Land Use Policy 73 (2018) 49–58

Contents lists available at ScienceDirect

Land Use Policy

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

Does smart city policy lead to sustainability of cities?

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ARTICLE INFO

Keywords:
Smart city
Sustainable city
Sustainable urban development
Carbon dioxide emissions
Panel data model
United Kingdom

ABSTRACT

The popular smart city concept, for some, is viewed as a vision, manifesto or promise aiming to constitute the 21st century's sustainable and ideal city form, while for others it is just a hype. This paper places smart city practices from the UK under the microscope to investigate their contributions in achieving sustainable urban outcomes. Panel data analysis methods were employed to investigate changes in carbon dioxide emissions level of 15 UK cities with differential level of city smartness over the period of 2005–2013. The findings reveal that the link between city smartness and carbon dioxide emissions is not linear, and the impact of city smartness on carbon dioxide emissions does not change over time. This finding calls for better aligning smart city strategies to lead to concrete sustainable outcomes. The paper concludes by highlighting the importance of prospective investigations to accurately scrutinise existing smart city projects' outcomes, and emphasising the necessity of developing smart city agendas that deliver sustainable outcomes.

1. Introduction

Not to a surprise, the 21st century is promoted as the 'century of cities' (Carrillo et al., 2014). By 2030, 60% of the world's population is expected to live in mega-cities; by 2050, 75% of the world's population will be living in urban areas; and this figure will reach to over 80% at the end of the century (Hardoy et al., 2013; Dizdaroglu and Yigitcanlar, 2014). Today, some of the developed nations have already exceeded this urbanisation rate. For instance, in the UK well over 80% of the population is residing in urban areas. Moreover, the Anthropocene era is already upon us, which is characterised by massive human impacts on geological and ecological systems (Crutzen and Steffen, 2003).

Urban growth is a major phenomenon of the Anthropocene era, which is taking place on an unprecedented scale globally, and its impacts on society and the environment are evident (Perveen et al., 2017). Particularly, greenhouse gas (GHG) emissions, including carbon dioxide (CO_2), are major contributors of the global warming (Mahbub et al., 2011; Yigitcanlar and Dizdaroglu, 2015). Climate change in this era has severe implications for the security of individuals, communities, cities, regions, and the planet (Deilami et al., 2018). Mitigating global climate change and neutralising the impacts of fossil fuel-based energy policy on the environment have emerged as the biggest challenges for the planet, threatening both natural and built systems with long-term consequences (Dur and Yigitcanlar, 2015; Arbolino et al., 2017). In recent years, a broad consensus is established on sustainable urban development—or smart growth—being a panacea to the ills of the Anthropocene era—such as the Paris Agreement (Dizdaroglu et al., 2012; Yigitcanlar and Kamruzzaman, 2014). Consequently, the challenge of sustainable urban development has resulted in 'smart cities' and appeared as a hot topic of research and practice globally.

Over the past decade smart urban technologies, as part of the smart city agenda, have begun to blanket our cities with an aim of forming the backbone of a large and intelligent infrastructure (Lee et al., 2008). Along with this development, dissemination of the sustainability ideology has had a significant imprint on the planning and development of our cities (Zhao, 2011; Goonetilleke et al., 2014). Today, the smart city concept is viewed as a vision, manifesto or promise aiming to constitute the 21st century's sustainable and ideal city form. In other words, smart city is an efficient, technologically advanced, green and socially inclusive city (Vanolo, 2014). This is to say, smart city applications place a particular technology focus at the forefront of generating solutions for ecological, societal, economic, and management challenges (Yigitcanlar, 2016). However, despite their promise to deliver sustainable outcomes with the aid of advanced technology, smart cities are heavily criticised as being just a buzz phrase that has outlived their usefulness (Kunzmann, 2014; Shelton et al., 2015).

Smart cities' primary focus mostly being exclusive to technology has been heavily criticised by a number of scholars. For instance, the darker side of smart cities—particularly the extreme dependency on technology, and on corporations dominating technology and related services—is mentioned in the literature as threatening. As stated by Kunzmann (2014, p. 17), "sooner or later society will not manage any more to live without the ICT-based services. Like addicts, or chronically sick patients who are extremely suffering from the lack of some

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https://doi.org/10.1016/j.landusepol.2018.01.034
Received 14 November 2017; Received in revised form 9 January 2018; Accepted 21 January 2018

substance, respectively the medicine they are relying on, citizens will become sick, if the access to smart ICT services will be cut-off. They will soon forget how to survive in cities, once smart ICT technologies are not available any more. The concentration processes, which characterize the global market of smart technologies, are threatening".

Smart city projects are big and expensive investments that are supposed to drive societal and environmental transformations. However, for example after more than a decade of investment, Songdo City (Korea)—widely referred to as the world's first smart city—is still a 'work in progress' project without concrete sustainable outcomes (Yigitcanlar and Lee, 2014). On the contrary, Shwayri (2013) pinpoints the negative environmental externalities caused by the development of the Songdo smart city.

In spite of the heavy criticisms of smart city sceptics of this type of urban form and development practice, as presented above, there is a general sense among the scholars that rethinking our cities' planning and development paradigms and processes in the age of digital disruption and climate change is a good thing (Angelidou, 2017). It is, thus, imperative to clearly understand what smart city agenda can deliver for cities before our governments are heavily investing on, and jumping on to the smart city bandwagon. However, despite the increasing popularity of the paradigms of smart and sustainable cities, measuring sustainability levels of smart cities is an under-investigated research area. Moreover, there are no empirical studies, so far, scrutinising the GHG emissions of so-called smart cities—the literature mainly focuses on the sustainable city context rather than smart cities (Coutts et al., 2010; Velasco and Roth, 2010).

Against this backdrop, the study aims to capture the big picture view on whether smart city practices have been making considerable contributions to local sustainability agendas by improving sustainable urban development outcomes. Empirically investigating sustainability achievements of smart cities is important to provide evidence on whether this new and popular smart city policy contributes to the sustainability agendas and/or accomplishments of cities. As both smart cites and sustainable urban development concepts are highly complex in nature, for practical reasons, the paper uses proxies for these concepts: (a) Smart cities concept is characterised as city smartness, and; (b) Sustainable urban development concept is characterised as CO_2 emissions. In order to address the critical issue of whether smart city policy leads to sustainability of cities, the paper focuses on the following two research questions:

(a) Does city smartness bring sustainability to cities in terms of CO_2 emissions?
(b) Does the impact of city smartness on CO_2 emissions change over time?

Following this introduction in Section 1 of the paper, Section 2 provides a review of the literature on smart city concepts, and their potential links with urban sustainability. Next, Section 3 outlines the data and methods applied to address the research questions. Afterwards, the findings of the empirical analysis are presented in Section 4, and discussed in policy terms. Finally, Section 5 concludes this paper by highlighting the key findings of the study.

2. Literature review

The adoption of technology is a global phenomenon, and the intensity of its usage is impressive all over the world. Particularly, state-of-the-art smart urban information technologies play critical roles in supporting decision-making, design, planning, development, and management operations of complex urban environments (Yigitcanlar, 2015). Their role in dealing with complexity and uncertainty and in generating sustainable and liveable urban environments has been a popular subject for many scholars (Lee et al., 2014). This has brought, with strong push from major global technology companies—such as IBM, Cisco, Schneider Electric, Siemens, Oracle—, the smart city notion and practice to the forefront of urban agenda in many cities of the world (Alizadeh, 2017).

As stated by Goh (2015, p. 169), "visions of a kind of technology-infused smart city are becoming reality, translated from the realm of concepts into actual urban space". Particularly the development of smart urban systems through effective use of smart urban technologies is providing an invaluable foundation for smart cities to surface. Today, more and more governments are showing interest in smart urban system investment to make cities more efficient, sustainable and inclusive. Consequently, it is estimated that the global market for smart urban systems for transport, energy, healthcare, water and waste will be around US$400 billion per annum by 2020 (Yigitcanlar, 2016). This is to say smart urban systems will fast become an integral part of our lives. In recent years, many researchers explored the most common and advanced smart urban systems, and offered examples of their adoption in the contemporary cities of the world (Klauser and Albrechtslund, 2014).

Over the past decade smart urban technologies have started to form the backbone of a large and intelligent infrastructure network in cities. Along with this development, dissemination of the sustainability ideology has had a significant imprint on the planning, development and management of our cities (Dizdaroglu and Yigitcanlar, 2016). Accordingly, the concept of smart cities, evolved from intelligent cities (Komninos, 2008), has become a popular topic particularly for scholars, urban planners, urban administrations, urban development and real estate companies, and corporate technology firms.

Despite its popularity, so far, there is no prevalent or universally acknowledged definition of smart cities. Instead, there are numerous perspectives on what constitute a smart city. These are ranging from purely ecological (Lim and Liu, 2010) to technological (Townsend, 2013), and from economic (Kourtit et al., 2012) to organisational (Hollands, 2015), and societal (Deakin and Al Waer, 2012) views. Ecological perspective of smart cities focuses on getting local governments, businesses and communities to commit to reducing GHG emissions, reversing sprawling development, increasing urban density, increasing greenspaces, encouraging polycentric development, and so on (Lazaroiu and Roscia, 2012). Technological perspective focuses on adoption of smart urban technology solutions to improve liveability of communities and sustainability of cities—these technologies also include infrastructural ICTs that serves as the backbone such as internet and world wide web (Paroutis et al., 2014). Economic perspective focuses on generating an innovation economy through smart technology solution development, thus increasing the GDP and self-containment of the city (Zygiaris, 2013). Organisational perspective focuses on establishing a transparent and democratic governance model (Meijer and Bolívar, 2016). Societal perspective focuses on establishing socio-economic equality and public participation in the smart city planning and initiatives (Lara et al., 2016).

As for Kitchin (2015), smart city symbolises a new kind of technology-led urban utopia. Utopia or not, in all above mentioned perspectives the vision of technology and innovation is a common ground to shape our cities into a form that we want to leave to our descendants. This is to say, without a commonly agreed definition, the smart cities concept is broadly viewed as a vision, manifesto or provocation—encompassing techno-economic, techno-societal, techno-spatial, and techno-organisational dimensions—aiming to constitute the sustainable and ideal 21 st century city form (Yigitcanlar, 2016). Nevertheless, presently, there are no fully-fledged smart cities (Trindade et al., 2017).

Stated by Glasmeier and Christopherson (2015, p. 4), "over 26 global cities are expected to be smart cities in 2025, with more than 50% of these smart cities from Europe and North America". Smart cities are a global phenomenon today, as there are well over 250 smart city projects underway across 178 cities around the world. The potential success of these cities triggers much more cities to follow their