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Analysis of freight distribution flows in an urban functional area

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ABSTRACT

Cities are a huge growing market for distribution companies (logistics), whose object is to cover goods/products supply requirements, deliver parcels and replenish stocks. Supplying the companies and businesses located in cities is a daily challenge for any logistics company. Among various existing city models, the so-called compact cities presently tend to have more pedestrian zones in cities, which consequently affect surrounding areas; e.g., limited parking areas, restricted access for traffic, difficulties to enter with goods, and even access difficulties for the neighbors who live in these areas. The main objective of this work was to analyze logistic flows by paying special attention to the detailed description of traffic that depends on the urban outline in order to analyze the logistic flows of goods, and to discuss different policies to improve urban goods logistics without forgetting that routes exist and form part of a the development of a more humane city, where delivery vehicles enter pedestrian zones. This study focused on the center of the city of Cartagena (Spain), a Mediterranean compact city characterized by having numerous pedestrian zones.

1. Introduction

Cities represent a huge growing market for distribution companies (logistics) whose object is to cover goods/products supply requirements, deliver parcels and replenish stocks, among others (Joerss, Nehuaus, & Schroeder, 2016). The commercial activity that takes place in urban areas involves a wide range of products (traditional business, banking, telephone businesses, food, etc.), and takes place in differently classified establishments and buildings (retailers, wholesalers, warehouses, many hotel business activities, etc.). Supplying these business or companies is a daily challenge for any logistics company. Urban freight distribution must be sustainable in line with three bases: economic, social and environmental. Development must be supportable (socially and environmentally), fair (socially and economically) and feasible (environmentally and economically) (Muñuzuri, Onieva, Cortes, & Guadix, 2016). In order to minimize the problems that result from freight transport in towns, several different actions have been taken; for instance, creating goods consolidation points or establishing distribution time windows. It is also important to bear in mind that the activity horizon of most logistics chains exceeds any political frontier, and supply chain management (SCM) is responsible for handling large supply networks (Rushton, Croucher, & Baker, 2014).

Herce (2009) identifies three factors that can considerably complicate SCM in urban areas to help encourage an increase in transport vehicles:

- First the factor of production, which requires materials or components being received at certain times during its activity;
- Second the factor of products purchased from catalogues or electronically being distributed;
- Third the fact that consists in self-employed workers (services companies) in the city as a result of the crisis in the industrial work model that concentrates in large production centers.

Urban logistics is the last step in the supply chain, and is basically made up of a mixture of "last-mile" deliveries to the end consumer. Urban logistics plays a key role in relation to commerce and city life; it is necessary to strike a balance between an effective and efficient logistics system and its consequences (Russo & Comi, 2016). In order to conduct a good urban logistics study, making a detailed evaluation of policies ex-ante is fundamental (Gatta & Marcucci, 2016).

The Supply Chain Management Professionals Board has estimated that last-mile transports represent 28% of all transport costs (Coupland, 2013); based on empirical studies, Russo & Comi concludes that urban

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freight transport represents 6–18% of all urban transport, 14% of all the kilometers covered by vehicles, 19% of all used energy and 21% of CO_2 emissions (Russo & Comi, 2016). Cutting the expense of the last chain stretch is a major challenge for distribution, and it comes with other challenges, like cutting carbon emissions and increasing sustainability. As a whole, companies and society need to optimize urban logistics operations as a key element to generally benefit companies. The final-stretch process of distributing goods has a direct effect on a supply chain's economic results, and directly influences customers' experience as receivers of goods. It can be concluded that good urban logistics meets several objectives in supply chains: cutting costs, increasing sustainability and improving responses to customers. Conversely, as Muñuzuri, Cortes, Guadix, and Onieva (2012) explain by citing Dablanc (2008), the scientific community has not made huge efforts to adapt urban logistics guidelines to the day-to-day reality, a trend that has reversed in recent years. Until 2008 very few research works have been conducted to date to study real activity in order to collect relevant data with which to analyze goods traffic in urban settings (Allen & Browne, 2008). Collecting data to study urban logistics implies considerable difficulties and a high economic cost (; Gatta & Marcucci, 2016; Muñuzuri et al., 2016Russo & Comi, 2016), and the data collection stage is an important stage that must not be underestimated.

Moreover, no standardized format exists to observe circumstances, and such work usually requires a wide range of measures to confer a scientific basis to the process and to decision-making (Herce, 2009; Taniguchi, Thompson, & Yamada, 1999). It is not feasible to talk about urban logistics with sustainability criteria without bearing in mind the urban design, and each city requires specific data (Nuzzolo, Comi, Ibeas, & Moura, 2016). Systemic approaches must be used to perform more accurate and exact analyses of urban logistics and to, thus, include the approaches of all shareholders, but the fact that each city has its specific aspects must be taken into account. A street is the basic element of communication in cities, and it concentrates all circulation functions on which the interrelations that connect people, vehicles and different economic activities they perform take place. We ought to bear in mind that a road system which is functionally designed for all of today's uses should include sections of sideroads, which hardly fit in most of the streets of our cities. The only possibility is to share the public roadway for all uses as it is limited (Muñuzuri et al., 2016).

This article examines the problems that urban freight transport causes in a historic city center. The unsuitability of urban centers to citizens-pedestrians because of, among other reasons, their morphological characteristics, has led municipal authorities to take measures to improve conditions in historical city centers to support the neighbors who live in them. Some measures that affect transport include restricting goods transport vehicle movements (e.g. time to access with goods, restricted vehicle weights or adjusting routes), and converting part of the public space into pedestrian zones (Grosso, Muñuzuri, Cortes, & Carrillo, 2014). As such changes are made, supplying urban centers becomes more difficult for logistics operators; at the same time, shops and other activities continue to demand products in their area based on efficient, swift and accurate logistics.

This article explores and analyzes freight distribution flows in a city center by implementing a method to collect data about freight distribution flows. The taken measures form a basic part of the work which, in principle, offers information about traffic flows, bottlenecks and available spaces. The analysis and discussion of the end results allows possible urban logistics policies to be made to help improve distribution in the study area. The measuring method used (Ros-McDonnell et al., 2013) was implemented into mobile devices in order to use this system in other cities.

2. The urban functional area (UFA) definition

To first apply and then extrapolate the conclusions drawn from this study, it is necessary to specify the urban functional area concept, which is the study area. "An Urban Functional Area (UFA) is defined as a physical space that identifies urban developments which are drawn together by a labor market (metropolitan area or region). An urban area contains no rural space" (Wendell, 2015).

It is worth considering that the meaning of urban area can differ from one country to another. The study classification employed herein is (Wendell, 2015):

- Megacity – a mass of more than 10 million inhabitants
- Metropolis – a wide-ranging population of more than 3 million inhabitants
- Large urban area – an urban area with more than 500,000 inhabitants
- Small historic area – medium-sized cities with "sensitive" areas owing to the importance of the population or city in cultural or historical terms. Mediterranean compact cities usually enter this category.
- Other small urban areas – the rest of urban areas with less significant road traffic density and better air quality.

The models used in urban logistics have been developed mainly according to an approach that intended to study aspects from the supply process perspective rather than from the end consumer perspective (Russo & Comi, 2017). The intention to frame work in a UFA was to study the interactions among urban logistics shareholders in the study area.

More than half the world's population lives in an urban area. In 2015 some 34 megacities existed in the world, and there were 75 urban areas with over 5 million inhabitants. This circumstance evidences the need to improve the logistics sector in urban areas. The fact that *"Sustainable Urban Development in the European Union: A framework for Action"* was adopted in 2008 and the communication of *"Towards a Thematic Strategy on the Urban Environment"* in 2004 show that the EU is working toward urban sustainability (Bulkeley & Betsill, 2005). The foreseeable demographic growth and urban concentration are a formidable future challenge to supply and support the logistics that inhabitants in urban areas to come will require (DG MOVE, 2012; MDS, 2012).

2.1. Negative impacts of freight distribution flows on an urban functional area

During the urban design process, we ought to remember that the wealth of the urban area lies in the diversity of activities that it houses, and also in its capacity to adapt to new social situations and demands. Although UFAs are established for studies to study cities, urban spaces are not isolated spaces, but form part of series where continuity guarantees the "system" condition, which is an urban system in this case.

Unlike the rural setting, the urban setting concept involves distance between the place where things are produced and the points where they are used (e.g., food, leisure, traditional commerce); this distance condition, and thus the consequent transport requirement, are fundamental for the city to operate and are essential for industrial activity, commerce, and even leisure activities. Studies conducted into urban logistics management contribute to improve the development and efficiency of freight transport in an urban setting, and to better support citizens' needs.

Given its nature, urban freight transport must be simultaneously managed, but with independent objectives to passenger transport. The main problems encountered in the urban logistics of goods are the following (OECD, 2003):

- Access for delivery vehicles, mainly due to insufficient infrastructures, restricted access or congestion
- Environmental: harmful emissions, noise, vibrations and physical obstacles