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Data from mobile phone operators: A tool for smarter cities?

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ABSTRACT

The use of mobile phone data provides new spatio-temporal tools for improving urban planning, and for reducing inefficiencies in present-day urban systems. Data from mobile phones, originally intended as a communication tool, are increasingly used as innovative tools in geography and social sciences research. Empirical studies on complex city systems from human-centred and urban dynamics perspectives provide new insights to develop promising applications for supporting smart city initiatives. This paper provides a comprehensive review and a typology of spatial studies on mobile phone data, and highlights the applicability of such digital data to develop innovative applications for enhanced urban management.

1. Introduction

1.1. Impact of ICT on cities

There is a vivid discussion in the literature concerning the impact of Information and Communication Technologies (ICTs) on cities. Important contributions can be found in the seminal work of Graham and Marvin (1996, 2001) on '*Splintering Urbanism*'; in Batty's (1997) ideas on '*Virtual Geography*'; and in Castells's (1996) '*Space of Flows*'. All these studies share one common idea: "The city itself is turning into a constellation of computers" (Batty, 1995, p. 155). But this observation is not yet the end: it can be argued that, nowadays, computers have become mobilized and personalized. Sheller (2004) argues that contemporary networked cities are made up by flows of people, vehicles, and information. Data about such massive flows are difficult to collect, but are becoming increasingly available for social science research, even on a real-time basis (Shoval, 2007). Such data could enable us to better 'tune' our cities, since most of their functions are being constantly monitored. Moreover, the use of such data in urban analytics of high spatio-temporal resolution has now actually become a trend in various scientific fields including geography (Arribas-Bel, 2014; Miller, 2010). The last two observations show the potential of such 'big data' in urban planning and urban management, encapsulated in the question: Can insights derived from research using such data help us to improve our cities? This is the main research question of this paper.

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1.2. The role of time–space information in geography

Several approaches can be employed to highlight or critically review the value of real-time geography in urban research (Tranos, Steenbruggen, & Nijkamp, 2012). For example, the basis of a critical urban-political approach rests on the general argument that the pervasive character of ICTs across different economic sectors and urban environments supports the operation of the free market system at the global level (e.g. Sassen, 1991). Advocates of critical geography may even argue that space has become dehumanized and objectified (Graham, 1997). For instance, Soja (1989) highlights how, in the past, planning and geography have understood space as a dead, fixed, immobile, and undialectic entity, which is based on passive measurements instead of on actions and meanings. This creates the possibility of a new dimension for Newtonian influenced approaches towards space and time. Massey (1992) criticizes this research tradition by highlighting that space and time are conceptualized in classical physics as independent objects: "*Space is a passive arena*, *the setting for objects and their interaction*". Nonetheless, post-modern urban theory argues that there is little gain by separating space and time. On the contrary, there is only the joint effect of *space–time* (Thrift, 1996). Parallel to the non-linearity and multiplicity of time, places are non-contiguous, dissimilar, overlapping and dynamic entities (Graham and Healey, 1997). Geography based on digital data, e.g. mobile phone data, may address the above criticism of positivistic approaches to urban theory, as it enables the research community to analyze and model the *pulse of the city* (Batty, 2010). Such approaches do not focus exclusively on the physical form, but rather on human activity per se and its projection on cities. The underlying assumption here is that cities are not represented as a static canvas of urban zones. Instead, such research adopts a dynamic understanding of the urban environment, as manifested in numerous and diverse individual urban lifestyles. Space is not separated by time; the domain of such geography is the space–time continuum.

1.3. The role of mobile phone data to facilitate smart city objectives

In general, space–time data form a way to better understand the urban environment and its dynamics. Such data can serve to reveal how we as citizens relate to our urban contexts. In this sense, data analytics, usually enabled by data visualizations, can empower a city with knowledge and intelligence by helping us to identify patterns and relationships, enabling citizens and city managers with tools that support better decision making, discovery, exploration, and explanation of the city. The changes that digital technology – including the mobile telephone – have introduced in cities are, inter alia, reflected in a new faster pace of the urban lifestyle, and, in general, in a new and speedier urban systems metabolism. The latter refers to a *real-time city* which acts – and can be monitored – instantaneously (Graham, 1997; Townsend, 2000). This new characteristic of temporal and spatial responses from the standpoint of the urban user, which are then followed by reactions in terms of monitoring, creates a new exciting opportunity for urban planners and urban governance institutions.

For every 100 inhabitants of many cities, there were more than 85 mobile phone subscriptions[4] in 2011 (ITU, 2012). This remarkable increase (454 per cent in 2001–2011) indicates that mobile phones – including their broad communication options – have become an integral part of – and have undoubtedly transformed – the everyday life of a great part of the earth's population. Although this is easily visible to every observer, there is also another reading of this phenomenon: a great part of the earth's population can be now used as agents for data collection for (nearly) real-time, fine-grained spatial observations. In other words, what was initially introduced as an innovative mobile communication tool has now been transformed into a tool for socio-spatial research. And this is the particular focus of this paper, which provides a review and builds a typology of the various studies which utilize mobile phone data for spatial research in a smart city environment.

1.4. Aim and structure of the paper

The main objective of the present paper is to analyze, on the basis of an extensive literature review, whether and how the use of mobile phone data can facilitate urban management and planning. In other words, this paper aims to study whether and how research using fine-grained data from mobile phone operators can improve our cities. The starting point of this analysis is the 'smart city' framework, since the core of this concept is based on the interaction between ICT and urban space. Therefore, in Section 2, we discuss different smart city perspectives. Section 3 is devoted to a description of the nature of mobile phone data. Section 4 then focuses on the use of mobile phone data for analyzing human activity patterns. Section 5 provides a review of earlier urban studies based on data from mobile phone operators. Section 6 follows with a concise but broad overview of the applicability of such data, in order to develop a range of smart city applications to highlight different urban management functions and their objectives. Finally, in Section 7, we discuss the contributions and limitations of these data, and how they can contribute to urban management and planning, while Section 8 concludes the paper.

2. A panorama of smart city perspectives

The increasing concentration of people in urban agglomerations calls for the design of new strategies to maintain and improve a liveable, sustainable, accessible, and economically-viable environment and settlement pattern for citizens. The

[4] This figure goes up to 122 for the developed world and down to 78 for the developing world.