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Analyzing the relation between land-use/urban freight operations and the need for dedicated infrastructure/enforcement — Application to the city of Lisbon

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ABSTRACT

Urban freight (UF) operations include deliveries, pickups and transfers of physical goods within urban areas. A significant issue in UF operations is the need for law enforcement to deter non-freight vehicles from occupying loading/unloading bays. This paper aims to evaluate the level of service (LoS) of the loading/unloading bay infrastructure (i.e., the number of establishments/bay within a walking range) and the scale of illegal parking. A zone in Lisbon was selected as a case study and was analyzed, according to the relative locations of bays and establishments, as well as the establishment size and Number of Equivalent Commercial Stores (NECS). A higher LoS was expected for zones with a potentially higher UF parking demand. A Point Density and Commercial Homogeneity analysis provided an overview of the concentration of establishments. Clusters were confirmed with Global and Local Statistics of Spatial Association. The LoS was calculated for four commerce clusters, identified as likely areas of higher demand. Main clusters did not show an improved LoS. The usage of loading/unloading bays by all vehicles was observed for 17 days in a street with near-optimal spatial distribution of bays. The observed occupation of bays by non-freight vehicles was 80% of the freight vehicle demand.

1. Introduction

Urban freight (UF) can be defined as the activities that, within the boundaries of urban areas, include any kind of delivery, pickup or transfer of physical goods. These movements are subject to urban traffic and urban morphology (Muñuzuri, Larraneta, Onieva, & Cortes, 2005) and are essential for maintaining the current urban lifestyle. For Allen, Anderson, Browne, and Jones (2000), UF activities can include non-physical goods, such as maintenance services aimed at supporting businesses operating in urban areas. Although UF operations encompass a variety of modes, this research only considers road transport. Relevant freight flows are represented by the "last mile" concept (Rodrigue, Comtois, & Slack, 2009): the final journey between the distribution centers or warehouses and the customer (establishments or houses). This journey is characterized by an atomization of the cargo, increased frequency of deliveries, lower capacity vehicles and lower capacity usage (Dezi, Dondi, & Sangiorgi, 2010; Di Bugno, Guerra, Ambrosino, Boero, & Liberato, 2008).

UF traffic has evolved, with light goods vehicles taking on increased importance (Browne, Allen, Nemoto, & Visser, 2010). Smaller, specialized establishments are the main generators of freight vehicle activity, as larger retailers (>500 m^2 sales area) generally use larger vehicles, and are more likely to have more streamlined operations (Cherrett et al., 2012). "Establishments" here mean business establishments, which can be a firm/company or parts thereof. In physical terms, they represent the point of sale of goods or services from businesses to the end-user or to other businesses.

Parking policies, and transport infrastructure supply, are considered the most powerful means that urban planners and policymakers can use to manage travel demand and traffic congestion in urban centers (Pendyala, Shankar, & McCullough, 2000; Shiftan & Burd-Eden, 2001). Nevertheless, little is known about the impacts resulting from illegal parking and related obstruction by freight and non-freight vehicles. In the literature, freight-supporting infrastructures are sometimes ignored in the myriad of approaches that attempt to minimize the detrimental effects of UF transportation. The focus of this research is one type of infrastructure – the loading/unloading bays – specifically those that are on-street, in public areas. These will be defined as "*stop areas, (…) not suitable for parking, where the driver can stop his vehicle to perform freight loading and unloading operations, without disrupting traffic flows, to the commercial and industrial activities in a limited radius*" (Delaître, Awasthi, Breuil, & Molet, 2007). Bays can have periods for specific uses and commonly consist of more than one parking space.

In the context of an urban area that has a parking supply deficit, i.e. lacks loading/unloading bays, delivery vehicles tend to park in active traffic lanes (double parking), compromising road capacity, safety and

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freight carriers cost/service levels (Aiura & Taniguchi, 2006). Sometimes vehicles also park on sidewalks, interfering with pedestrian traffic. However, the provision of loading/unloading bays should fit the delivery requirements. Otherwise, the over-provision of bays would generate poorly used public space, which is already scarce.

Allen et al. (2000) have conducted research into which good practice initiatives are more likely to encourage easier-to-perform and more efficient goods and service operations in urban areas. Good practices are policies and/or regulations which, even when their effectiveness is deemed highly dependent on the context, are considered as generally good approaches to tackling common problems. The following measures are considered good practices with the potential for making UF operations easier and more efficient:

- improving on-street loading/parking facilities for freight and service vehicles; and
- better enforcement of parking regulations for non-freight vehicles.

We wish to explore the complementarity of these two good practices in this paper. It is claimed that in cities where there is no UF culture, it is essential to focus on the basics, avoiding radical changes (Muñuzuri, Cortés, Grosso, & Gaudix, 2012b). The optimization of the number, location and size of loading/unloading bays is considered a starting point (Dezi et al., 2010). In the framework devised by van Duin, Quack, and Visser (2008), parking enforcement is identified as one of the success factors for the correct use of loading/unloading bays. Aiura and Taniguchi (2006) also highlighted the importance of raising the awareness of law enforcement officers responsible for enforcing loading/unloading bays' correct usage. Various experiments/pilot tests have been carried out with a view to proving the link between loading/unloading bay availability and improvements in logistics operations (Ishida et al., 2006; Muñuzuri, Larraneta, Nibanez, & Montero, 2006).

Browne, Allen, Nemoto, Visser, and Wild (2008) have argued that the aforementioned good practices address, in particular, traffic problems in central areas generated by a low level of discipline (e.g., double and illegal parking) causing a decrease in network capacity. However, this must be seen in light of the fact that delivery drivers' expectations are met by the existence of these good practices. In a survey, the majority of drivers stated that they wished for more delivery areas and parking enforcement far above other measures (Debauche, 2008). Hence, it can be concluded that the problem does not lie solely in the lack of discipline of delivery drivers. The main causes of obstructive or illegal parking are threefold: the lack of delivery areas (IAURIF, 2004 in Delaître, 2009); the lack of adequate and suitable infrastructure (Morris, Kornhauser, & Kay, 1998); and the lack of enforcement of correct usage. Further confirmation of these conclusions has been published:

- between 50% and 86% of freight vehicles are parked illegally and/or in situations prone to causing traffic disturbances (IAURIF, 2004, in Aiura & Taniguchi, 2006; Cherrett et al., 2012; Delaître, 2009; Dezi et al., 2010);
- between 47% and 54% of loading/unloading bays are illegally occupied (Aiura & Taniguchi, 2006; Mairie de Paris, 2006);
- 57% of drivers justified not using bays because of its illegal occupation and 29% because these were inexistent (Dezi et al., 2010).

This research will focus on exploration of the following hypotheses:

a) the capacity to accommodate freight demand is not higher in those areas where commerce is highly concentrated; and
b) there is frequent usage of loading/unloading bays by non-authorized vehicles.

To test these hypotheses, this research sets out to a) analyze the relationship between the distribution of commercial activity and the distribution of loading/unloading bays; and b) analyze the relationship between freight and non-freight parking in loading/unloading bays. This research aims to contribute on two fronts: methodologically, by proposing a suitable methodology to test the chosen hypotheses in a low data availability context; and practically, by using a case study to illustrate the suitability of the chosen methodology for identifying locations with likely inadequate combinations of infrastructure/enforcement.

This paper is structured as follows. In the Introduction the importance of a specific freight-supporting infrastructure (loading/unloading bays) is presented, as well as the necessity of parking law enforcement to balance the over-provision of bays, as there is also illegal parking in bays. In the Methodology section, the case study's specificities are detailed, as well as the 5-step analysis process that aims to analyze the relationship between the distribution of commercial activity and the distribution of loading/unloading bays. The observation process that led to the comparison of freight and non-freight vehicles parking demand in loading/bays is also described. In the Results section, we consolidate the findings on the most relevant centers of commerce in the case-study zone and assess the differences in the provided parking infrastructure versus the case-study average. The results of the parking observation process are also presented. Finally, under Conclusions, the main findings of this research are discussed. Suggestions on how results could inform city policy are provided in the Implications for managerial practice section and the academic relevance is considered under Contribution to scholarly knowledge.

2. Methodology

The methodology presented herein was developed in a context of low data availability. In Portugal, as in several other countries, data sources suitable for UF research purposes are not only considerably difficult to obtain but also scarce, with regard to the minimum data requirements needed to characterize UF activities.

The methodology and subsequent analysis is split into two distinct, but complementary, sections. The first part builds on the hypothesis that despite the existence of clusters of commerce, the level of service (LoS) is not optimized. LoS was defined as the number of establishments served by a single loading/unloading bay within walking distance. We assume that a lower number of establishments per bay is synonymous with a higher LoS. Hence, this part is related to the geographical analysis of the spatial distribution (location/number) of establishments and loading/unloading bays. Most of the analysis was carried out with GIS (ArcGIS/ArcMap®) software, a tool that is becoming increasingly important in revealing spatial patterns in urban contexts, as shown by Mazzulla and Forciniti (2012). The second part builds on the hypothesis that illegal parking has an impact on the availability of loading/unloading bays. It is predominantly based on freight and non-freight vehicles parking observation records.

2.1. Case study

The case study used here was an area in the city of Lisbon, Portugal. In this city, the generalized disrespect by freight carriers and private vehicle drivers for parking rules is perceived as a relevant problem. Viegas (2003) and the City Council (CML, 2005) characterized UF operation problems as follows:

1. usage of the road itself to perform loading/unloading operations;
2. the overlapping of freight distribution schedules and traffic peak hours;
3. frequent usage of loading/unloading bays by non-authorized vehicles (even by establishment owners);
4. inadequate availability of infrastructure (availability of loading/unloading bays) to support logistical activities, especially with respect to small/medium distributors due to small load consolidation;
5. excessive concentration of commerce and services in streets/avenues whose capacity has not increased to match that demand; and
6. lack of information regarding the distribution process, flows, needs, logistic profiles, planning of dedicated infrastructures and definition of the rules for loading/unloading operations.