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Retail Mobility Environments: A methodological framework for integrating retail activity and non-motorised accessibility in Zaragoza, Spain

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ABSTRACT

While adequate integration of land use and transport is seen as crucial for achieving sustainable outcomes, the reciprocal interconnection between retail activity and non-motorised accessibility is yet to be adequately examined. To address this gap, this paper proposes the concept of Retail Mobility Environment (RME) and develops a methodological process for identifying and mapping RMEs, using the city of Zaragoza, Spain, as a case study. The concept of RME is developed through three methodological phases: (i) definition of non-motorised Accessibility Zones (AZs), using three indicators (walking accessibility, bicycling accessibility, betweenness); (ii) definition of Retail Zones (RZs), also using three indicators (retail density, retail diversity, retail contiguity); and (iii) definition of RMEs, where both retail activity and non-motorised indicators were weighted and combined using multi-criteria analysis. In total, four RMEs were identified and mapped: short-distance environments, motorised environments, non-motorised environments, and long-distance environments. The paper concludes with a discussion on the need to unravel the relationships between retail activity and non-motorised accessibility, in order to reach sustainable planning goals, as well as the potential usefulness of RMEs for transport policy-making.

1. Introduction

The complex relationships between land use and transport has received considerable attention in academic literature (Banister, 2005; De Vos and Witlox, 2013; Ewing et al., 2016). The dominant view is that the benefits of mobility increase if land use and transport are reciprocally supportive, which is associated with the principles of New Urbanism (USA) and the compact city (Europe). The emerging long-standing body of theories and practical applications emphasises the effect of the land use and transport binomial on: (i) human health (Andrews et al., 2012; Wang et al., 2016); (ii) travel behaviour (Lamíquiz and López-Domínguez, 2015; Schwanen et al., 2001; Van Acker and Witlox, 2010; van Wee, 2011; Witlox, 2007); and (iii) environmental issues such as noise and air pollution (Mat Yazid et al., 2011; Loo et al., 2015).

The need to translate academic empiricism into practice has provided multiple planning concepts with different levels of real-life applicability (e.g., Transit Oriented Development, accessibility-based planning, etc.). The analytical concept of "mobility environment" as a planning concept is also a case in point. Inspired by Bertolini and Dijst (2003), mobility environments are places where land use and transport are reciprocally interrelated in a specific way (Soria-Lara et al., 2015). Mobility environments can be used for both understanding how transport and land use are mutually connected and for developing planning criteria (Soria-Lara et al., 2016; Talavera-Garcia and Soria-Lara, 2015 or Zandvliet et al., 2008). The concept of mobility environments in transport practice, therefore, has enhanced the understanding of how land use and transport are affecting urban congestion, air pollution, noise, and walkability. While mobility environments traditionally focus more on the relationships between motorised transport modes and residential areas in cities and regions, limited attention has been paid to how retail activity interacts with non-motorised transport modes at city level as well as the resulting impact on daily mobility.

The argument behind the proposed identification and mapping of Retail Mobility Environments (RMEs) at city level, as well as their implications for policy-making, builds on the idea that an adequate combination of both retail activity and non-motorised accessibility can yield beneficial impacts on trip frequency, choice of destinations (Iacono et al., 2010), modal shift (Cerin et al., 2007), location of socialization places (Evans, 2009), and improved health of mobile populations (Ståhle et al., 2005; Tight et al., 2011).

This paper seeks to explore the following research question: *How can RMEs, as a conceptual framework integrating retail activity and non-motorised accessibility, be identified and mapped at city level*? The city of

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Zaragoza, a representative example of a compact-city model in the Spanish context, serves as the case study. A compact-city environment provides a good study area for two main reasons. First, the relevance of non-motorised accessibility is presumably higher than in other less compact urban contexts. Second, retail activity also tends to be more complex, in terms of diversity (variety of retail activity) and spatial location, than in other built environments. A quantitative methodology was employed to identify and map RMEs in Zaragoza, combining georeferenced data and a survey to citizens.

In the remainder of the paper, Section 2 presents a theoretical discussion on the concept of RME, including the working hypothesis. Section 3 describes the case study. Section 4 outlines the research design, while Section 5 presents the main results. Finally, Section 6 covers the concluding remarks and the implication of RMEs for policy-making.

2. What makes a retail mobility environment?

This section reviews the traditional approaches to analysing retail activity and non-motorised accessibility at city level, further distilling a working hypothesis for identifying and mapping RMEs.[1]

2.1. Non-motorised accessibility

There is a growing concern regarding how non-motorised accessibility has been measured over the last decades (van Wee, 2016), focusing on the strong limitations posed by the absence of high-quality data on non-motorised movements (Iacono et al., 2010; Roig-Tierno et al., 2013) as well as the limited attention paid to bicycling (Vale et al., 2015). In the context of this research, non-motorised accessibility refers to the physical capacity to reach retail activity by both walking and bicycling. While a wide range of methods are used to measure non-motorised accessibility (Clarke et al., 2002; Jaskiewicz et al., 2016; Kang, 2015; Lee and Hong, 2013; Negron-Poblete et al., 2014; Vale et al., 2015), here the focus is on place-based and centrality approaches.

In place-based methods, transport studies rely primarily on gravity-based indicators (Miller, 2005). Their distinctiveness lies in estimating the cost for reaching different urban activities according to an impedance function (Vale et al., 2015), based on the time or distance that people are willing to travel. Studies conducted by Kockelman (1997) and Iacono et al. (2010) highlight that the impedance function form to measure non-motorised accessibility should vary depending on trip purpose (e.g. working, shopping, etc.). Iacono et al. (2010) used a gravity-based measure as a baseline to illustrate the integral accessibility of different urban activities by non-motorised modes. Scott and Horner (2008) also applied a gravity-based model to evaluate accessibility of several types of urban activities by different socio-economic groups. The authors sought to define and locate places with a social exclusion risk. The gravity-based approach has also been applied to assess bicycling accessibility. For example, Lowry and Callister (2012) developed a gravity-based method to assess the quality of bicycle travel, following a scheme based on impedance function similar to functions used in walking studies.

Centrality-based approached are fundamentally based on topological relationships, without taking into consideration origins and destinations of mobile population. They complement traditional gravity-based indicators, providing additional insights into how accessibility is understood and perceived. Specifically, centrality-based measures provide key information about street features and retail hierarchy. The study carried out by Porta et al. (2009) examined the relationships between street centrality and densities of retail activities in Bologna, Italy, revealing that "betweenness" and "closeness" indicators are highly correlated with larger retail densities. Wang et al. (2014) also examined the location patterns of various retail stores in Changchun, China, finding that street centrality and location advantage are highly correlated.

2.2. Retail activity

Retail activity patterns are extensively explored in the literature. Retail density, diversity, and proximity are the traditional indicators used for the assessment of retail activity (Teller and Elms, 2010). These studies usually focus on the definition of market area boundaries (Lee and Lee, 2014) or the attractiveness valuation of retail places (Teller and Reutterer, 2008), among other characteristics.

Regarding retail density, Marashi-Pour et al. (2015) explored the association between tobacco outlets density, socio-economic status and proximity of secondary schools. They used a kernel density estimation, signalling correlations between tobacco outlets, disadvantaged neighbourhoods and the proximity to secondary schools. The study conducted by Roig-Tierno et al. (2013) used retail density to determine potential places for locating a new supermarket in Murcia, Spain. The authors combined kernel density of current supermarkets (geocompetition) and kernel density of population (geodemand), finding that the combination of both kernel densities delivered the best locations for supermarket activity.

Indicators traditionally used in ecological studies (e.g. Shannon-Weaver, Simpson or Ullman-Dacey), have been applied to retail diversity. Aguilera Ontiveros and Bárcenas Castro (2014) calculated Shannon-Weaver indicator in San Luis Potosí, Mexico, metropolitan area to analyse the correlation between retail diversity and employment opportunities. Higher diversity values indicated places that are more attractive for visitors (Kärrholm et al., 2014) and resilient (Wrigley and Dolega, 2011). However, other methods, such as counting different type of stores in a search radius have also been used. For example, Negron-Poblete et al. (2014) calculated diversity (within a 500 m radius) as a complementary measure to pedestrian accessibility for ageing people in three areas of the greater Montreal, Canada.

Finally, retail proximity is the third indicator to be presented. The most common approach is studying the number and proximity of shops to households and jobs within a given distance. However, in this research, the concept of retail proximity would be closer to the fragmentation approach, i.e. contiguity between retail stores in a specific place. For example, Rotem-Mindali (2012) studied retail activity fragmentation in metropolitan areas, with the aim of uncovering opportunities to increase connectivity and accessibility by both private car and public transport. His findings suggested that higher retail fragmentation requires the use of private cars as complementary modal choice.

2.3. A working hypothesis to identify and map RMEs

The basic hypothesis underlying this research is that the RME can provide a comprehensive understanding of the relationships between retail activity and non-motorised accessibility at city level, as well as deliver valuable inputs in the policy-making process.

To identify RMEs in the case study, the central idea focuses on confronting the two sides of the spectrum: non-motorised accessibility and retail activity. This facilitates to distinguish at least four basic RMEs (Fig. 1):

i) **Short-distance environments**: high values for both retail activity and non-motorised accessibility, resulting in lively places where motorised modes are not essential and walking/bicycling is recurrent for covering shopping activities. On the one hand, indicators based on non-motorised accessibility would reveal places well-connected by a non-motorised network, as well as places highly accessible by walking and bicycling from anywhere within the case study. On the other hand, indicators based on

[1] To elaborate this section, relevant academic articles were systematically reviewed by conducting two searches of the Scopus database using keywords such as non-motorised, accessibility, retail activity, and commerce. The literature selection used two filters: (i) publications covering local and regional spatial scales; and (ii) publications using different methodological approaches to study both retail activity and non-motorised accessibility at city level.