

The 9th International Conference on City Logistics, Tenerife, Canary Islands (Spain), 17-19 June 2015

Cluster analysis and spatial modeling for urban freight. Identifying homogeneous urban zones based on urban form and logistics characteristics

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Abstract

Confronted with the issues of the ‘last mile’, delivery providers have to adapt their logistics organization in cities for more economic and environmental efficiency and in order to meet consumer requirements. A better and systematic use of the providers’ knowledge of the local conditions and of their expertise of cities’ specificities and delivery conditions is one way to reorganize logistics more efficiently and deal with urban logistics challenges. This article develops a preview of a decision-making tool using spatial modeling and clustering which help organize delivery regarding city’s characteristics. The framework could help distribution providers achieve relevant and complete territorial diagnosis, prior to the settlement of efficient logistics organizations that suit cities’ characteristics.

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Peer-review under responsibility of the organising committee of the 9th International Conference on City Logistics

Keywords: spatial modeling ; geographical analysis ; decision-making tool ; urban freight planning ; urban planning

1. Introduction

Courier, express and parcel players are currently facing strong challenges within cities regarding urban logistics and last-mile deliveries (new shopping and logistic patterns) leading to growth in deliveries (Weltevreden, Rotem-

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Mindali (2009); Gevaers, et al. (2011)). At the same time, recipient requirements have become more and more complex and B2B and B2C logistics requirements regarding delivery speed, reliability and simplicity are converging (Ducret (2013)). Moreover, firms and stores have modified their supply chains in cities (Menge, Hebes (2011); Dablanc (2011)). Finally, for fifteen years, public authorities in urban areas, informed about the essential role of urban goods distribution in cities (Lindholm, 2012 ; Cherrett, et al., 2012), have implemented measures and projects to deal with externalities and enhance the urban distribution efficiency (Macharis, Melo, 2011 ; Russo, Comi, 2012; Diziain, et al., 2013).

Confronted with the issue of the ‘last mile’, CEP players have to adapt their logistics organizations in cities for more efficiency – economic as well as environmental – and in order to meet consumer requirements. Mobilizing the CEP knowledge of the local delivery conditions and analyzing cities’ spatial organization and specificities could be new vectors of innovation for CEP logistics organizations within urban areas. Bringing urban analysis and spatial studies closer to urban logistics could help reorganize logistics more efficiently and finally meet urban logistics challenges. Among disciplines that have tried to understand the organization of urban logistics and urban goods distribution, geography and spatial studies have always taken a backseat as compared to the economy, management, political science and transportation engineering sciences (Ogden (1992); Hesse (2010); Macharis, Melo (2011); Hall, Hesse (2012)).

In that context, the global objective of the paper is to find new ways of innovation for urban parcel deliveries and urban logistics. The main goal of the paper is to demonstrate that spatial modeling can help better organize logistics within cities. It aims at describing in details the preview of a decision-making tool for urban deliveries structured by a spatial clustering based on urban form and logistics characteristics. It also aims at arising questions for an efficient spatial modeling process for urban freight.

The article will be structured as follows: first, we will provide a short review of urban logistics from a spatial and geographical point of view in order to demonstrate the relevance of a new approach. Then, we will describe and explain the methodology of the decision-making tool for urban logistics based on urban modeling, geographical analyses and operational data that has been developed during a research project. We will finally present an operational case study of the decision-making tool for the city of Angers and discuss the limitation and perspectives of this work.

2. Urban Freight and Spatial Modeling : Trends and Gaps

2.1. Relationships between urban freight and spatial characteristics: an opportunity for urban freight management

Urban logistics researchers have observed that until recently geography and spatial studies have not sufficiently investigated urban freight as a research field and tried to understand the role of spatial organizations in distribution (Ogden (1992); Woudsma (2001); Macharis, Melo (2011); Hall, Hesse (2012)). Contrary to urban passenger transport studies and the interactions between passenger transport and urban form that have been largely explored in urban studies and more broadly in geography, freight transport has been neglected until now (Allen, et al. (2012)).

More recently, when exploring the link between urban characteristics and urban logistics, researchers have established that urban freight is more influenced by the nature of economic activities in cities than by features of spatial organization (with the exception of the size of the city) (Dablanc (2011)). But some researchers have argued that urban transport activities are also 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 land use, and the position of the city in the supply chain (Allen, et al. (2012); Lindholm (2012); Dablanc (2011)). Precise case study and research are rare. Allen, et al. (2012) have 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 freight journeys. Moreover, relationships between the size of the city, the street design of the city center and the efficiency of the last-mile delivery has been studied by Tozzi, et al. (2013) for the city of Parma in Italy. Even if over the past few years, geographers as well as researchers in urban freight have become aware of the impact of geographical features on logistics organizations, so far very few researchers have tried to apply and verify those assumptions. Among others, we can quote Macario’s concept of “logistics profile”

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