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Cagliari and smart urban mobility: Analysis and comparison

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ABSTRACT

In recent years, city officials in Cagliari (Italy) have shown a particular interest in policies and strategies that promote sustainable urban mobility. The Urban Mobility Plan (*Piano Urbano della Mobilità*), drafted in 2009, provides an important tool, transforming Cagliari's mobility in a smart direction by promoting alternative means of transport to the private vehicle. This paper describes a quantitative methodology for evaluating urban mobility in Cagliari, using a synthetic indicator, and suggests steps that Cagliari could take to meet international best practices for transportation. The data needed to analyse Cagliari's urban mobility are gathered, and the findings are compared to those from other comparable international cities. This intercity comparison allows the authors to consider how best to orient Cagliari's mobility towards international best practices.

1. Introduction

Continuing population growth and uncontrolled urbanization have led to the development of a new model of the city, called a 'smart city'. In recent years, the definition of a smart city has been widely discussed, leading the European community, academics, and public and private companies to develop a strong interest in this topic. However, there is as yet no unique definition of this concept. In this paper, the authors interpret this term as a synonym for growth, environmental sustainability, and inclusiveness. In all of this, the Information Communication Technology (ICT)'s tools enable leaders of smart cities to foster urban development (Caragliu & Del Bo, 2015), to 'economize time, improve individual mobility, facilitate access to information and services, save energy and resources, and participate in urban decision-making processes' (Kunzmann, 2014, p. 12). In doing so, a holistic and integrated approach is adopted to all aspects of development.

This integrated approach is also reflected in the transport sector—an important component of the economic and social development of urban areas.

The principal role of transport in economic growth depends on the capacity to move people and things, and on the application of intelligent transport management processes that improve the quality of life (European Commission, 2011; Montanari, Gragnani, & Franceschini, 2008; WBCSD, 2004).

Chun and Lee (2015) write that smart mobility 'is a concept of comprehensive and smarter future traffic service in combination with smart technology. A smart mobility society is realized by means of the current intelligent traffic systems'. Moving smartly depends on an efficient means of public transport having a low environmental impact (reduced greenhouse gas emissions and energy consumption), a network of safe and continuous cycle lanes, and interchange parking that avoids the city congestion, among others. However, the authors believe that the mobility cannot be considered smart if it is not also sustainable.

Transferring part of the demand from the private car to public transport influences the smartness of the urban context under study. However, the overall level of smartness is also affected by the transport system used. For example, this transfer of demand could occur with the use of internal combustion means, rather than electrical means. In the latter case, the level of smartness is greater than in the first, because it is more sustainable. Furthermore, the smart mobility concept appears to be more dynamic than the sustainable mobility concept, because it depends on the technology used. In the above example, the transfer of existing demand could occur, regardless of its sustainability. For example, reducing private car traffic appears smart. As a second step, the means could simply be replaced with electric cars even if the demand is unchanged. This positively impacts the level of smartness because electric cars are more sustainable. In fact, it is generally accepted that 'sustainable transport implies finding a proper balance between current and future environmental, social, and economic qualities', and that 'sustainable transport is that which satisfies current transport needs without jeopardising the ability of future generations to meet these needs' (Yigitcanlar, Fabian, & Coiacetto, 2008; p. 29).

This complexity is also attracting interest, especially with regard to smart cities' strategic policies (Banister, 2008; Bertolini, 2012; Lopez-Lambas, Corazza, Monzon, & Musso, 2013; Papa & Lauwers, 2015; Sheller & Urry, 2006).

A major difficulty of addressing congestion in urban areas—greenhouse gas emissions and the integration of various planning tools—is

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related to the lack of clear definitions of sustainability and sustainable transport (Van Nunen, Huijbregts, & Rietveld, 2011).

City planners often tend to focus on sustainable transport objectives and on measurable impacts, ignoring more complex immeasurable impacts (such as policies and human behaviours) that might play a greater role. According to Litman and Burwell (2006, p. 333), 'sustainable decision making can therefore be described as planning that considers goals and impacts regardless of how difficult they are to measure'. Bertolini (2012) analyses the evolutionary processes of cities from the time of the industrial revolution to the modern city, and focuses on how mobility has evolved in relation to urban changes, and especially to those changes linked to contemporary societies' needs. These needs become problematic if increasingly faster means of transport include more secure, integrated, and, above all, sustainable, transport. 'Planning urban mobility in the contemporary world must start from the acknowledgment of this core dilemma, and develop conceptual and practical tools for coping with it' (Bertolini, 2012, p. 18). Papa and Lauwers (2015) note that the smart mobility concept evolved in two stages. In the first stage, technology was a tool used to improve and optimise transport planning. The second stage incorporated the consumer as a key component of smart mobility.

This analysis suggests that viable mobility achieves an effective and efficient transport system through the use of technology (Ali-Vehmas & Casey, 2015; Ilarri, Stojanovic, & Ray, 2015), and the integration of physical and technological capital with human and social needs (Caragliu, de Bo, & Njkamp, 2011; Garau, 2015). Other researchers have concluded that contemporary sustainable transport mobility strategies must propose and promote alternative modes of travel, such as e-mobility (Arena et al., 2013; John, Schulz, Vermesan, & Kriegel, 2013; Longo & Roscia, 2014), and the closer integration of transport planning with the territory (Bos, Straatemeier, & Temme, 2014; Hull, 2011; Jones, 2012; Kim, Hwang, & Suh, 2014; Lopez-Lambas et al., 2013; Manaugh, Badami, & El-Geneidy, 2015).

Although performing this kind of integration is complex, Mattoni, Gugliermetti, and Bisegna (2015) propose a method for advancing integrated planning that is useful for local administrators, by analysing the interrelationships between the various strategic axes of smart cities (economy, mobility, environment, people, living, governance), in order to create a global vision of what happens in urban settlements.

The EU strategies 'Horizon 2020' set targets for urban contexts (such as: transforming the use of conventionally fuelled vehicles in urban areas, tackling urban road congestion, demonstrating and testing innovative solutions for cleaner and better urban mobility), and consequently, cities in the EU now use benchmarking to monitor and evaluate their implementation of smartness and the effectiveness of their transportation strategies (Giffinger et al., 2007; Zhu, 2009).

Giffinger et al. (2010, p. 300) assert that 'city rankings have become an important empirical base for disclosing comparative advantages and sharpening specific profiles and consequently for defining goals and strategies for future development'. However, this type of assessment has drawbacks if cities fail to collaborate in the collection and dissemination of their data for a major comparative study, and/or when they delay improving their performance, after obtaining a good ranking. Thus, they lack the dynamic characteristic typical of being smart. Positive results should not be considered a goal but an incentive to continuously improve.

Few studies measure smartness using quantitative indicators (Garau, Masala, & Pinna, 2015; Moeinaddini, Asadi-Shekari, & Zaly Shah, 2014) because of difficulties associated with finding the necessary data, and the lack of a well-defined system of indicators. Castillo and Pitfield (2010, p. 181) note that selecting qualitative indicators—applicable independent of the availability of data—is problematic, because there are many possible potential indicators, and identifying those most representative of system performance is challenging.

The innovative dimension of this paper is that it describes a system of quantitative indicators that can be used to assess smart mobility in terms of public transport, alternative mobility options, and technological mobility services. The authors chose to deepen these aspects, because they consider these factors to be principal aspects of smart mobility. In particular, public transport and alternative mobility options are fields of action, while technological mobility services enhance the efficiency and effectiveness of the fields of action.

Cagliari has been chosen as the case study because officials in this city have for three years been engaged in a smart mobility urban development project. They are encouraging the use of public transport, and experimenting with alternative forms of mobility. Comparing Cagliari to other national and international cities (to allow subsequent generalisations) facilitates the evaluation of today's development policies in relation to mobility, and provides an orientation to mobility in Cagliari. Details of the methodology used for this case study are explained next, after which a city profile of Cagliari and a description of the city's mobility characteristics are provided. Application of the study's methodology to Cagliari is explained, and the results are compared to other urban contexts. The discussion summarises the study's findings, and the concluding section provides six recommendations for improving Cagliari's mobility.

2. Methodology

Numerous studies have used indicators to measure and evaluate the performance of various sectors, including mobility (Caragliu et al., 2011; Debnath, Chin, Haque, & Yuen, 2014; Garau et al., 2015; Giffinger et al., 2007; Moeinaddini et al., 2014). Debnath et al. (2014) analyse private and public mobility, as well as commercial and emergency mobility. Four membership categories have been identified for each selected indicator: non-availability, testing, partial coverage, and full coverage. Different subsets of indicators have been identified to analyse these aspects of mobility. Moeinaddini et al. (2014) use indicators extrapolated from the international organisation for public transport authorities, operators, and policy decision-makers (UITP) to evaluate private motorized mobility in Hong Kong and Chicago. This evaluation uses a mobility index 'for evaluating transportation in cities at the macro-level' (Moeinaddini et al., 2014, p. 30). Garau et al. (2015) construct a synthetic urban mobility indicator to assess the infrastructures of different transport services (public transport, cycle lines, bikes, and car sharing, and the technological tools available to support mobility), and to assess the mobility options' smartness.

2.1. Determining the synthetic indicator

Garau et al. (2015)—to whom we particularly refer in this paragraph—chose six variables to generate a smart mobility synthetic indicator. In comparison, the value of this paper is demonstrating the applicability of the methodology previously applied to Italian case studies for international cities, despite cultural, behavioural, and legislative differences. This article also facilitates understanding the variables used, and highlights the relative ranking of each city using a graphical representation of the key variables: public transport, cycle lanes, bike sharing, and car sharing.

This synthetic indicator is considered smart because it combines the main modes of transport with smart technology's management of movements. It can be used to analyse a city's mobility from different aspects, since each variable is comprised of a sub-set of the indicators shown in Table 1.

The first four variables in Table 1 are measurable indicators (identified by one or more units of measurement), while the last two indicators are evaluated for their presence or absence with a numerical value. The synthetic indicator of smart mobility has been defined with a geometric mean, thereby allowing researchers to merge the six variables under study, using Formula 1:

$$I_{SM} = (I_{PT} * I_{CL} * I_{BS} * I_{CS} * I_{PMSS} * I_{PTSS})\ (1/6) \qquad (1)$$

Standardization enabled the comparison of each variable's indicators, which are expressed in different units, and facilitated the design of a scale