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Understanding 'smart cities': Intertwining development drivers with desired outcomes in a multidimensional framework

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ABSTRACT

The convergence of technology and the city is commonly referred to as the 'smart city'. It is seen as a possible remedy for the challenges that urbanisation creates in the age of global climate change, and as an enabler of a sustainable and liveable urban future. A review of the abundant but fragmented literature on smart city theories and practices, nevertheless, reveals that there is a limited effort to capture a comprehensive understanding on how the complex and multidimensional nature of the drivers of smart cities are linked to desired outcomes. The paper aims to develop a clearer understanding on this new city model by identifying and linking the key drivers to desired outcomes, and then intertwining them in a multidimensional framework. The methodological approach of this research includes a systematic review of the literature on smart cities, focusing on those aimed at conceptual development and provide empirical evidence base. The review identifies that the literature reveals three types of drivers of smart cities—community, technology, policy—which are linked to five desired outcomes—productivity, sustainability, accessibility, wellbeing, liveability, governance. These drivers and outcomes altogether assemble a smart city framework, where each of them represents a distinctive dimension of the smart cities notion. This paper helps in expanding our understanding beyond a monocentric technology focus of the current common smart city practice.

1. Introduction

Improper and deliberate human activities pushed the planet into the Anthropocene epoch—characterised by significant impacts on geology, ecosystems, and climate change (Dizdaroglu & Yigitcanlar, 2014; Smith & Zeder, 2013). Despite representing only about 2% of the geographic space and accommodating over 50% of the world population, cities today produce 80% of greenhouse gas (GHG) emissions and consume 80% of the world's resources (Arbolino, Carlucci, Cira, Ioppolo, & Yigitcanlar, 2017; Arbolino, Carlucci, Cira, Yigitcanlar, & Ioppolo, 2018; Ioppolo, Cucurachi, Salomone, Saija, & Shi, 2016; Ioppolo, Heijungs, Cucurachi, Salomone, & Kleijn, 2014; La Greca & Martinico, 2016). A heavy reliance on non-renewable resources increases GHG emissions including a vast amounts of carbon-dioxide (CO_2) responsible for global warming (Goonetilleke, Yigitcanlar, Ayoko, & Egodawatta, 2014; Mahbub, Goonetilleke, Ayoko, Egodawatta, & Yigitcanlar, 2011; Szopik-Depczyńska et al., 2017; Yigitcanlar, Dodson, Gleeson, & Sipe, 2007).

At the dawn of the catastrophic global climate change era, 'smart cities' came to the scene as a potential panacea to, somehow, reverse or ease the impacts of ill urbanisation, industrialisation, and consumerism practices (Taamallah, Khemaja, & Faiz, 2017; Trindade et al., 2017; Wiig, 2015). Although the initial rationale for the smart city developments was mostly related to environmental concerns, the practice, unfortunately, indicates that only marginal attention is paid to these concerns. Current practice is mostly unidimensional with technology at the core (Yigitcanlar, 2016). This unidimensional focus is a result of, as well as points to, a number of challenges that smart city practice is facing to overcome. These are briefly elaborated below.

Firstly, the fourth industrial revolution (Industry 4.0) helps leading

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global cities to advance their innovation edges, and hence, further secure their global hub status in innovation and knowledge generation (Edvardsson, Yigitcanlar, & Pancholi, 2016; Yigitcanlar, Guaralda, Taboada, & Pancholi, 2016; Yigitcanlar, Sabatini-Marques, Costa, Kamruzzaman, & Ioppolo, 2017). Subsequently, cities that are falling behind started to strategize their economic development to increase abilities in fostering, attracting, and retaining innovation activities (Holland, 2015; Millar & Choi, 2010; Pancholi, Yigitcanlar, & Guaralda, 2017a; Yigitcanlar, Edvardsson, et al., 2017). Smart cities agenda in many cities—e.g., Amsterdam, Vienna—goes hand-in-hand with these knowledge-based economic development efforts (Carrillo, Yigitcanlar, García, & Lönnqvist, 2014; Esmaeilpoorarabi, Yigitcanlar, & Guaralda, 2016, 2018; Sarimin & Yigitcanlar, 2012). Today, smart cities are seen as the hubs of technological innovation—e.g., San Francisco, Seoul—(urban areas generate 93% of the world's patented inventions) rather than cities of sustainable development.

Secondly, smart city projects, nonetheless, are big and expensive capital investments—supposed to drive societal and environmental transformations—, thus very hard to properly deliver. Current practice is highly ad hoc in nature in transforming cities and societies into truly smart ones. For example, after over 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 achieving any concrete desired outcomes (Yigitcanlar & Lee, 2014). This ad hoc approach makes the smart city practice highly risky to accurately identify, produce and/or meet desired socio-spatial outcomes.

Next, Han and Hawken (2018, p. 1) underline the monocentric focus on technology of the present smart city practice by stating: "Current discourse on smart cities is obsessed with technological capability and development. Global rankings reduce cities to a one-dimensional business model and series of metrics. If the term 'smart city' is to have any enduring value, technology must be used to develop a city's unique cultural identity and quality of life for the future." The comprehension of smart cities in current practice carries a risk of leading to a long-term trend towards increasing dependency on technology, and negligence of socio-spatial issues (Yigitcanlar, 2016).

Fourthly, the popularity of smart cities agenda is mainly an outcome of the aggressive promotion/push of major global technology, development, and consultancy firms and their programs—e.g., KPMG and CISCO's partnership in smart cities, and IBM's Smarter Planet, and Smarter Cities Challenge initiatives (Alizadeh, 2017). While smart city sceptics raised their concerns about the ongoing global craze on this new city brand (Anthopoulos, 2017; Grossi & Pianezzi, 2017; Kunzmann, 2014), many governments across the globe are still jumping on the smart cities bandwagon by turning a blind eye to these warnings (Caragliu, Del Bo, & Nijkamp, 2011; Townsend, 2013).

Lastly, there are too many smart city definitions/conceptualisations—focusing on separate aspects of drivers or outcomes—in the rapidly growing literature. These are coined by scholars and commercial, government and international organisations and mostly vague or inchoate in conception (Dameri, 2013). However, due to the infancy, interdisciplinary nature or generally poor conceptualisation, there is not a commonly agreed definition of smart cities. This is due to the lack of a sound and/or common conceptual understanding. Scholars, practitioners, and organisations developed their frameworks that suit their own particular practical perspectives—rather than (in general) a generic framework outlining the complexities and links of various dimensions of smart cities in a comprehensive and at the same time a simple way.

Against this backdrop, this paper aims to address the broad conceptualisation and multidimensionality issues through developing a better understanding of the smart cities notion—in terms of identifying the key development drivers and desired outcomes and placing them under a multidimensional framework. This would, in turn, help urban administrators and smart city practitioners better grasp the smart city notion and assist them in undertaking necessary actions to utilise the smart city drivers to achieve the desired outcomes. The methodological approach adopted in this research includes a systematic but at the same time critical review of the interdisciplinary literature on smart cities focusing on conceptual analysis in order to develop a multidimensional framework. By developing such framework, this study contributes to the efforts of a few other scholars, who have developed multidimensional conceptualisations and frameworks, and expands the understanding beyond a mostly monocentric focus of the current common smart city practice.

2. Smart cities in a nutshell

2.1. Origin and definition

In recent years, the development of smart cities is at the forefront of the urban discourse due to rapid urbanisation rate and associated socioeconomic, environmental and governance challenges, along with the global innovation leadership challenge (Belanche, Casaló, & Orús, 2016). Nevertheless, the concept of smart city is not new. The term was first coined in the mid-1800s to describe new cities of American West that were efficient and self-governed. However, it has its contemporary origins in the 'smart growth' movement of the 1990s—referencing to sustainable urbanisation (Eger, 2009; Albino, Berardi, & Dangelico, 2015; Susanti, Soetomo, Buchori, & Brotosunaryo, 2016).

Since 1990s, the smart city concept has evolved to mean almost any form of technology-based innovation in the planning, development, operation and management of cities, for example, the deployment of smart mobility solutions to combat urban traffic challenges (Battarra, Gargiulo, Pappalardo, Boiano, & Oliva, 2016; Harrison & Donnelly, 2011; Yigitcanlar, Fabian, & Coiacetto, 2008). With the offerings of digital technologies and online urban planning opportunities, this concept increased its popularity among the urban technocrats (Aina, 2017; Pettit et al., 2018; Yigitcanlar, 2005, 2006).

Although originated from the smart growth movement, a smart city can be, sometimes mistakenly, termed in other jargons. These include sustainable city (Bulkeley & Betsill, 2005), digital city (Aurigi, 2005), intelligent city (Komninos, 2008), ubiquitous city (Lee, Yigitcanlar, Han, & Leem, 2008), techno-centric city (Willis & Aurigi, 2017), creative city (Baum, O'Connor, & Yigitcanlar, 2009), and knowledge city (Yigitcanlar, Velibeyoglu, & Martinez-Fernandez, 2008). However, the notion of smart city is not equivalent to these city brands; but smart cities carry some of the common characteristics of other city brands or their conceptualisations. For example, an intelligent city is not equivalent to the notion of smart city, instead it focuses on only either a single aspect of the smart city field (e.g., ICT) or on other less closely related issues (e.g., resilient city). These branding variations have occurred as a result of different interpretations of what an ideal city should be like, and which policies these cities utilise to sustain growth, and address socio-spatial inequalities of resources (Chang, Sabatini-Marques, da Costa, Selig, & Yigitcanlar, 2018). However, subsequent to the increasing popularity of the smart city phenomenon, in recent years many cities across the globe incorporated the 'smart' tag in their brands. For instance, Songdo was initially branded as a 'ubiquitous city', but the new brand is now a 'compact smart city'.

During the last two decades, the pace of globalisation has accelerated a number of large multinational corporations' focus on the lucrative smart urban technology and engineering solutions. IBM, Cisco, Microsoft, Hitachi, Samsung, LG, Siemens, ARUP, KPMG, and a number of national telecommunication companies—e.g., Alcatel, KT Corporation—are among the front-runners of the industry that led the expansion of smart cities movement, and technology deployment across the global cities (Yigitcanlar, 2016). Moreover, today various technology and car manufacturing companies—e.g., Google, Uber, Volvo, Tesla, Audi, BMW, Mercedes-Benz, Nissan to name a few—also joined the smart cities bandwagon with their smart mobility solutions of autonomous vehicles or driverless cars (Shladover, 2017). The global