Objectives and motivation

An increased concentration of population in urban centers generates a growing demand for goods. Urban freight operations, supporting this growing demand, are commonly associated with negative externalities (i.e., noise, pollution, poor parking practices) which can be originated by lack of capacity and infrastructure inefficiencies. For example, double parking can be a result of scarce or poorly located dedicated freight parking (1) (i.e., loading/unloading – l/u – bays, where freight vehicles can park without disturbing cars or pedestrian traffic), or from the undue occupation of l/u bays by non-freight vehicles (1, 2, 3). Poorly dimensioned l/u bays (3) can lead to inefficiencies in the delivery process, causing delays. The very structure of the road network can be a contributor to increased freight movements within a defined area, due to lane structure or street directionality (4).

The assessment of the existing freight parking problems at a city-wide level, or even in a defined zone, can be a time consuming endeavor, implying extended observation periods. This paper adds to the existing body of research by exploring the relations between perceived urban freight delivery issues and commercial establishments’ characteristics, associated distribution channels, delivery operation patterns, location of establishments and land use patterns using a Structural Equations Modeling (SEM) framework.

The main motivation is to test the hypothesized relations between the stated elements as a way to perform an indirect, but informative, freight infrastructure assessment. The hypothesized model structure allows exploring, for example, if the distribution channel characteristics’ (e.g., most frequent vehicle type) could be associated with a certain type of parking behavior/preference due to operation requirements, which could result in perceived freight parking issues.

General description

The analysis included several variables. Explored establishment characteristics are, for example, size in number of employees and weekly deliveries. Distribution channels are characterized by the predominant delivery agent and vehicle type. Delivery operations are represented by the most common parking location. The perceived issues include, among other issues, blocked vehicles, lack of l/u bays or illegal parking within l/u bays. The land use patterns were first modeled for each establishment by using a factor analysis technique as a data reduction and multicollinearity elimination technique. The factors characterize a) zones with mixed land use characterized by high commercial variety and density and high residential density, b) zones with a smaller density of establishments by street length c) zones with a higher density of l/u bays surrounding each establishment. The factors captured 84% of the total variance of these land use variables.

The chosen variables were selected from a plethora of sources and merged into a single coherent dataset.

- An Establishment-based Freight Survey with geo-referenced establishments, detailed in (5).
- The Commercial Establishment Census, performed by the City Council, where a detailed geographical record of the existing establishments’ location and industry category is available.
- The road network for the city of Lisbon from OpenStreetMap (6) including details about road type and segment length.
- The 2011 National Census records, made by the National Statistics Institute (INE) (7).
- Mobility/Parking agency records of the locations of l/u bays.

The SEM model was developed aiming to confirm several hypothesis relating the influence/interaction between perceived urban freight delivery issues and commercial establishments’ characteristics, associated distribution channels, delivery operation patterns and land use patterns. These hypothesized influences/interactions are illustrated in Figure 1. Special relevance is given to a variable which could fall under the umbrella of “establishments’ characteristics”, the total of weekly deliveries. Its role in the model justifies that it should be considered as an endogenous variable, since we also aim to estimate the total weekly deliveries as a function of other variables present in the model. The proposed relations are inevitably influenced by the data generation process, and likely to be expanded if other variables were to be considered. The model was estimated using Bayesian Estimation and implemented using the AMOS™ software.
Results and conclusions

From the results of the model it is possible to conclude that the great majority of proposed relationships hypothesis hold. This allows claiming that it is possible to perform an indirect, but informative, freight infrastructure assessment using data on perceived freight operations issues. It must be noted that it is not claimed that such assessment is fully capable of informing policy decisions. Nonetheless, it might be valuable for policy-makers to be aware of the issues which receivers are more concerned about and how they interrelate with each other.

Relevant relations were revealed by the model such as those between distribution channels and land use patterns and those between establishments' characteristics' and perceived freight issues. For example, higher delivery durations are positively related with perceived congestion, which could be due to its derived disturbance. Although, it is suspected that some relations might be derived by a predominance of a particular type of establishments and should be subject of further investigation. Total deliveries were, as expected, related with establishment and distribution channels characteristics (e.g., number of employees or predominant origin of goods). Double parking is revealed as a source of most perceived issues, whilst parking in metered places has the opposite effect. This could be a hint that it is the second best option to the inexistence or undue occupation of l/u bays.

Regarding the interactions between endogenous variables, there was no evidence that weekly deliveries have any relation with the perception of freight parking issues. Still, the relations between some of the perceived issues are closely connected. It can be hypothesized that there is some causality, such as between the lack of infrastructure and/or inadequate usage, and blocked vehicles, which is subsequently related to congestion. Further work could be related to the validation of the stated issues with an observation pro-cess for a selected sub-sample. The development of follow-up models (with an expanded set of variables) to assess if there are significant changes in the obtained results are also planned.

References

Keywords: Urban freight; Land use; Freight delivery; Parking issues; Structural equations modeling