adequate number of optimally located l/u bays and/or assuring bay availability (e.g., by reducing illegal use by freight/non-freight vehicles). Kladeftiras and Antoniou (2013) have estimated the impacts of double-parking on traffic conditions and the environment using microscopic simulation. They demonstrated that all chosen traffic indicators would be improved if double-parking was only even partially reduced. Similar conclusions have also been reached by Alho et al. (2016), with results showing that benefits can be obtained from the optimization of l/u bays location and not necessarily from increasing the number of parking spaces.

Reflecting stakeholders' interests, Gatta and Marcucci (2015) tested policy interventions including combinations of the total number of l/u bays, the probability of finding them unoccupied and entrance fees to a restricted zone. Among their conclusions, these authors highlight that transport providers are more interested in the number of l/u bays, while retailers are more concerned about the probability of finding them available. We surmise that while a single agent may provide only one of many perspectives on the performance of the existing freight parking system this information can still be valuable for informing policy decisions.

[1] However, illegal parking can also generate extra expenditures when drivers are fined.

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