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Connecting demand estimation and spatial category models for urban freight: First attempt and research implications

Raphaëlle Ducret[a], Jesus Gonzalez-Feliu[b]*

[a] *Ecole des Mines Paritech, 60 boulevard Saint Mihel, 75006 Paris, France*
[b] *EVS-PIESO, Institut Henri Fayol, Ecole des Mines de Saint-Etienne, 158 Cours Fauriel, 42023 Saint-Etienne Cedex 2, France*

Abstract

This paper proposes a combination of models to estimate in a mesoscopic and microscopic way different patterns of urban goods demand according to the area within the city. The two proposed models are a category classification model for demand estimation and a spatial-based typology model defining different elementary zone within a city based on urban forms characteristics. Both models are applied to the same dataset for the city of Angers (France).In case of the identification of general rules, this new approach will help the transferability of goods practices in urban freight from a zone of a city to the same zone of another city.

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Keywords: Spatial modeling; demand-estimation model; urban freight; urban planning; transferability

1. Introduction

Over the past twenty years urban logistics has become a shared issue in several big cities around the world (Dablanc, 2011). One of the main topics of urban logistics research is that of modeling, mainly motivated by the need of public (and private) stakeholders to support their decisions by quantitative estimations of impacts of urban logistics actions (Gonzalez-Feliu et al., 2013). However, we observe that for the most part, urban goods transport is neglected by the field of urban planning; this could be said to contrast with the centrality of the study of urban

* Corresponding author. Tel.: +33-(0)4-77-49-97-84; fax: +33-(0)4-77-42-66-33.
E-mail address: jesus.gonzalez-feliu@emse.fr

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passenger transport. As a result, modeling tools for urban freight based on geographical analyses and urban modeling are scarce. Most of urban freight models have few connections to cities' characteristics or spatial criteria (Anand et al., 2012). However, spatial approaches could complement technical approaches because city characteristics influence urban goods transport organizations in various ways (Dablanc, 2009; Allen et al., 2012; Lindholm, 2012; Tozzi et al., 2014; Ducret et al. 2015).

This paper is an attempt to connect a demand-estimation model and a spatial modeling classification in order to identify the possible connections and interactions between urban form characteristics and freight movements. We are trying to identify relations and links between the spatial organization of the city and the demand for freight transport, in terms of deliveries and trucks. In case of the identification of general rules, this new approach will help the transferability of goods practices in urban freight from a zone of a city to the same zone of another city.

The paper will be structured as follow: first, after a brief review of the link between spatial studies and urban freight modeling, we will develop in detail the research questions analyzed in this paper. The case study developed in this paper will be also described. In a second part, we will describe in detail the methodology constructed in order to connect demand-estimation model and spatial modeling for urban freight. In a third part, we will develop the main results of the connection between spatial analyzes and demand-estimation. Finally, we will discuss those results and the research implications and perspectives of this work.

2. Research questions and case study

2.1. Urban freight modeling and spatial studies: a review

Among disciplines that have tried to understand logistics organizations and the distribution of urban goods, geography and spatial studies have always taken a backseat compared to economy, management and especially transport engineering sciences (Woudsma, 2001; Hesse and Rodrigue, 2004; Macharis and Melo, 2011; Hall and Hesse, 2012). Contrasting with the fact that relations between urban transport and urban planning have been studied since the 1970s and modelled in various ways since then through successful land-use and transport interaction models (LUTI, De la Barra, 1989), links between spatial organization and goods distribution in urban areas have been overlooked.

Several literature review papers aimed to synthesize the modeling efforts of the last 40 years (Anand et al., 2012; Comi et al., 2012; Gonzalez-Feliu and Routhier, 2012; Taniguchi et al., 2012). We observe three main types of models: demand estimation models, which mainly aim to define commodity or trip O-D matrices related to truck in urban areas; route construction approaches that aim to build those routes from commodity O-D matrices and behavioral and multi-agent models that aim to simulate a realistic behavior of the involved stakeholders in urban logistics.

With the exception of models based on LUTI frameworks (De la Barra, 1989), most of urban freight models, have few connection to cities' characteristics or spatial criteria (Bonnafous et al., 2014). Anand et al. (2012) have analyzed the descriptors of a great number of city logistics models and have shown that the most commonly used descriptors are traffic flow and commodity flow, freight and trip generation, loading rate, pollution level and transport cost. Location and land use, which are more spatial oriented descriptors, are used comparatively little (Anand et al., 2012). Even planning models are not always based on spatial oriented descriptors. In that context, we would like to open urban freight modelling to spatial data and generalize spatial study for urban freight, providing a decision-making tool based on spatial data and territorial analysis (Gonzalez-Feliu et al., 2013).

Nevertheless, from our point of view, spatial approaches could complement technical approaches because city characteristics influence urban goods transport and distribution. According to Allen et al. (2012), urban transport activities are affected by spatial and geographical factors and certain "urban form prerequisites", like the city's size and density, layout and urban form, street design, urban morphology, the location of activities, land use, and the position of the city in the supply chain just as well as economic factors. The authors also note that the interactions between vehicle trip, urban form and land use have been under-researched. Thanks to a precise study of urban areas in the United Kingdom, they subsequently demonstrated that several geographical, spatial and land use factors such as the facility's location, the city's size and location in the city network, street design, settlement size and density, city layout, and commercial and industrial land-use patterns are likely to influence the efficiency and intensity of