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The making of smart cities: Are Songdo, Masdar, Amsterdam, San Francisco and Brisbane the best we could build?

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ABSTRACT

Transforming urban areas into prosperous, liveable, and sustainable settlements is a longstanding goal for local governments. Today, countless urban settlements across the globe have jumped into the so-called 'smart city' bandwagon to achieve this goal. Under the smart city agenda, presently, many government agencies are attempting to engineer an urban transformation to tackle urban prosperity, liveability, and sustainability issues mostly through the means of technology solutions. Nonetheless, the notion of smart cities is ambiguous, and there are limited conceptual frameworks to assist cities and their administrations in understanding the big picture view of this urban development paradigm. The aim of this paper is to generate a clear understanding on the making of successful smart city practices. This is done by elaborating the smart cities notion through a multidimensional conceptual framework, examining smart city best practices across the globe—i.e., Songdo, Masdar, Amsterdam, San Francisco, Brisbane—, and providing insights of smart city approaches from these cases. The findings of the study disclose the need for a comprehensive smart city conceptualisation to inform policymaking and consequently the practice. This will help in the formation of a much-needed smart urbanism model for the resilient settlements of the climate emergency era.

1. Introduction

The number of urban dwellers has been growing at a rate of around 60 million people annually during the last decades (Goonetilleke et al., 2014). This trend, day by day, is turning our planet into an exceedingly urbanised one. The worst side of that this growth is largely unplanned or informal and sprawling in nature. This urbanisation practice—in the Anthropocene, a geological era of human domination on earth's resources—leads to many complex problems, most important one being the climate emergency (Dizdaroglu et al., 2012). During the last few years, various solutions have been put forward to combat the consequential problems of unsustainable urbanism. These include adopting new paradigms to make cities more sustainable, resilient and smarter—and as a consequence to generate prosperity, liveability, and wellbeing for the citizens, and making cities more environmentally friendly (Yigitcanlar, 2009; Albino et al., 2015).

These solutions, however, did not find large scale application grounds across the globe. Problems, hence, caused by rapid urbanisation—and also dependency on fossil fuel—remained catastrophic. Most parts of the world, city administrations are challenged to provide essential services to the urban population such as accessibility, safety and security, healthy built and natural environments, social equity, clean energy, affordable shelter, and amenities—let alone addressing the sustainability problem adequately (Gilbert et al., 2013; Konys, 2018). This issue has led to seeking smarter solutions for the delivery of urban services—through innovative services, efficient mechanisms, and smart and sustainable infrastructures (Yigitcanlar, 2015).

The notion of smart city has been introduced at the early 2000s (Lara et al., 2016). It was initially conceptualised as technology-assisted—through sensors, surveillance cameras, control centres, autonomous driving, and connected infrastructure and communities—was assumed to result in increased productivity, efficiency, innovation, and safety (Trindade et al., 2017; Zawieska and Pieriegud, 2018; Faisal et al., 2019). In other words, the main objective of smart cities is to

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provide a way of improving quality of life through the deployment and use of smart urban technologies (Yigitcanlar and Kamruzzaman, 2018, 2019). Another objective concerns of boosting urban innovation and economic productivity through a sustainable industrial ecosystem development (Ioppolo et al., 2016; Arbolino et al., 2018; Aldieri et al., 2019c). The concept of sustainability was generally used as an ancillary goal, and so far, has not been adequately incorporated in the smart city practice (Han and Hawken, 2018; Martin et al., 2018). Conversely, it is essential for a smart city to generate high-quality, sustainable, and liveable places for all—rather than to offer cutting-edge digital technology services for the urban elite (Leem et al., 2019).

Despite its abovementioned practice limitations, the smart city movement has gone viral globally during the last decade. This is a result of technology—aggressively promoted by the global technology, construction, and consultancy companies—being seen as a remedy to urbanisation problems (Chang et al., 2018). While a massive consumption society is an integral contributor of the experienced problems, the existing smart city agenda has a negligible focus on the consumption behaviour change. The reason for that is technology is a commodity—constantly producing new versions, and making earlier ones redundant—and its materialism is profitable for the technology companies that drive the (corporate) smart city agenda (Hollands, 2015). For example, some scholars perceive innovation/technology as a vehicle to conquer the growth limits of capitalism (Yun, 2015).

This mostly consumerist, corporate, and technology-centric perspective, however, has become subject to heavy criticism among some scholars. These critics include: (a) The notion of smart city being ambiguous; (b) Existence of only limited conceptual frameworks to help cities and their administrations understand the grand challenge of this new paradigm, and; (c) Current efforts not being able to address the climate emergency—that is the single biggest problem of our time (Stanley et al., 2009; Ersoy, 2017).

Against this backdrop, the paper focuses on investigating and shedding light on the unclear aspects of the making of smart cities, and providing a thorough critique of and insights into the smart city paradigm and practice. This investigation is done by reviewing the literature, elaborating the smart city notion through a multidimensional conceptual framework, placing global smart city best practices—i.e., Songdo, Masdar, Amsterdam, San Francisco, Brisbane—under the microscope. The findings of the study disclose the limitations of the smart city practice in incorporating sustainable development principles (Yigitcanlar, 2010).

2. The concept of smart cities

Thanks to the advances in science, engineering, and technology, today we live much longer and more prosperous lives than ever before. It is also predicted that the average of global life expectancy will rise 4.4 years by 2040 (Foreman et al., 2018). We have made huge advances to create conditions for better health for billions of people. Nevertheless, this progress is taking a heavy toll on the planet's natural systems—e.g., ecological and climate emergencies. Consequently, the damages made in the natural systems have started to affect dramatically not only our quality of life, but also wellbeing—along with other species of the planet (Albouy et al., 2016). Climate change is the prevailing outcome of the damages made. We are entering a new era—the era of disasters—as the world warms 2 °C degree beyond preindustrial levels. As stated by Glasser (2019, p.3), "across the globe of record-breaking heatwaves, prolonged droughts, massive bushfires, torrential flooding, and record-setting storms" are being observed.

Advancing technology has created a (false) hope to ease, if not to cure, the damages made in the natural systems. The idea of technology as the saviour is promoted by the large technology, construction, start-up, and consultancy companies globally (Paroutis et al., 2014). Consequently, a new ideology is formed to address our malpractice urbanisation and incorrect energy resource choices with technological solutions (Buuse and Kolk, 2019). This ideology firstly gave birth to the intelligent city, and then the smart city concept. Today, smart cities are widely seen as urban settlements that adopts the state-of-the-art technologies to address various urbanisation challenges. For instance, stated by Mora et al. (2019, p.90), "[t]ransforming urban areas into smart cities is an ambition that local and regional governments are trying to realise by developing strategies that make it possible to tackle urban sustainability by means of ICT solutions."

Even though, the notion is widespread, smart cities are at their infancy. According to Harrison and Donnelly (2011, p.6), "the current ad hoc approaches of smart cities to the improvement of cities are reminiscent of pre-scientific medicine. They may do well, but we have little detailed understanding of why. Smart city is a field in want of a good theoretical base". Smart city optimists argue that through time the concept and its practice will eventually evolve and mature (Yadav et al., 2019). However, Yigitcanlar et al. (2018, p.156) emphasise that "the delay in the conceptualisation will highly likely result in inefficient policies, poor investment decisions, and not being able to address the urbanisation challenges properly in a timely and adequate manner".

Time is, unfortunately, something that we do not have much of it. The 2018 Special Report of Intergovernmental Panel on Climate Change (IPCC) on the significant impacts expected from 1.5 °C degree of global warming—the aspirational limit that countries adopted in the Paris Agreement—generated widespread and deep concerns. Moreover, the report revealed that we have only 12 years left to act on climate change (IPCC, 2018)—that is 11 years now and counting. Responding to climate emergency at the global scale is a major task given that there is limited time and still no clear intergovernmental agreement on the required actions (Harris, 2018). The recent global school strikes for climate action (a.k.a. Fridays for Future)—initiated by Nobel Peace Prize nominee environmental teen activist Great Thunberg—evidence that scientists and youth are pressuring politicians to get on-board before it is too late.

In their current conceptual and practical foci, there is no evidence that smart cities actually have the capacity, and hence will generate genuine solutions to unsustainable urbanisation problems—including climate emergency. Mora et al. (2017, p.20) remind us that, "the knowledge necessary to understand the process of building effective smart cities in the real-world has not yet been produced, nor the tools for supporting the actors involved in this activity". Having said that, the whole planning process of smart cities needs to be revisited.

Particularly, a crosscheck is required that smart city projects will actually be creating the desired outcomes targeted at the beginning of the planning stage. While this is all well and good in theory, the issue is that most of the smart city initiatives are not integrated with the urban planning mechanisms of that city; besides their fit in the planning process is not clearly stated in these projects' reports Caragliu and Del Bo (2019). The main reasons for this are the inexistence of a sound framework to link smart city concept with urban planning/development processes, and the lack of clarity on the expected outcomes from these projects—such as clear metrics on what the desired sustainability targets are (Yigitcanlar et al., 2019b).

In support of the abovementioned limitations, Mora et al. (2017) indicate that the smart cities notion has not been conceptualised adequately to deliver sustainable urbanism outputs. A reason for this is that cities are not taking advantage of the environmental innovation efforts for sustainable urban development (Szopik-Depczyńska et al., 2018; Aldieri et al., 2019a, 2019b).

On that note, it is useful to share the views of Caragliu et al. (2011, p.67) on what makes a city smart: "(a) The utilisation of networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development; (b) An underlying emphasis on business-led urban development; (c) A strong focus on the aim of achieving the social inclusion of various urban residents in public services; (d) A stress on the crucial role of high-tech and creative industries in long-run urban growth; (e) Profound attention to the role of social

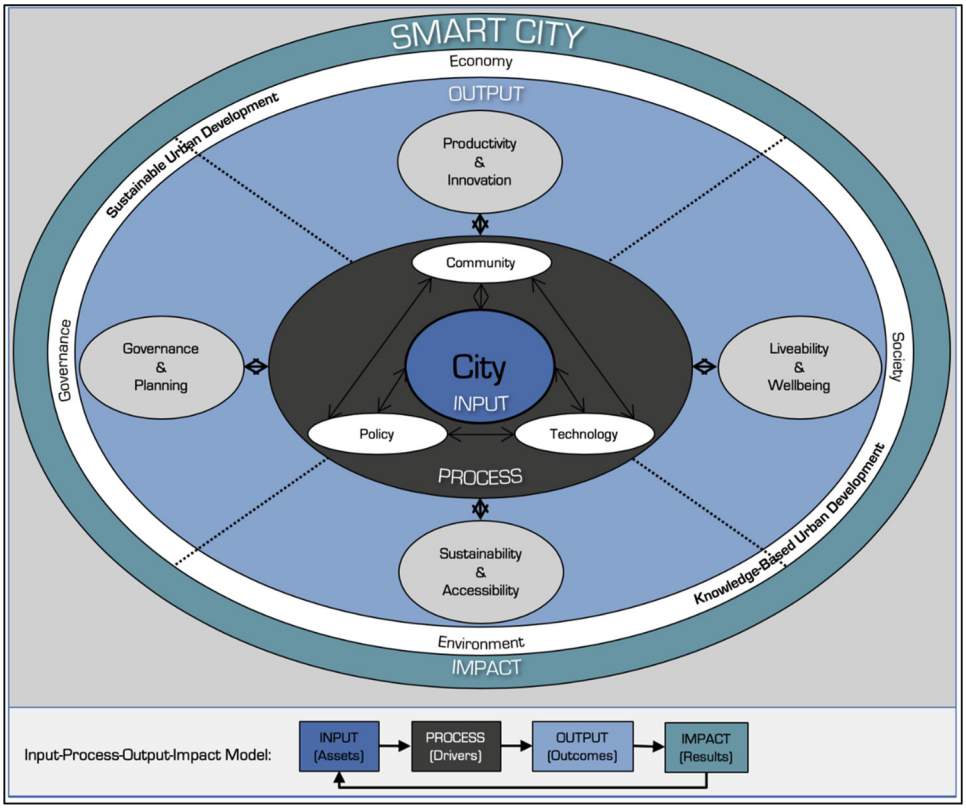

Fig. 1. Smart city conceptual framework (derived from Yigitcanlar, 2018).

and relational capital in urban development, and; (f) Social and environmental sustainability as a major strategic component for smart cities".

There are significant limits of the currently available smart city frameworks. For instance, they lack of a 'system of systems' view (McLoughlin, 1969), and the development drivers are not lucidly intertwined with desired outcomes. The urgency for a consolidated theorisation of smart city notion comes from the lack of incorporation of the sustainable development theory (Ingrao et al., 2018; Ioppolo et al., 2019). This has led to the development of new conceptual frameworks in recent years. One of these frameworks, by Yigitcanlar (2018), aims to establish the missing link between smart city development frameworks and the sustainable urban planning and development processes. This conceptual framework is illustrated in Fig. 1, and elaborated below.

The conceptual framework (Fig. 1) bases itself on an input-process-output-impact model—that also contains a 'system of systems' view—that is a widely used model in urban and regional planning (Fincher, 1972; Chadwick, 2013). Assets of a city are the main inputs of that city's smart urbanism endeavours. These assets are put into use through various processes. These processes include the key drivers of technology, community, and policy. Various desired outputs are expected to be realised, in the case of assets and drivers are successfully operationalised. The procedure is to generate sustainable and knowledge-based development outputs—i.e., in the economic, societal, environmental, institutional development domains—to achieve desired outcomes. Given the ampleness of the desired outcomes—i.e., productivity, innovation, liveability, wellbeing, sustainability, accessibility, governance, planning—, the resulting impacts transform the city into smarter one.

The inner workings of the framework have been discussed in the literature (Yigitcanlar et al., 2018, 2019a). Instead of repeating these, we highlight that the framework perceives urban *technology* only as a 'mean' or an 'enabler' to an end—that is to achieve desired urban outcomes. This perspective is in line with Kanter and Litow (2009, p.2) view of "a smart city as an organic whole of a network and a linked urban system". Additionally, the framework emphasises the role of wider urban *community* as users and developers of the smart city they live in. This is in line with Hughes and Spray (2002) view of providing necessary technology to engage community in local smart city projects. Furthermore, the framework places urban *policy* at the heart of smart city development as a process that is critical to get it right—where technology is only one of the integral elements. This is in line with Aurigi (2006) view of strategies for the selection and adoption of technology or relevant solutions in appropriate ways.

In sum, this conceptual framework establishes a consolidated notion of smart cities, and seeks ways for achieving desired urban outcomes for an effective and efficient smart city transformation. While doing so, the framework also offers the following consolidated definition of what smart cities are: "Smart city is an urban locality functioning as a healthy system of systems with sustainable and balanced practices of economic, societal, environmental and governance activities generating desired outcomes and futures for all humans and non-humans" (Yigitcanlar, 2018, p.108).

3. Methodology

The overall methodological approach of this study is fourfold. Firstly, the study undertakes a thorough review of the literature on smart cities and its environmental sustainability dimension. This review is undertaken with an aim to provide a clearer picture of the concept, and showing the limited understanding on the interpretation of the smart city notion by the practitioners.

Secondly, following the review of the academic literature, the study introduces one of the conceptual smart city frameworks that provides a comprehensive view of the smart cities from the angle of the input-process-output-impact model—presented in Fig. 1.

Thirdly, the study evaluates the global best smart city practices using the introduced smart city conceptual framework as a lens (Fig. 1).

Fig. 2. A view from the footpaths of Songdo, 2019. A copyright free photo by Hon Kim on Unsplash: https://tinyurl.com/y6xrauzu.

Due to the limitations of detailed data collection on the investigated smart city case studies, the research uses available academic and grey literature and the research team's extensive personal knowledge on these cases as the main data sources. Due to the challenges of obtaining detailed data for analysis, the study only uses the core part of the smart city conceptual framework (Fig. 1) that contains the following smart city foundations: (a) Technology; (b) Community, and; (c) Policy. These three foundational elements are adopted in this study as the indicators of the global smart city best practice analysis.

Lastly, the study provides an analysis of the findings from the five smart city case studies—i.e., Songdo (Korea), Masdar (UAE), Amsterdam (The Netherlands), San Francisco (USA), Brisbane (Australia). These smart city practices are selected as they are widely referred to as the best practices in the literature (Albino et al., 2015; Ching and Ferreira, 2015; Russo et al., 2016; Angelidou, 2017). In this study, we limit the case study numbers from each major region of the world—i.e., Asia, America, Europe, Middle East, Oceania—to one.

The following methodological limitations should be noted when interpreting the study findings: (a) The study undertook a review of the literature on the best practice smart cities; (b) The study relied on the judgements of the research team, consist of five smart city experts, in interpreting the findings; (c) The study only scrutinised five case study smart city best practices, and; (d) The study adopted a particular smart city conceptual framework and its three core elements—i.e., technology, community, policy—as the lenses to evaluate smart city lessons of the selected case cities.

4. The practice of smart cities

There are no best practices yet in line with the consolidated notion of smart cities discussed in the earlier section. There are, however, some promising initiatives (those are referred in the literature as good or best practices) that help us understand the current status of smart city practice. The paper investigates some of these best practices—namely Songdo (Korea), Masdar (UAE), Amsterdam (The Netherlands), San Francisco (USA), and Brisbane (Australia). These cities are selected from the five different regions of the world, and they have distinctive smart city characteristics and visions. Focusing on their strength and weaknesses, in the light of the technology, community, and policy smart city foundations, could help generate insights on where we are at with the smart city practice, and where we want to be.

4.1. Songdo, Korea

4.1.1. Background

Songdo is an exemplar new city development from Korea based on the smart city concept (Lee et al., 2008; Shwayri, 2013). Initially inspired from Dubai, Songdo is a master-planned international business hub developed on sea-reclaimed land, located near the Incheon international airport. The smart city development is planned to be fully completed in 2020, and will house about 65,000 residents and 300,000 workers. Songdo is referred to as the most progressive large-scale greenfield-based smart city project in the world (Kim, 2010).

4.1.2. Technology

Songdo is an outcome of joint work among real-estate developers, corporate technology companies, and national and local level governments for building an urban centre from scratch that is filled with cutting-edge technologically enhanced infrastructure and services. In Songdo, all of the state-of-the-art technology wired high-rise towers are received green building ratings, neighbourhoods are smartly designed, an urban oasis is created modelled on the Central Park of New York, a robust public transit system is in place, an effective water recycling system is installed, are and the city is wired with ubiquitous broadband internet connections (Strickland, 2011). The city aims to excel particularly in bio, nano, information, and ubiquitous technologies, and become a prosperous global hub for innovation and technology development (Carvalho, 2012). Many leading international and Korean technology companies located their research and development (R&D) facilities in the city. As for Townsend (2013), these investments are turning Songdo into a testbed for radio frequency identification (RFID), and a centre for R&D in its crucial smart urban technologies.

4.1.3. Community

Yigitcanlar and Lee (2014) offer a comprehensive appraisal of Songdo from the angle of economic, societal, spatial and governance perspectives. The top-down development strategy in Songdo is found problematic, as without involvement of all stakeholders—including local communities—achieving desired outcomes are not possible. For instance, socio-cultural infrastructures have been neglected, as the city's focus is more on international businesses rather than catering for the socio-cultural needs of residents/workers (Millar and Ju-Choi, 2010). Primary reason for this exclusion is that the smart city planning process does not involve wide community participation in Korea (Lee et al., 2008). Nevertheless, with the high cost technology, innovative building material and infrastructure investment, the city can only serve to those who can afford and becoming a city for the affluent class only. Fig. 2 is a snapshot from an urban scene of Songdo, with two creative class of knowledge workers commuting to work on foot—a reference to the walkability and highly efficient clientele politics of the city (Benedikt, 2016).

4.1.4. Policy

Stated by Shwayri (2013, p.52), Songdo's master plan is "based on a combination of sustainable design principles, such as sustainable modes of transport and a mix of open and green spaces, which received the Sustainable City Award in 2008". However, it is contradictory that the city is located on a sea-reclaimed land and caused destruction of precious wetlands, home to some of the rarest species on the planet. In Songdo, cutting-edge urban technologies linked with sustainable urban design practices are targeting to create a utopian future city and lifestyle. However, the top-down policymaking practice generates only technocratic solutions for the smart cities that are built from scratch—such as Songdo. Smart city policy in Korea should be expanded to the retrofitting of existing cities, as building new smart cities is not a sustainable approach—increasing the urban footprint—, while existing cities needs upgrades to become more sustainable.

4.1.5. Global implications

The city is widely considered as a role model of the Southeast Asian smart city (Strickland, 2011; Angelidou, 2014). The development of ubiquitous urban environment is in fast progress in Songdo, and the ambitious smart city initiative provides an optimistic view for establishing smart cities of our time—but only in the case that we favour techno-centric smartness over a collective one (technology-community-

policy smartness). Today, it is widely accepted that Songdo has created a new development path for and setting the benchmark high for smart urbanism (Kolotouchkina and Seisdedos, 2018). Nevertheless, it is not clear how much hope the Songdo project generates in terms of truly sustainable urbanism.

4.2. Masdar, UAE

4.2.1. Background

Masdar is a planned smart city project situated in a desert location near Abu Dhabi. Masdar smart city development project was initiated in 2006, in line with Dhabi's Vision 2030. Masdar smart city is designed as a living laboratory for sustainable urban technologies, and one of the first projects from the Middle East aiming towards a master-planned, zero-carbon, sustainable, and smart settlement form (Cugurullo, 2013). The city is widely viewed as a role model Middle Eastern smart city (De Jong et al., 2019). The first stage of development completed in 2011, and soon after the opening Masdar claimed to be the largest planned development in the world that solely uses renewable energy sources. Today, the city is seen as an emerging global clean-technology cluster located on one of the world's most challenging geographies fighting for a sustainable urban development powered by renewable energy. As for Sgouridis and Kennedy (2010), when the development is completed in 2025, there will have 50,000 residents, 1500 clean-tech companies, start-ups staffed by 10,000 new employees, a research university and 60,000 daily commuting workers will be generated on site. Fig. 3 is a snapshot from the solar energy fields of Abu Dhabi— the world's largest single-site solar project with a capacity of 1.177 GW (Kennedy, 2019).

4.2.2. Technology

According to the plans residents' transport needs will be addressed with high-technology smart and active mobility solutions—that includes an autonomous and electrified public transport system, and walking and cycling network. The power for the city is supplied from 22-hectare field designated for solar panels. Additionally, rooftops of buildings are also covered with solar panels. Shared autonomous electric vehicles are planned to be replacing cars in the city. The design of the walls of the buildings reduces demand for air conditioning by 55%. All buildings have movement sensors that cut electricity consumption by 51% and water usage by 55% (Hopwood, 2010). Technology and innovation sectors are also planned to be the primary economic activities of the city. Despite the desert climate, Masdar encourages walkability through using smart solutions. Smart innovations in comfortable walkability include: Smart wind tower, sheds, shelter, bus stop, street furniture, and pavement (Kamel, 2013).

4.2.3. Community

At the conception stage of the Masdar projects challenges were mostly economy-driven. However, today these challenges are expanded to include natural resource depletion, population growth, climate emergency, and the Arab Spring (Cugurullo, 2016). At present, Masdar is for the affluent to reside, and workers of the city commute by private motor vehicles. In the urban plan of the Masdar city only 20% of the accommodation areas are assigned to the low-income workers—due to the planning code requirements (De Jong et al., 2019). In spite of the social sustainability in the vision of Masdar, the city is largely occupied by affluent population, pointing to exclusiveness of the city (Cugurullo, 2013). Moreover, Mezher et al. (2010, p.757) suggest that "in order to ensure social prosperity in Abu Dhabi, all stakeholders must be engaged in direct coordination and collaboration to develop the right energy policies, incentives to invest in projects, ensure the funding is available for R&D, put in place the needed market mechanisms for diffusing renewable energy technologies, and build public awareness".

Fig. 3. A view from the photovoltaic fields of Abu Dhabi, 2019. A copyright free photo by David Mark on Pixabay: https://tinyurl.com/yyj98uxm.

4.2.4. Policy

Masdar adopted a top-down planning and design approach, and so far, the city has best performed in the environmental domain of sustainable urban development. As much as smart urban technology utilisation, another reason of the success was replicating the traditional Arabic urban form—such as city's shape, orientation of streets, windcatcher, courtyard, the pattern of streets, and density and mixed use. Hassan et al. (2016) compared urban form attributes of the medieval Cairo with the modern Masdar, and revealed that the success of Masdar lays in pursuing, learning and including characteristics of traditional city. As a consequence of the planning strategy, unlike the other iconic cities of the region—such as Doha and Dubai—, Masdar does not accommodated any high-rise buildings. As for the environmental sustainability policy, as highlighted by Cugurullo (2016), in Masdar, sustainability strongly links environmentalism with consumerism. Although, Masdar is one of the first attempts in constructing carbon-neutral cities, it creates hope for the development of a sustainable smart city. However, the Masdar project is not economically feasible. The project heavily capitalises on environmental concerns to generate profit (Cugurullo, 2016). Nevertheless, the project not being able to attract as much as innovative industries as hoped to be along with the impacts of global financial crisis forces Masdar to scale back its budget and ambitions (Mezher et al., 2011).

4.2.5. Global implications

Although, most of the ideas to develop Masdar into a truly smart and sustainable city were innovative and ambitious, not so many of them could find application ground at the city scale. For instance, the autonomous electric public transit system, which is the flagship feature of Masdar's car-free strategy, has been discarded due technology not being able to meet the city's transport needs. There are also delays in the development of the planned light rail network and metro system. Additionally, it is realised that construction of large solar panels would be less effective than anticipated due to local dust storms, which are reducing the solar power output at least by 40% (Crot, 2013). Similarly, the hydrogen power plant project in Abu Dhabi was placed on hold due to lack of resources and change in the project priorities. These downgrades, due to either technology miscalculations or the economic downturn, pushed the city administration to change the city brand from 'zero-carbon' to 'carbon-neutral' (Mezher et al., 2010). Similar to Songdo, Masdar has also been a pioneer testbed to trial smart urbanism concepts due to the bold steps of the national administration. While the attempt is commendable and provided learnings of what works and what does not, the Masdar project does not managed to showcase a successful smart and sustainable urbanism practice. Both Songdo and Masdar brings an important questions in mind: Should we focus on transforming cities step-by-step into smart ones, rather than building new ones from scratch at scale? Furthermore, another key question to consider is: How can the near bankruptcy of major smart city development fantasies, such as Middle-Eastern smart cities, be avoided?

4.3. Amsterdam, the Netherlands

4.3.1. Background

The City of Amsterdam, Amsterdam Economic Board, internet operators jointly initiated the Smart City Amsterdam project in 2009. Smart City Amsterdam aims to turn itself into a more sustainable city by working along two principles to: (a) Enable stakeholders to apply innovative technologies, and; (b) Stimulate behavioural change with end users (Sauer, 2012). The starting point of the project, thus, was not merely providing technical solutions, but the collaboration, co-creation, and partnership between stakeholders within the city for moving towards sustainable and smart solutions. The project, hence, was developed in a quadruple-helix partnership model between public, private, academia and community. The operational aim of the smart city project was to help achieve ambitious sustainability targets set in Europe (Manville et al., 2014).

4.3.2. Technology

Different than previously presented Songdo and Masdar cases, technology is not central in Amsterdam's smart city approach, although the testing and implementation of smart city technologies has been integrated into most projects (Van Winden et al., 2016). However, the smart city initiative of Amsterdam is still famous not only engaging technology solutions for a smarted city development, but also using the smart city living labs to engage local communities to determine in a bottom-up manner solutions to the city and its residents. According to Van Winden et al. (2016, p.12), in the roll-out of a smart city initiative, "a technology or solution that was successfully tested and developed in the pilot project is commercialised/brought to the market, widely applied in an organisation, or rolled out across the city. Possibilities for rollout largely emerge from living lab projects (such as Climate street and WeGo), where companies can test beta versions of new products/solutions" within a local community. Fig. 4 is a snapshot from one of Amsterdam's canals that self-driving/autonomous boats—so-called 'roboat'—are being trailed (Vincent, 2016).

4.3.3. Community

In 2013, this smart city platform of Amsterdam established partnerships with over 80 partners that are engaged in a number of smart city initiatives. These initiatives focused on a variety of areas including over 40 projects on smart living, smart working, smart mobility, smart public space, and open data themes. These projects particularly aimed to support sustainable real-estate development, company energy consumption improvement, and employee awareness to work in a smarter manner. Besides, the following initiatives that deployed solutions in the Smart City Amsterdam are worth pointing out: Climate Street, Ship-to-grid, Smart building management systems, and Health Lab (Dameri, 2014). Initial smart city project was top-down in nature, but later on community input and involvement was also considered and became an integral part of the smart city initiative—such as earlier mentioned living lab programs. The Amsterdam Smart City platform is an important connector in this respect as it has evolved in to a facilitator of the smart city community in the Amsterdam region (Van Winden et al., 2016).

Fig. 4. A view from one of Amsterdam's canals, 2019. A copyright free photo by Ethan Hu on Unsplash: https://tinyurl.com/y5ja88y6.

4.3.4. Policy

Planners expect to boost the local economy through high-tech infrastructure investment that also would cut emissions by 40% by 2025, which would also convert Amsterdam into a smart city (Dameri, 2014). Amsterdam smart city project also established and maintained strong linkages with a number of other European smart city initiatives, including NiCE, Citadel, Digital cities, Open cities, and Common4EU (Manville et al., 2014). Amsterdam shares data openly with wider community and provides critical info on transport environment and so on through a dedicated city dashboard—similar to many other European smart cities, e.g., Birmingham, Dublin, London. Furthermore, Amsterdam is one of the most walkable and cyclable cities in the world (Lehmann, 2016). The smart city policy assures increased green and active transport options in the city.

4.3.5. Global implications

As in the most of the European smart city projects, Amsterdam also adopts a retrofitting approach in its efforts for developing the Amsterdam Metropolitan Area into a flourishing smart city. It has successfully integrated both environmental and societal goals with economic and technologic ones. Hence, the city could be considered as a role model European smart city. This smart city development is managed to embed all kinds of digital infrastructure and networks, devices, sensors and actuators; as a result, the volume of data produced has grown exponentially. Smart city data managers need to pay special attention to this issue as stated by Kitchin (2014), this may create a concern with the data quality, fidelity, security, management and validity of analytics that interpreted and acted upon. Furthermore, underlined by Townsend (2013), even though Amsterdam is widely recognised as a global leader in smart solutions for sustainable urban outcomes, emissions generated from the city are still rising 1% annually. This brings down the issue to the non-renewable energy use, and not addressing the climate emergency seriously.

4.4. San Francisco, USA

4.4.1. Background

San Francisco sees smart city strategies as an important method to build its sustainable urban future. In recent years, many Silicon Valley based companies have made a move to base their headquarters in San Francisco, due to high quality of life and place offerings to companies' talented staff, along with affordability and tax benefits. Today, the city is home for a large number of internet-based companies. San Francisco offers large number of free Wi-Fi hotspots in various public locations. For example, on a main road downtown, there is about five-kilometre-long free Wi-Fi zone (Hudson, 2010; Zhu et al., 2017). Fig. 5 is a snapshot from San Francisco's famously twisty Lombard Street, which is a symbol of smart solutions the city generates—the crookedest street in the world was built in 1922 in its unusual form to reduce the slope to allow driving (Leadbeater, 2019).

4.4.2. Technology

San Francisco is renowned amongst the global trendsetters when it comes to smart urban technology initiatives. San Francisco has an ambitious goal that is becoming a carbon-free city by 2030. The city has implemented a number of incentive programs that involves smart technology applications. For example, 'SF Energy Map' is a tool that tracks solar and wind energy potentials of locations across the city. With this application, residents and businesses can check their solar potential. Similarly, 'Energy Use Challenge' is an application for sharing energy bill data, where this data to be used to enhance energy efficiency

Fig. 5. A view from San Francisco's Lombard Street, 2019. A copyright free photo by Brandon Nelson on Unplash: https://tinyurl.com/y3j4ykhp.

programs. Likewise, 'Honest Buildings' is a software platform focuses on buildings to help buildings save energy (Dahlquist and Fell, 2015). Moreover, 'SF Park' is an application to improve parking in the city through real-time parking information. This way traffic congestion can be avoided or eased, less energy is consumed, and consequently lesser pollutants are released to the atmosphere. Additionally, 'ChargePoint' is an application to help track usage and functional status of electric vehicle charging stations. The app provides real-time status of the chargers, and generates long-term reports. Furthermore, today, San Francisco is 41% renewable energy powered, and the city houses over 300 LEED certified buildings (Scheer, 2012). San Francisco has been upgrading transport services through smart mobility technologies that have advanced urban policy aims in the arena of transport governance for sustainability (Davis, 2018). This resulted in increased public transport service quality and efficiency in the city/region. San Francisco is the home of ride hailing service companies such as Uber and Lyft, and a trial city for shared autonomous vehicle projects (Yigitcanlar et al., 2019c).

4.4.3. Community

Primarily, San Francisco's high concentration of talent base, strong entrepreneurial culture, and close proximity to the world's most innovative technology cluster contributes to the establishment of an urban ecosystem in the city that accelerates smart and sustainable urban outcomes. A number of apps use the open data source provided through Data SF, such as 'Metro San Francisco', 'Transit Bay', and 'Walkonomics' are among the apps that are used widely by local residents to improve their mobility in the region (Brown et al., 2011). One of the big smart city challenges of the city is provision of affordable housing to its residents. The popularity of the city has attracted technology companies and talented workers, and in consequence property prices sky rocketed in the city—and leading to social problems (Palm and Niemeier, 2017).

4.4.4. Policy

The city is widely acknowledged as a leader in embracing sustainability and smart urban development policy and practice as it excels in smart and sustainability initiatives. San Francisco has an ambitious goal of achieving zero-waste by 2020. In order to zero-waste goal, the city introduced various smart city initiatives. For instance, 'RecycleWhere' is an online tool that provides residents with recycling, reuse, and disposal options. Similarly, 'Zero Waster Signmaker' is another online tool that residents and business owners can create compost, recycling, and landfill signs for their homes and businesses. Because of these initiatives, the city has reached to 80% waste diversion rate (Kaufman et al., 2010). Another important development that supports the smart city formation of San Francisco is the open data legislation that passed in 2009. This pioneering legislation has made all city departments to provide public access for all non-confidential datasets through the city's e-government portal.

4.4.5. Global implications

San Francisco is considered as one of the greenest cities and the clean-technology capital of North America. The city has various smart city support mechanisms for its clean-technology and innovation firms that eventually contribute to the city's economic development, neighbourhood revitalisation, and sustainable operations. For example, the 'living innovation zones' project helps businesses use city assets to demonstrate new and emerging technologies. Likewise, 'smart grid' and 'LED street-light conversion' projects help the city save energy (Lee et al., 2014). A critical evaluation of the functions and effectiveness of the smart city framework of San Francisco by Lee et al. (2014, p.84) indicate the following key characteristics and issues of the city's twist on smart urban technology utilisation: "Urban openness; Service innovation; Partnership formation; Urban pro-activeness; Smart city infrastructure integration; Smart city governance". The city, henceforth, could be considered as a role model North American smart city. San Francisco showcases a successful model of urban transformation; however, it comes with social costs that require further attention and solid policies to tackle.

4.5. Brisbane, Australia

4.5.1. Background

Brisbane is one of the early adopters of the smart city concept. Queensland's 1998 Smart State Strategy underlines the importance of Brisbane's, the capital city of the state, transformation into a smart city. The smart cities policy, initiated in 2007, was an applied economic development and land use macro plan for Brisbane as the nucleus for smart state development (Yigitcanlar et al., 2012). Smart cities policy recommended various strategies to turn Brisbane into a prosperous smart city. These were: (a) Creating a legible structure plan; (b) Uniting disparate precincts; (c) Creating definitive pedestrian spines; (d) Linking the city centre by mass transit; (e) Defining a knowledge corridor; (f) Investing on sustainability; (g) Developing effective planning processes, and; (h) Developing a smart city model (Hortz, 2016). These strategies also resulted in the development of Brisbane's knowledge corridor—a milestone project that connects all key innovative institutes of the city physically. Today, the knowledge corridor is highly active and Brisbane's global innovation districts are gaining international recognition, turning city into a prosperous smart city (Pancholi et al., 2015a; Esmaeilpoorarabi et al., 2018).

4.5.2. Technology

The city invested in improving its road infrastructure, as well as public transport system, by developing a number of tunnels to ease rush hour traffic congestion (Dur and Yigitcanlar, 2015). In these projects, high technology smart traffic systems are utilised including digital message signs, CCTV cameras, and Bluetooth sensor devices to deliver notifications to motorists and improve the road intelligence. Brisbane also adopted Sydney's Coordinated Adaptive Transport System to manage traffic signals, and installed pedestrian countdown timers. Additionally, Brisbane has installed numerous way-finding devices for people with vision impairment. Furthermore, free Wi-Fi systems are installed in the major city parks, libraries, shopping malls, and suburban shopping strips, and this is followed by erection of smart poles in the major public spaces for big data collection (Hamstead et al., 2018). Fig. 6 is a snapshot of a target smart pole location—to collect data on pedestrian and cyclist traffic, construction and traffic noise levels, flood levels and air quality, among other potential uses including hosting CCTV cameras, free Wi-Fi/5 G and USB charging points (Stone, 2019).

4.5.3. Community

Brisbane pursues an effective smart city vision with its sustainable brand of smart urbanism (Hollands, 2008). Brisbane is amongst the

Fig. 6. A view from a target smart pole location from Brisbane, 2019. A copyright free photo by Photo by Michael on Unsplash: https://tinyurl.com/y2rudeel.

limited cities that committed to economic growth and the environment sustainability, simultaneously, while developing mechanisms for community involvement in major urban policy decisions. For instance, Brisbane has utilised the smart label in conjunction with notions of the 'sustainable city' with regards to its smart water, water recycling, draught combatting measures, resilient infrastructure, and subtropical building and urban design programs (Pancholi et al., 2015b). While at the sustainable urbanism front, the city has gone a long way, in terms of smart urban technology development, adoption and deployment the city is still behind most of the other cities from abroad claiming the smart city title (Berger, 2019). As for the community programs, the city has been committed to the smart community development program (Alizadeh, 2015).

4.5.4. Policy

Following the success of smart cities policy, in 2009 Brisbane City Council launched 'CitySmart' to help make Brisbane Australia's most sustainable city. Unlike the previous policy attempts, CitySmart is financially supported to deliver projects. Major CitySmart projects include: (a) Australia's first district cooling energy system to provide cheaper/more efficient air conditioning for CBD buildings; (b) 'Reduce Your Juice', an energy efficiency program tailored specifically for our city's low-income young adults; (c) 'Queensland Watt Savers', which supplied more than 300 SMEs easy-to-use tools and expertise to reduce energy consumption and related expenses; (d) 'EzyGreen', a residential energy reduction program, which engaged 61,000 Brisbane households to save over $10 million in annual energy costs, and; (e) City's first electric vehicle charging station (Muriuki et al., 2016).

4.5.5. Global implications

Brisbane, with its long history on smart and sustainable city initiatives, could be seen as a role model Oceanian smart city. The city, today, is capable of collecting and analysing real-time data to improve liveability, in the case the city puts more efforts in investing in the technological architecture and collaborates with businesses to realise its potential. At this front, presently Brisbane is following the European information sharing model—a popular smart city practice (e.g., Amsterdam, Birmingham, Dublin, London) to share information through city dashboards and digital public displays—by adopting a citywide dashboard to enable to monitor weather, energy consumption and traffic flow. There is no fully-fledged statutory smart city policy in the city yet. However, Brisbane has developed a brief smart city agenda policy in 2017—'Smart, Connected Brisbane'—a first step toward an umbrella smart city strategy for Brisbane (BCC, 2017). Despite Brisbane being a policy rich/obsessive city, the city lacks of a clear overarching smart city strategy to guide the transformation of the city into a smart and sustainable one.

5. Discussion and conclusion

The smart city literature and investigated best practices—i.e., Songdo, Masdar, Amsterdam, San Francisco, Brisbane—have shown that we are at the beginning of a new era that technology and the city are converging (Stimmel, 2016). At present, smart city is a highly popular topic in urban policy circles/debates in many cities of the world. However, our knowledge on smart cities are highly limited, and our expectations from them are unrealistic and full of speculations. This brings serious criticism and scepticism to the smart city discourse. In line with the views of Vanolo (2014), there are some underlying issues associated with smart cities, as they are increasingly becoming an idealised development paradigm, without proper critical debates and politics.

The notion of smart city, despite some promising attempts, has not been conceptualised adequately yet. The lack of conceptualisation is mainly due to perceiving the 'smart' in smart cities as technological smartness rather than human/decision smartness. This is evident in some of the investigated case studies—e.g., Masdar, Songdo. They present, in general, the development and application of advance technology much more than the development and implementation of correct decision or policy. This issue has resulted in so far not being able to build a truly smart city.

As the study findings reveal, different approaches are followed in different corners of the globe for the conceptualisation and practice of smart cities. In Southeast Asia, smart cities are used as a vehicle to create national identity, boost economy through technological innovation, and test and implement technologies on large scale urban development projects. On the contrary, in Europe, North America, and Oceania, the smart cities model is mostly adopted to improve the urban and household quality of living, along with establishment of a more sustainable urban future—but generally in relatively small-scale projects.

One of the critical issues behind the limited large-scale application of smart city projects is the reservations towards how the smart city model is perceived. Today there are a number of self-claimed smart cities (Hollands, 2008) based on the only fact that they are using technology tools. While *smart technology* is critical, technology alone cannot create smart cities, as it takes more than just the state-of-the-art technological solutions to transform cities into truly smart and sustainable ones.

Moving away from a heavily smart technology-centric view to a smart decision or *smart policy* view may change the reserved attitudes towards these projects. As identified by Yigitcanlar and Lee (2014), current failures in the development of smart cities will help us not to make the same mistakes, and plan, design, develop and manage the next generation cities much better than we have done before. However, we might not have the luxury of time for too many trial and errors in the era of climate emergency.

We will, hence, have to establish a consolidated smart city paradigm as soon as possible to form a role model for the cities of the future—-such as the post-Anthropocene city that provides quadruple-bottom-line sustainability for all humans and non-humans (Yigitcanlar et al., 2019b). In other words, in line with the views of Ratti and Townsend (2011), more than smart systems that improve efficiency in the city, what needed is to make the city itself 'smart'—that includes its people, in other words *smart community*.

The making of successful smart cities highly depends on adequately linking conceptual developments in the field with sustainable practices. So far, as Wiig (2015) indicates the smart city practice is a techno-utopian policy in motion, its results are in the outward self-promotion of cities in attracting multinational corporations that are selling urban and technology products.

This paper advocates the adoption of a comprehensive view on the smart city conceptualisation to inform policymaking and urban planning and development practices. Deliberated by Yigitcanlar et al.

(2019b), the renewed smart city approach carries a high potential to become an ideal model to address the climate emergency and build the cities of the future. However, realisation of this potential depends on the adoption of three critical guiding principles. These principles are, the smart city notion to: (a) Contain a system of systems approach; (b) Adopt a balanced quadruple-bottom-line sustainable urban development perspective, and; (c) Mainstream the urban metabolism approach (Kennedy and Hoornweg, 2012; Ioppolo et al., 2014).

Based on the conducted literature review and investigated smart city best practices, we compile the following insights into the making of successful smart cities.

Firstly, in terms of economic development in smart cities (*smart economy*), we need to give our cities the capability of developing their technologies unique to their own developmental problems and needs. This in turn contributes to the establishment of a local innovation economy and prosperity that is a central element of smart cities.

Secondly, in terms of sociocultural development in smart cities (*smart society*), we need to develop our cities wired with the appropriate, affordable, and effective smart urban technologies not only exclusive to urban elites, but also inclusive to those unfortunate, in other words to all. This in turn helps in establishing socioeconomic equality—and formation of smart communities—that is an essential element of smart cities.

Thirdly, in terms of spatial development in smart cities (*smart environment*), we need to reform our cities by adopting sustainable urban development principles—e.g., minimising urban footprint, limiting emissions, encouraging active and green transport use, establishing urban farms, and addressing urban waste problem. This in turn helps in generating ecological sustainability that is a critical element of smart cities.

Fourth, in terms of institutional development in smart cities (*smart governance*), we need to equip our cities with highly dynamic mechanisms to better plan their growth and manage their day-to-day operational challenges. This in turn helps in performing appropriate planning, development, and management practices that is a core element of smart cities.

Lastly but not least, as discussed earlier, a balance between the four development domains of cities is critical to build successful smart cities, and perform smart urbanism practices. The fundamental drivers of such development include: (a) Community (a knowledgeable, conscious, forward-thinking, engaged, united despite differences, and active community); (b) Technology (a locally developed, affordable, appropriate, energy efficient, and effective technology), and; (c) Policy (a strategic, comprehensive, long-term, dynamic, well-intend, inclusive, and effective public/urban policy).

In sum, the study at hand disclosed some lessons from the best practice smart cities, and at the same time revealed their limitations in building truly smart and sustainable cities. Insights generated from the study point out to a more comprehensive and consolidated view on what smart cities are or should be. In a quest to determine 'how a truly smart and sustainable urbanism practice can be realised', further research efforts are needed to advance our understanding particularly on the development of effective local government smart city policies. In that perspective the following research questions are worth considering in the prospective research concerning the role of local government and policy in the smart city transformation:

a) What are the most common local government smart city policy characteristics across the globe, and how effective are they in delivering desired outcomes?
b) What are the conceptual differences in smart city policy adaption in local governments across the globe, and what is the impact of the local context?
c) What are the most needed government policy mechanisms to produce effective smart city practice that delivers desired outcomes?
d) How can a comprehensive local government smart city policy framework be developed to guide effective smart city policy development?
e) How can such a policy framework assist smart city transformation and support local governments and practice achieving their desired outcomes?

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