Cities 60 (2017) 234–245

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

What are the differences between sustainable and smart cities?

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ARTICLE INFO

Article history:
Received 22 June 2016
Received in revised form 13 September 2016
Accepted 14 September 2016
Available online 26 September 2016

Keywords:
Smart city
Sustainable city
Indicator
Assessment framework
Performance measurement

ABSTRACT

City assessment tools can be used as support for decision making in urban development as they provide assessment methodologies for cities to show the progress towards defined targets. In the 21st century, there has been a shift from sustainability assessment to smart city goals. We analyze 16 sets of city assessment frameworks (eight smart city and eight urban sustainability assessment frameworks) comprising 958 indicators altogether by dividing the indicators under three impact categories and 12 sectors. The following main observations derive from the analyses: as expected, there is a much stronger focus on modern technologies and "smartness" in the smart city frameworks compared to urban sustainability frameworks. Another observation is that as urban sustainability frameworks contain a large number of indicators measuring environmental sustainability, smart city frameworks lack environmental indicators while highlighting social and economic aspects. A general goal of smart cities is to improve sustainability with help of technologies. Thus, we recommend the use of a more accurate term "smart sustainable cities" instead of smart cities. However, the current large gap between smart city and sustainable city frameworks suggest that there is a need for developing smart city frameworks further or re-defining the smart city concept. We recommend that the assessment of smart city performance should not only use output indicators that measure the efficiency of deployment of smart solutions but also impact indicators that measure the contribution towards the ultimate goals such as environmental, economic or social sustainability.

1. Introduction

According to an estimate by the United Nations, by 2050 66% of the world's population will live in urban areas (United Nations, 2015a) giving rise to extensive challenges regarding air pollution, congestion, waste management and human health (OECD, 2012). As the European Union (European Commission, 2014) and United Nations (2016) have set ambitious climate and energy targets for the coming years, there is an urgent need to develop smart solutions to overcome the challenges of urbanization.

Cities have a key role in fighting against climate change and the deployment of new intelligent technologies is seen as key factor in decreasing greenhouse gas emissions and improving energy efficiency of cities. These technologies need to be smart, lean, integrated, cost-efficient and resource-efficient, and they should have an impact not only on environmental sustainability targets but also on citizens' wellbeing and financial sustainability.

In recent years, there has been a shift in cities striving for smart city targets instead of sustainability goals (Marsal-Llacuna, Colomer-Llinàs, & Meléndez-Frigola, 2015). However, these are interconnected and often smart cities share similar goals as sustainable cities. A large variety of smart city definitions exist (Albino, Berardi, & Dangelico, 2015) and not all definitions reflect their relation with the sustainability targets. Hence, there is a need to better understand the relation of the smart and sustainable city concepts (Bifulco, Tregua, Amitrano, & D'Auria, 2016).

In European Union's (2011) view the smart city concept supports the idea of environmental sustainability as its main aim is reducing greenhouse gas emissions in urban areas through the deployment of innovative technologies. The growing interest in the smart city concept and the needs to solve the challenges related to urbanization lead to several private and public investments in the technology development and deployment. This can be seen in the high number of smart city initiatives, city implementation projects and jointly-funded public research projects. In 2012 there were 143 ongoing smart city projects of which 47 were located in Europe and 30 in the USA (Lee & Hancock, 2012). Cities have also been setting high targets for a clean future by taking part in initiatives and city networks such as Covenant of Mayors (Covenant of Mayors), CIVITAS (CIVITAS), CONCERTO (CONCERTO) and Green Digital Charter (Green Digital Charter). These were established to support the striving for the ambitious energy efficiency and CO_2 reduction targets such as the European Union 2030 targets. Tools are needed

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http://dx.doi.org/10.1016/j.cities.2016.09.009
0264-2751/

to help the decision makers to take actions towards the wanted direction, derive these to the operational level and to assess cities' progress in pursuing these targets. Therefore, several frameworks have been developed to assess urban performance, some focusing on urban sustainability and others more on the smart cities technologies itself.

The aim of this study is to develop understanding of the similarities and differences between the sustainable and smart cities concepts and respective assessment frameworks. To do so, eight existing sustainable and smart city performance measurement systems were compared with regard to the application domains and impact categories of the indicators used.

1.1. Urban sustainability

In our study we compare smart city assessment frameworks with urban sustainability frameworks and therefore a brief review on the development of these two types of urban assessment is given.

In line with the original definition of sustainable development (WCED, 1987), a city can be defined to be sustainable "if its conditions of production do not destroy over time the conditions of its reproduction" (Castells, 2000). More recently, Hiremath, Balachandra, Kumar, Bansode, and Murali (2013) have characterized urban sustainable development as "achieving a balance between the development of the urban areas and protection of the environment with an eye to equity in income, employment, shelter, basic services, social infrastructure and transportation in the urban areas". A large number of environmental assessment tools and frameworks have been developed for the building sector to help political decision making and to ensure that with the measures taken the built environment sector as well as transport is moving towards sustainability goals. Recently there has been a change in the focus and instead of single buildings the targets of assessment now consist of neighborhoods and districts enabling the simultaneous consideration of built environment, public transportation and services, among others (Haapio, 2012).

According to Marsal-Llacuna et al. (2015) urban monitoring started in the 1990s when the Local Agenda 21 (United Nations, 1992) established indicators to monitor sustainability of urban areas. Quality of life aspects with respective indicators appeared in the following decade, initiated by Mercer's annual quality of life survey (Mercer, 2014) and the Economist Intelligence Unit's quality of life index (Economist Intelligence Unit, 2005). The livable city concept has further been presented by at least two well-known rankings by media companies: Monocle's Most Livable City (Monocle, 2014) ranking and International Living's Quality of Life Index (International Living, 2014).

McManus (2012) presents that urban sustainability indicators are produced by three types of organizations: environmental organizations, organizations promoting green citizenship and sustainable capitalism and consultancy organizations. The tools that have been developed are either sustainable city rankings or tools that allow cities to compare best solutions and find best practices. A number of indicator systems have also been developed by research organizations and research projects. According to Tanguay, Rajaonson, Lefebvre, and Lanoie (2010) sustainable development indicators are increasingly used by public administration in order to confirm cities' sustainable development strategies especially by enabling assessment and monitoring activities. However, as Huang, Yeh, Budd, and Chen (2009) remark, there are limitations with the use of sustainability indicators as they neither reflect systemic interactions, nor provide normative indications on the direction to be followed.

Diverse urban sustainability assessment tools approach sustainability from different angles. Well-known neighborhood sustainability rating tools, such as LEED, BREEAM and CASBEE, analyzed for example by Sharifi and Murayama (2013), aim at labelling. On the other hand, Hedman, Sepponen, and Virtanen (2014) present a tool which was developed to help city planners to assess the energy efficiency of a detailed city plan, by analyzing the energy demand of buildings and transportation as well as the energy system and source of energy. In addition, transportation has been the focus of several assessment frameworks, developed particularly for densely populated Asian cities, such as the Partnership for Sustainable Urban Transport in Asia (PSUTA) (CAI-Asia Program) and the Bangalore Mobility Indicators (Directorate of Urban Land Transport, 2011). The versatility of different approaches can however be seen as a problem when looking for a holistic assessment framework for steering integrated challenges. As Tanguay et al. (2010) suggest, "the absence of a less general and more universal definition of sustainable development has given rise to multiple interpretations and in particular has triggered an explosion of indicators".

Even though sustainability is typically characterized by simultaneous consideration of economic, environmental and social impacts, the existing assessment tools usually have a strong environmental focus (Berardi, 2013; Robinson & Cole, 2015; Tanguay et al., 2010). For example, the most well-known sustainable neighborhood rating schemes BREEAM, CASBEE and LEED assign very low weight to direct economic and social measures (on average 3% for business and economy and 5% for well-being) (Berardi, 2013). Moreover, the so called "green" or "sustainable" design approaches have been criticized to only focus on reducing the pace of doing harm to the environment (Cole, 2012; Reed, 2007), and therefore the more integrative and holistic term of "regenerative sustainability" has been suggested instead (Robinson & Cole, 2015). As most of the sustainability assessment tools have been developed top-down by expert organizations, many scholars (Berardi, 2013; Reed, Fraser, & Dougill, 2006; Robinson & Cole, 2015; Turcu, 2013) have called for the integration of citizen-led, participatory, localized and procedural approaches.

In order to properly address the interactions between the different aspects of a city a systemic approach is needed. Cities need to be understood as urban ecosystems that are composed of interactions between the social, biological and physical components (Nilon, Berkowitz, & Hollweg, 2003). The understanding of the relationships between people, their activities and the environment is key to achieve sustainability. Urban morphology studies the spatial structures and character of a city. The spatial distribution of activities and accessibility of different services – especially urban forms, functions and their connections – are crucial aspects of a sustainable city that uses its resources most efficiently (Bourdic, Salat, & Nowacki, 2012; Salat & Bourdic, 2012).

1.2. The smart city concept

The concept "smart city" was introduced already in 1994 (Dameri & Cocchia, 2013) and since 2010, after the appearance of smart city projects and support by the EU, the number of publications regarding the topic has considerably increased (Jucevicius, Patašienė, & Patašius, 2014). While this concept is widely used today there is still not a clear and consistent understanding of its meaning (Angelidou, 2015; Chourabi et al., 2012; Caragliu, Del Bo, & Nijkamp, 2011; Hollands, 2008; Marsal-Llacuna et al., 2015; Wall & Stravlopoulos, 2016). A common understanding, also shared by the European Commission, is that diverse technologies help in achieving sustainability in smart cities (European Commission, 2012). According to the latter source, smart cities and communities focus on the intersection between energy, transport and ICT, which are also the fields that have received most of the EU's public smart cities related funding (under the Horizon 2020 program "smart cities and communities"). Marsal-Llacuna et al. (2015) present that the smart city assessment builds on "the previous experiences of measuring environmentally friendly and livable cities, embracing the concepts of sustainability and quality of life but with the important and significant addition of technological and informational components". Even if both policy makers and academia have recognized the use of modern technologies as an inseparable aspect of smart cities, a great number of definitions with slightly different angles have been provided.