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Smart city policies: A spatial approach

Margarita Angelidou *

Aristotle University of Thessaloniki, School of Architecture, Department of Urban Planning and Regional Development, Urban and Regional Innovation Research Unit (URENIO), Greece

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ABSTRACT

This paper reviews the factors which differentiate policies for the development of smart cities, in an effort to provide a clear view of the strategic choices that come forth when mapping out such a strategy. The paper commences with a review and categorization of four strategic choices with a spatial reference, on the basis of the recent smart city literature and experience. The advantages and disadvantages of each strategic choice are presented. In the second part of the paper, the previous choices are illustrated through smart city strategy cases from all over the world. The third part of the paper includes recommendations for the development of smart cities based on the combined conclusions of the previous parts. The paper closes with a discussion of the insights that were provided and recommendations for future research areas.

Introduction

Smart cities represent a conceptual urban development model based on the utilization of human, collective, and technological capital for the enhancement of development and prosperity in urban agglomerations. However, strategic planning for smart city development still remains a rather abstract idea for several reasons, including the fact that it refers to—as yet—largely unexplored and interdisciplinary fields. Stakeholders (local governments, research institutions, grassroots movements, technology vendors, property developers, etc.) are often driven by conflicting interests. The tendency to believe that innovative technological instrumentation automatically transforms a city into a 'smart' one, and a biased use of the buzzword 'smart' in fragmented or superficial ways, actually hinder the clarification of the subject even further. Regarding the above situation, this paper reviews the spatial factors which differentiate smart city policies, in an effort to provide a first and clear view on the strategic choices that should be considered when mapping out a smart city strategy.

The addressed problem is rooted in the fact that there is currently a great misunderstanding about what smart cities actually are, let alone how they can be realized. Despite the extensive discussion, no agreed definition on 'smart' and 'intelligent' cities exists. In the smart cities arena, we encounter a multitude of definitions, and solutions without an existing prevalent or universally acknowledged definition (Allwinkle & Cruickshank, 2011; Chourabi et al., 2012; Hollands, 2008; Komninos, 2011; Lombardi, Giordano, Farouh, & Yousef, 2012; Nam & Pardo, 2011a; Papa, Garguilo, & Galderisi, 2013; Wolfram, 2012). Furthermore, strategic planning for the development of smart cities is still a largely unknown field (ABB, 2012; Abdoullaev, 2011; Chourabi et al., 2012; Gsma & Cisco, 2011; Hollands, 2008; Huber & Mayer, 2012; Komninos, 2011; Nam & Pardo, 2011a) and the terms 'smart' and 'intelligent' are used interchangeably throughout the literature (Hollands, 2008; Pardo, Nam, & Burke, 2012; Wolfram, 2012). This paper makes no distinction between the two expressions. For the purposes of this paper, the working definition of 'smart cities' is the following: smart cities are all urban settlements that make a conscious effort to capitalize on the new Information and Communications Technology (ICT) landscape in a strategic way, seeking to achieve prosperity, effectiveness and competitiveness on multiple socio-economic levels.

This paper commences by reviewing the factors which differentiate policies for the development of smart cities. Four strategic choices with a spatial reference are identified: national versus local strategies, strategies for new versus existing cities, hard versus soft infrastructure-oriented strategies, and sector-based versus geographically-based strategies. The advantages and disadvantages of each strategic choice are presented, again as they emerge from the smart city literature. In the second part of the paper, the previous choices are illustrated though smart city strategy cases from all over the world. The third part of the paper includes recommendations for the development of smart cities based on the combined conclusions of the previous parts. The paper closes with a discussion of the insights that were provided and recommendations for future research areas.

* Tel.: +30 2310995581.
E-mail address: mangelidou@urenio.org

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This paper contributes to the smart city discourse by helping dissolve the confusion about strategic choices regarding smart city development and stating the advantages and disadvantages of these strategic choices. An intensive effort has been made to draw material together on the basis solely of the smart city literature. Furthermore, the paper provides a starting point for the design of smart city strategies, documents differentiating factors via examples of applied strategies in each category, and keeps the smart city conversation ongoing by instigating further research.

A range strategies for smart city development

National versus local strategies

A major differentiating characteristic among smart city strategies is whether they concern an entire country or nation, or they are focused on a more local level, be it a neighborhood, municipality, city, metropolitan area or even a region.

Most applied strategies are built on the local level. The advantages of local-level smart city strategies, as they have been recently cited in the smart city literature, include that:

- Innovation has a geographical locus and knowledge has a geographical 'stickiness' – therefore their advancement on a local level is more effective in making cities smart (Auci & Mundula, 2012; Bria, 2012; Coe, Paquet, & Roy, 2001; Hodgkinson, 2011; Nam & Pardo, 2011a; Townsend, Pang, & Weddle, 2009).
- Becoming smart includes fostering a competitive economy; competition and competitiveness are clearly a matter of the urban scale, as currently local characteristics are the ones that differentiate cities among each other (Cosgrave & Tryfonas, 2012; Giffinger & Gudrun, 2010; Giffinger, Haindlmaier, & Kramar, 2010; Hodgkinson, 2011).
- Cities are capable of engaging various constituents in the innovation process on a much broader range of activities, fostering citizen-centric governance; the result is well established smart city ecosystems (Bria, 2012; Hodgkinson, 2011; Paskaleva, 2011; Streitz, 2011).
- Cities are more flexible in exploring and adjusting a variety of business and governance models to their own profit. Their experience, agility and proximity provide them the necessary knowledge and ability to set up a favorable climate for the purposes of becoming smart (Hodgkinson, 2011; Misuraca, Reid, & Deakin, 2011).
- Urban problems are of manageable size and known nature, and respond to locally selected goals, which make them less effort-intensive (Caragliu & Del Bo, 2012; Hodgkinson, 2011).
- Cities have peers (i.e. other cities with similar characteristics), from which they can pool insights on how to become smarter (Hodgkinson, 2011; Tranos & Gertner, 2012).

On the other hand, the disadvantages of local-level smart city strategies include the following:

- Small and medium sized cities compete for resources against larger and better-equipped cities; therefore they are less likely to be able to receive or afford the necessary funds for smart city projects (Giffinger et al., 2010).
- Cities will have to find a way to align their smart city strategy with the complex web of policy agendas already operating at the government level (Hodgkinson, 2011; Nam & Pardo, 2011a).
- Innovative pilot projects and small-scale developments do not necessarily guarantee an effective uptake on city-wide level (Pike Research, 2011).

Furthermore, it is worth mentioning that even within the 'local strategy' spectrum there is a variety of views about the most suitable implementation level. At one end of the local scale, it has been advocated that strategic regional planning has a significant impact in smart city development, as its role is to harmonize and coordinate top-level with low-level policies (Walters, 2011). At the other end, however, small-scale smart city pilot programs allow the accomplishment of short term achievable goals and provide a platform to assess the viability of specific smart city solutions and services in real-life contexts (Bria, 2012; Carter, Rojas, & Sahni, 2011; González & Rossi, 2012).

Considerably far fewer researchers advocate the implementation of smart city strategies on a national level (i.e. to become a 'smart country'). National-level strategies enjoy state backing; they allow for a broader view and firmer control over related policies and coordinated resource pooling, and by doing so they provide a very strong point of reference for smart city strategies. The advantages of national-level smart city strategies, as they have been recently cited in the smart city literature, include the following:

- Top-level coordination and resource allocation encourages the assignment of clear roles and responsibilities to the institutional authorities involved, enhancing the effectiveness of the strategy (ABB & European House-Ambrosetti, 2012).
- The operational continuity of basic choices at all levels is guaranteed and a common platform can be implemented (ABB & European House-Ambrosetti, 2012).
- Complementarity in weak and strong points and joint addressing of challenges can be foreseen (Hodgkinson, 2011; Tranos & Gertner, 2012).

The disadvantages of national-level smart city strategies include:

- Possibility to fail in capitalizing on the sum of local resources effectively, and ignoring local needs and priorities (Paskaleva, 2011; Caragliu & del Bo, 2012; Giffinger et al., 2010; Walters, 2011).
- Horizontal measures may falsely assume that barriers and opportunities are the same in all of a country's cities (Copenhagen Cleantech Cluster, 2012; Liugailaitė-radzvickienė & jucevičius, 2012).

Urban development stage: new versus existing cities

Another significant qualitative characteristic of a smart city strategy is the urban development stage of the city they involve, i.e. existing or new cities (greenfield cities or 'cities from scratch' or 'planned cities').

On the one hand, and mostly in the Western world, urban planners endorse the belief that there is no need for new cities. Our long-lived cities are already big and complex enough to accommodate the current population and its activities. Emphasis should be placed on regenerating degraded urban areas, rather than developing new cities. Mostly in developing countries, on the other hand, several initiatives have been taken to develop entirely new smart cities, such as PlanIT Valley (Portugal), Skolkovo Innovation Center (Russia), Cyberport Hong Kong (China), Songdo International Business District (South Korea), Cyberjaya (Malaysia), Masdar City (Abu Dhabi-UAE). These new cities are designed and built from scratch, showcasing leading edge 'smart' technology and certifications of green physical planning. They are highly ambitious projects, encompassing tremendous investments for acquiring land, building infrastructure and erecting large scale settlements. It is impressive that in China alone, as many as 154 proposals have been

introduced to build a smart city (Yang, 2012), and population growth and migration will give rise to 81 new cities by 2025 (Bélissent, 2010). However, the existence of several recently-built but empty ghost cities in China—such as Kangbash, Zheng Zhou New District, Zhengdong New District, Erenhot, Dantu, Bayannoao'er and Tunnan University Campus—raises concerns about their exact purpose, affordability and building quality, and ultimately their ability to attract inhabitants and become sustainable in social terms.

The most important advantages of applying a smart city strategy for a new city include:

- Opportunity to address the smart city vision from inception, and clarity of purpose (Bélissent, 2010; Ratti & Townsend, 2011; Washburn & Sindhu, 2010).
- Integrated physical design and development of infrastructure and buildings, incorporating all aspects of edge technology, modern amenities and best practices of city planning (Bélissent, 2010; Washburn & Sindhu, 2010; Pentikousis et al., 2011).
- Capability to explore innovative business models and funding options (Bélissent, 2010; Townsend et al., 2009).
- Selection of a strategically placed location (Bélissent, 2010; Washburn & Sindhu, 2010).
- Replication of standard approaches, resulting to faster deployment, economies of scale and higher chance for success (Garner & Dornan, 2011; International new town institute, 2012; Pike Research, 2011; Shwayri, 2013).

The most important disadvantages of developing new smart cities include:

- There is an imminent risk of slow progression due to a variety of problems ranging from budgetary issues to insufficient planning and failure to attract residents and/or capital. Sondgo IBD in South Korea (Shwayri, 2013) and Cyberjaya in Malaysia (Brooker, 2008; Nordin, 2012; Yusof & van Loon, 2012) did encounter some of those problems.
- On average, greenfield projects have a budget up to ten times higher than the budget of brownfield projects (Alcatel-Lucent, 2011). Therefore they require generous investments and a conducive governance model (Alawadhi et al., 2012; Copenhagen Cleantech Cluster, 2012).
- Singular focus on efficiency could cause a restricted view of societal values, such as social cohesion and quality of life, questioning the 'sustainability' dimension of new cities (Bria, 2012; Lind, 2012; Ratti & Townsend, 2011).
- The replication of technological solutions entails risks. The same solution may not be suitable for all cities (Pike Research, 2011; Sassen, 2011; Townsend, Maguire, Liebhold, & Crawford, 2010).

On the other hand, comments on the new versus existing smart city discourse stress the importance of collaboration among public and private actors, and most importantly the engagement of the city's people, in order to design socially sustainable and livable smart cities (Bria, 2012; Paskaleva, 2011; Sassen, 2011; Townsend et al., 2010). In this sense, the most important advantages of applying a smart city strategy on an existing city are:

- Opportunity of employing open innovation techniques and a bottom-up approach (crowdsourcing, user engagement, living labs, open data, etc.) to accelerate the innovation process (Bakici, 2012; Bria, 2012; Paskaleva, 2011; Schaffers, Komninos, & Pallot, 2012; Schuurman, Baccarne, de Marez, & Mechant, 2012; Vicini, Bellini, & Sanna, 2012a).
- An ecosystem of stakeholders is already present, allowing for innovatory ways to collaborate and secure funding (Robinson, 2012).
- Smart city revenue sources now tend to extend from products to services (namely platforms and applications), eliminating the need for large investments on smart city infrastructure (Garner and Dornan, 2011; Walravens, 2011).

The most important disadvantages of applying a smart city strategy to an existing city are:

- Complex ecosystems of people, institutions and stakeholders require extreme effort to organize and discipline (Bélissent, 2010; Ratti & Townsend, 2011).
- An existing city's infrastructure could be old and outmoded, hindering the realization of the smart city vision (Bélissent, 2010; Pentikousis, Zhu, & Wang, 2011).
- Besides becoming 'smart', existing cities have many problems that must be addressed and which compete for a share of the city's recourses. Therefore, it is not possible to address all aspects of a smart city; the strategy has to be highly selective and based on a laborious prioritization process (Bélissent, 2010).

Hard versus soft infrastructure oriented strategies

This category refers to whether the smart city strategy will target the efficiency and technological advancement of the city's hard infrastructure systems (i.e. transport, water, waste, energy) or the soft infrastructure and the people of the city (i.e. social and human capital; knowledge, inclusion, participation, social innovation, social equity, etc.).

In the first case, technological endowment can be seen as recourse for the development of a smart city based on the belief that by instrumenting a city technically and investing in hard infrastructure, an output of enhanced service provision in different areas of the urban life and consequently development will be achieved. Infrastructure-oriented smart city products provide replicable solutions that address a range of common problems; these solutions can later be applied to many cities with minor modifications. However, a large fraction of smart city advocates tends to regard infrastructure-oriented strategies as fragmented, stressing the idea that *'Technology is not enough'*, meaning that it does not guarantee the real smartness of cities, and it actually does not necessarily make people themselves think or act smart (Anthopoulos & Tougountzoglou, 2012; Aurigi, 2006; Hollands, 2008; Komninos, 2009; Lind, 2012; Nam & Pardo, 2011a; Net!Works Expert Working Group, 2011; Neves, 2009; Schuurman et al., 2012).

In the second instance, a more complete view on smart city development is adopted, by taking advantage of all available recourses, including the knowledge, creativity and intellectual capital of the populace. A significant portion of the smart city literature has argued extensively about the importance of human and social capital for the development of smart cities (for instance: Hollands (2008), Paskaleva (2011), Glaeser and Berry (2006), Chourabi et al. (2012), Neves (2009), Liugailaitė-radzvickienė and Jucevičius (2012), Aurigi (2006), Komninos (2008)). Besides, the creativity and resourcefulness of the city's people, underpinned through web spaces of collective intelligence, is more powerful than any machine or individual intelligence (Ratti & Townsend, 2011). Human-centered approaches to the problems of the urban environment are an indispensable characteristic of the smart city (Bria, 2012), and therefore smart cities should put technology truly at the service of their inhabitants and not vice versa (Sassen, 2011).

No specific advantages of hard infrastructure-oriented strategies are mentioned in the smart city literature. On the other hand, their disadvantages include:

- Risk for social disparities among population groups, unequal access and knowledge on ICT usage—the digital divide (Chourabi et al., 2012; Coe et al., 2001; Marciano, 2012; Walters, 2011). Technological advancements and the complexities of cyberspace will continue to forge inequalities within the fragments of society (Neves, 2009; Townsend et al., 2010).
- Spatial polarization and gentrification, as technology take-up is not evenly spread throughout urban areas, with splintering effects on housing, consumption, lifestyle, leisure, etc. (Hollands, 2008; Walters, 2011).
- Citizen lock-in, control and surveillance. Issues of transparency, privacy and collection of personal data, pervasive targeting of consumers, institutional control (Bria, 2012; Haque, 2012; Net!Works Expert Working Group, 2011).
- Difficulties that arise due to proprietary smart city software and infrastructure: high costs (Alawadhi et al., 2012; Aldama-Nalda et al., 2012; Chourabi et al., 2012), difficulties in integration across different systems (Alawadhi et al., 2012; Aldama-Nalda et al., 2012; Chourabi et al., 2012), lack of trained staff (Alawadhi et al., 2012; Chourabi et al., 2012; Huber & Mayer, 2012), necessity for frequent updates (Aldama-Nalda et al., 2012).

The mentioned advantages of soft infrastructure and people-oriented strategies include:

- Advancement of human capital; citizen empowerment (informed, educated, and participatory citizens), intellectual capital and knowledge creation (Ratti & Townsend, 2011; Komninos, 2009; Liugailaitė-radzvickienė & Jucevičius, 2012; Chourabi et al., 2012; Aurigi, 2006; Neves, 2009).
- Advancement of social capital; social sustainability and digital inclusion (Batty et al., 2012; Caragliu, Del bo, & Nijkamp, 2009; Hodgkinson, 2011; Liugailaitė-radzvickienė & Jucevičius, 2012).
- Behavioral change – sense of agency and meaning (i.e. the feeling of community and that we are co-owners and equally responsible for our city) (Frenchman, Joroff, & Albericci, 2011; Townsend et al., 2010).
- Humane approach; technology responsive to needs, skills and interests of users, respect for diversity and individuality (Bria, 2012; Lind, 2012; Roche, Nabian, Kloeckl, & Ratti, 2012; Streitz, 2011).

The disadvantages of soft infrastructure-oriented strategies, on the other hand, include:

- Cyberspace is not a purely public space, as not all people have equal access to it –besides, capitalistic market forces often dictate its use for private interests (Neves, 2009).
- The availability of vast amounts of data and information does not automatically guarantee the enhancement of knowledge, and it does not ensure its integrity, either (Neves, 2009).
- Access is not equal to participation; community engagement is not automatically incurred by accessibility to digital recourses (Neves, 2009).

Reference area: economic sector-based versus geographically based

A final significant differentiating characteristic among smart city strategies is their reference area: economic sector-based versus geographically based strategies. This issue, although fundamental and clearly articulated, has not been studied extensively in the context of the smart cities topic, and thus the available literature is very restricted. However, it still remains as a differentiating factor among smart cities.

Economic sector-based strategies refer to smart city strategies aiming at the transformation of specific economic sectors of the city (Komninos, 2009, 2011; Bélissent, 2010). This seems to be the mainstream approach within the broader smart cities landscape, as most cities appear to be concerned with deploying new technologies for a range of sectoral and/or actor-specific objectives (Wolfram, 2012). In this framework, cities aiming to become smart focus on enhancing the intelligence of specific socio-economic aspects of everyday living, such as business, housing, commerce, governance, heath, education, and community, without placing specific emphasis on the geography of each sector, but on its effectiveness and performance instead. For example, IBM, through their 'smarter cities' program, offers solutions for 'government and agency administration', 'smarter buildings and urban planning', 'environment', 'energy and water', 'transportation', 'education', 'healthcare', 'social programs', and 'public safety' (IBM, 2013). In a similar manner, Cisco's 'Smart + Connected Communities' platform offers solutions in fields such as transportation, learning, safety and security, sports and entertainment, utilities, real estate, health and government (CISCO, 2013).

On the other hand, other smart city strategies focus on geographically-determined districts and clusters (Komninos, 2009, 2011), such as business districts, research and development clusters, university and education areas, logistical clusters, tourism and leisure clusters, or even smaller areas, such as neighborhoods. This is a spatially-determined perspective that acknowledges the prevailing character and main functions of the city's districts and develops applications to organize and support their effectiveness. It addresses specific user groups, who are meant to enjoy the benefits of the district/neighborhood they live in/work in/visit.

The existing literature on smart cities does not point out advantages and disadvantages of sector-based and geographically based strategies. The only related reference mentions the fact that geographically-based strategies enable economies of scope, as each district's functions are upgraded due to spatial proximity and resources savings (Komninos & Sefertzi, 2009).

Cases of applied smart city strategies

National versus local strategies

National strategy: Malta

'Smart Island Strategy (2008–2010)' (Malta) is a national ICT strategy commissioned by the Government of Malta for the country to become 'one of the top 10 information societies in the world'. Malta seeks to forge a knowledge-based economy and to create new jobs in the high tech/creative industry. The country will become a first class ICT cluster and media capital by attracting and hosting international ICT and media companies and providing them an operational environment of cutting-edge infrastructure and technological means. The strategy was based on five strategic points: a. alignment with the EU Commission's i2010 Action Plan, Malta's Research, Technological Development and Innovation strategy, Malta's Industrial Policy, b. creation of the entirely new township of SmartCity Malta (a technology park on an area of 36 ha), c. adoption of a 360-degree approach, accounting for the interests and objectives of the wider society, d. learning from best international practices and adapting them locally and e. experience and results would be the drivers of the strategy (Ministry for infrastructure transport, 2008).

Other countries that have contemplated or applied smart country strategies include Cyprus, Italy and Singapore. One cannot also overlook, however, that with the exception of Italy, most of the previous countries are fairly small in geographic terms, which means that under certain criteria, these countries could be considered as comparable to large cities or metropolises, rather than countries.

Local strategy: New York City

The city of New York followed a well-articulated digital strategy, which was shaped with respect to local recourses, priorities and needs. The study commenced with a thorough assessment of the initial state of the city's digital status and the number of public servants that are occupied in these fields. Details were gathered about which topics present increased interest to the public (e.g. education, buildings, parking, taxes, etc.), the way the public accesses the digital tools (e.g. which browser they use) and demographic data (age, income, etc.). This intensive procedure on the city's initiating status revealed that the city's administration has already been leveraging digital assets that were not broadly known to the public. Then the strategy proceeded to a research study, which was conducted with the engagement of residents, city employees and technologists through 4.000 points of engagement. Through this process, stakeholders of the public and private sectors provided insights and ideas for the development of New York's digital city. Finally, city employees proposed ideas for a next-generation strategy, new coordination tools, and shared resources to enhance digital communications efforts. The study culminated in the formation of New York City's Digital Road Map, which highlights New York City government's commitment to technology in the public service, and presents a comprehensive plan to achieve New York City's digital potential. An overview of the Road Map's four core areas of Access, Open Government, Engagement, and Industry was provided (The City of New York, 2011).

Urban development stage: new versus existing cities

New City: Songdo IBD

Songdo International Business District (IBD) is a $35 billon dollar venture of a new smart city, located in South Korea. It was built from scratch on 1.500 acres (610 ha) of reclaimed land along Incheon's waterfront in South Korea, 65 kms from the capital, Seoul. Songdo IBD aspires to become a business hub and encompasses principles of sustainable design and technology. The main developers are Gale International, Posco and Morgan Stanley Real Estate. It was masterplanned according to LEED-ND (Neighborhood Development) principles and calls for a synergistic mix of uses. In this newly-built city, CISCO showcases their Smart + Connected Communities program fully. The technology vendor employed state-of-the-art technology in buildings, deploying a network that connects all the components of the city, including residences, offices and schools. Residents are able to control some functions of their homes remotely and everyone is able to interact through video from anywhere through CISCO's telepresence system (CISCO, 2010a, 2010b).

The first phase of Songdo opened in August 2009. However, the construction of the city has been progressing slowly ever since, compared to the original plans, due to a range of complications, including budgetary issues, insufficient state backing, bureaucracy, stakeholder resistance and failure to attract foreign capital investment (Lee & Oh, 2008; Shwayri, 2013; Williamson, 2013). As a result, Songdo is today more of a wealthy suburb of Incheon city, mostly populated by locals (Shwayri, 2013).

Existing city: Amsterdam

Amsterdam Smart City is a partnership among businesses, authorities, research institutions, and the people of Amsterdam, today comprising over 70 partners, including CISCO and IBM. The initiative's main themes of focus are living, working, mobility, public facilities and open data (Amsterdam Smart City, 2013). The program involves 32 area-based projects across Amsterdam's neighborhoods, focusing on energy transition and open connectivity. These projects are initially tested on a small scale and the ones that prove to be efficient are later scaled to broader areas. The projects help citizens monitor their private consumption, thus encouraging them to manage it better. One of the most well-known projects of Amsterdam Smart City is the Climate Street, which ran from 2009 to 2011 on the popular shopping street Utrechtsestraat. During this period, a number of smart and energy-saving technologies were introduced in the street, both in its public spaces and in the private businesses along it: smart meters, energy displays, smart plugs and smart lighting. At the closing of the program, the final results of the Climate Street CO_2 emissions were estimated to have been reduced by 8% (energy saving) and 10% (savings achieved by switching to green energy) (Sauer, 2012). Another typical project is the West Orange project. In the context of this project, 400 households in Amsterdam were equipped with a new energy management system that makes residents more aware of their energy consumption and helps them save energy. The energy management system includes wireless energy displays, connected to digital gas and energy meters. The objective is to reduce energy consumption by at least 14% and at the same time achieve the equivalent amount of CO_2 reduction (Amsterdam Smart City, 2013).

Amsterdam Smart City has received international recognition as one of the world's most successful smart city initiatives; it was nominated the second smartest city in Europe for 2014 (Chief Digital Officer Club official website, 2014), while it won the World Smart Cities Awards 2012 and the European City Star Award 2011.

Hard versus soft infrastructure oriented strategies

Hard infrastructure-oriented strategy: Rio de Janeiro

One of the most characteristic infrastructure-oriented smart city models is the IBM solution for the *'Smarter City'*. According to IBM (Kehoe et al., 2011), city infrastructures and services are traditionally created and managed by independent departments or organizations. City domains are focused on their own operations, and only on a limited basis is information shared with other interested parties and the overall city. In a smarter city, however, information—in the form of metrics, events and processes—must be shared across organizations in a near real-time manner. With the support of analytics programs, city-wide operational processes using data from any number of domains can continuously predict and react to events and trends that are affecting the city. In 2010, IBM employed their first integrated operations center in Rio de Janeiro, pooling generous investments in sensor networks after signing a contract with the city of Rio de Janeiro. Rio had recently experienced devastating landslides that killed over 250 people, and it faced the forthcoming challenges of hosting the Olympics in 2016 and the World Cup in 2014. It was thus agreed that there was a need for the development of an Emergency Response System, with real-time automated command-and-control of emergency responses. The citywide system integrates data from about 30 agencies, serving primarily safety and transport functions and uses integrated business analytics and intelligence with predictive trend analysis. Administrative authorities can now make more informed and prompt decisions as they can view information from city services such as the police, traffic management and energy grid, all at the same time.

The smart city project for the city of Rio has suffered negative criticism in popular media. The reality of the sprawling mega-city, which suffers from high crime rates, social inequality problems and acute environmental issues cannot be left uncommented under the 'smartness' brand. The project was referred to as "Smarter Favela" by Lindsay (2010), an expression which was reproduced abundantly across the Web. Furthermore, concerns have been raised as to what degree city management should be delegated to private companies (Anthony, 2012; Honan, 2012).

Soft infrastructure oriented strategy: Barcelona

The mission of Barcelona in the context of the smart city strategy is centered on the notion that Barcelona is a *'city of people'*. It is a city that seeks to improve citizens' welfare and quality of life, as well as to foster economic progress. Smartness, in Barcelona's approach, is not an end in itself, but a means to achieve development (Ajuntament de Barcelona, 2014). The city utilizes knowledge as an engine of economic growth, aiming to support the production and the generation of talent on a local level (Bakici, Almirall, & Wareham, 2012). The engagement of the private sector and citizens and the development of an innovation ecosystem has been the primary concern of the city's strategy. In this context, the city created a friendly climate for Private–Public Partnerships (PPPs) to flourish, namely by providing the necessary legal framework and the space for these partnerships to settle. Collaboration is therefore key to Barcelona's smart city initiative, and the city takes a lead to facilitate it among stakeholders (businesses, academic institutions, government authorities and the residents), while allowing partners to operate as independently as possible and ensuring that their activities meet the aims of the smart city venture (Lee, Bakici, Almirall, & Wareham, 2012). In total, there are over 100 horizontal projects considered to be part of the smart city strategy in Barcelona and many of them have both a physical and a digital dimension, as Barcelona is one of the cities that paid specific attention to the territorial dimension of urban innovation. The latter is realized through high-quality urban planning and urban renewal projects, along with preservation of the city's historical patrimony.

The 22@Barcelona District is the most representative case of large-scale urban renewal projects: an innovation district built on 200 ha of formerly brownfield land, equipped with high-technology infrastructure, with the goal of attracting businesses, institutions and other organizations in a climate of openness and cooperation. Furthermore, by providing ubiquitous connectivity (corporate fiber optical network, Wi-Fi mesh network, sensor network and public Wi-Fi network), new services for the citizens (to amplify the efficiency of the public sector, to offer up-to-date information to citizens and foster their participation in the management of the city and to innovate by encouraging citizen-to-citizen services) and open public data (Bakici et al., 2012; Komninos, Pallot, & Schaffers, 2013), the city's people are expected to contribute to local governance and benefit from gaining access to the city's services and becoming more participative.

Overall, Barcelona's strategy places outstanding emphasis on human and social capital. Nevertheless, the city faced challenges in providing exact and appropriate infrastructure and in the deployment and management of wireless networks and cross-departmental cooperation has been challenging due to the difficulty in defining clearly the roles and responsibilities of each person and authority (Bakici et al., 2012).

Reference area: economic sector-based versus geographically based

Economic sector-based strategy: 'Intelligent Nation 2015 (iN2015)' (Singapore)

A characteristic and clearly articulated sector-based approach is the 'Intelligent Nation 2015' (iN2015), which is Singapore's 10-year masterplan towards becoming an intelligent island. The iN2015 masterplan, now close to its end, foresaw the transformation of seven key economic sectors, including the government sector, which were then enabled through related initiatives (Infocomm Development Authority of Singapore, 2012):

- *The Digital Media & Entertainment Sector,* to establish a digital marketplace for the creation and commercialization of new interactive and digital media technologies, content and services
- *Education and Learning*, to use ICT in the education process and link students with other students in and out of Singapore
- *Financial Services*, to help Singapore become an innovative hub for financial services in Asia
- *Government,* to offer personalized government services to citizens, promote interaction and feedback and realize a standard ICT operating environment across the public sector
- *Healthcare and Biomedical Sciences,* to use ICT to link healthcare providers, enable instant access to patient information and promote biomedical research
- *Manufacturing and Logistics,* to use ICT in research and product development, develop new manufacturing services business models, reduce time to market and support one platform for national trade information and transactions
- *Tourism, Hospitality & Retail,* to use ICT to enhance growth and competitiveness and to deliver seamless, efficient and personalized services to visitors

The government of Singapore did indeed realize the majority of its expectations, as they are manifested in the iN2015 masterplan. Singapore is today one of the most powerful ICT hubs globally, with a broadly prospering service economy. What remain to be seen are published results and the evaluation of the plan's progress through the years it ran.

Geographically based strategy: Thessaloniki

The city of Thessaloniki, Greece, is another fitting example of a geographically-based smart city strategy. The areas of focus for the 'Intelligent Thessaloniki' proposal are the most important districts of innovation and entrepreneurship within Thessaloniki, namely: (1) the port of Thessaloniki, (2) the Central Business District (CBD) and commercial center of the city, (3) the campus of the Aristotle University of Thessaloniki, (4) the technology district of eastern Thessaloniki, and (5) the airport area. Applications and e-services vary from one city district to another. In the port cluster, smart environments were proposed to enhance the competitiveness of the cluster and facilitate freight transactions and other port operations. In the CBD, smart environments were recommended to facilitate access and mobility and enable environmental monitoring. At the University campus, smart environments were proposed to facilitate research and the dissemination of knowledge and enforce the triple-helix model by encouraging collaboration with the private sector. Finally, in the Eastern technology district, smart environments were proposed to facilitate the promotion of the area's commercial properties and attract tenants, provide online technology services, and to support new business incubation (Komninos & Tsarchopoulos, 2012).

Conclusions and recommendations for the development of smart cities

Before mapping out a strategy for the development of a smart city, it is important to see what is already in place and how it can be improved. This may sound axiomatic and self-explanatory, but experience has shown that it is surprisingly easy to be allured by grandiose visions about the smart city of the future and to focus

on what is missing rather than capitalizing on existing smart city resources first. New York City's experience is characteristic: the city already had in place many digital assets that were either not known to the public, or had not been recently updated or were running on different platforms across various city agencies.

Municipal governments, and authorities operating at the lowest tiers of government, have traditionally had limited autonomy and resources for themselves, and this has only been exacerbated by an era of limited public funds and austerity, such as the one that is still ongoing in Europe. Cities should thus begin the journey towards becoming a smart city by selecting a few domains or areas that need to be improved urgently. Amsterdam, for example, chose open data and energy. Rio de Janeiro chose transport and security. Selectivity, synergies and prioritization are thus three standard core values in planning a smart city.

Smart city ventures are also called to address issues of political coordination among different levels of administration. They also have to address moral and ethical issues, such as the digital divide, transparency, privacy and security. Rio de Janeiro is one case of city that has been criticized for failing to achieve moral balance, by failing to provide accessibility for all to the city's smart assets. Another typical example is the case of the Cyberjaya city in Malaysia; the construction of the new smart city began in the framework of national policy with the endorsement of the local administration, and at that time both came from the same political party. When this changed, however, the city suffered major delays and long periods of stagnation. Political and moral balance is thus another important success factor for the development of smart cities.

In this sense, it is noteworthy that to produce morally balanced and socially aware smart city strategies, stakeholder engagement is crucial. Stakeholder engagement can provide valuable insights about the assets and the needs of the city (New York City), increase public acceptance of the smart city venture (New York City, Amsterdam) and elevate the 'smartness' of the city to a whole new level, leveraging human capital and collective intelligence (Amsterdam, Barcelona). Digital spaces and Web 2.0 tools facilitate this valuable interaction with stakeholders enormously, as they provide a collective and encoded space where large scale interaction and collaboration can take place.

What is more, it is highly desirable to combine digital changes with targeted physical and institutional ones, achieving economies of scope through integrated projects, like Barcelona did. Physical planning and social policy can and should underpin the digital or 'smart' dimension of the city. The digitization of citizen services can have splintering effects on the social cohesion of society, as social groups with limited access to digital resources may find themselves completely isolated by losing their access to their physical counterpart (think banks versus internet banking, city hall services versus online birth certificates, libraries versus e-books, voting centers versus e-voting, etc.). Rio de Janeiro is a smart city that was severely criticized exactly for failing to make this consideration; the 'Smarter Favela' motto is characteristic of the venture's inability to address the acute social inequalities of the city, widening the already existing social gap and enhancing spatial polarization.

Finally, having mentioned Barcelona, there is an emerging trend to approach smart cities and urban development through small-scale integrated projects. These projects create urban-scale innovation ecosystems that are embossed in the physical space of the city and impact positively their surrounding area. These small scale projects act as pilot projects that are more user-friendly, encourage citizen participation and raise awareness and acceptance in the transition towards becoming a smart city (see Amsterdam and Barcelona). However, these projects need to be part of a broader strategic plan and foresee synergies among different projects, as previously mentioned.

Discussion

The smart cities' topic is still largely under exploration. The smart city landscape is shaped under local characteristics, priorities and the needs of cities, in addition to global market forces and available technology. This paper has made a comprehensive effort to provide a clearer view of the strategic choices with spatial reference that may play a fundamental role in the design of a smart city strategy. The advantages and disadvantages of each strategic choice were presented, distilled after a comprehensive review of recent smart city literature. These different paths emerge as dual or multi-faceted, leading to a range of decisions that radically differentiate the outcome of the smart city. Which available option is best is open to discussion. Different strategies have been implemented in variations through smart city projects globally. Indeed, several proposed or applied smart city strategies lie somewhere in-between the extremes of the available strategic choices.

Furthermore, this paper has only addressed strategic choices with a spatial reference. In fact, there is a range of other strategic choices without spatial reference that need to be tackled in the smart city design process. One could be, for example, whether the strategy will be based on an open innovation or closed innovation model. Another one could address the business model and its social implications behind the smart city venture. These strategic choices have been referenced randomly throughout the smart city literature but have never actually been categorized comprehensively and documented as of yet.

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