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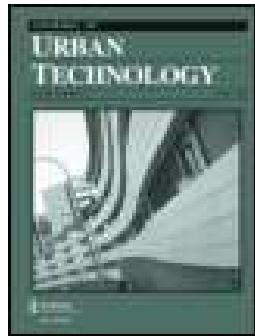
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The Role of Smart City Characteristics in the Plans of Fifteen Cities

Margarita Angelidou

ABSTRACT

This paper identifies the characteristics of smart cities as they emerge from the recent literature. It then examines whether and in what way these characteristics are present in the smart city plans of 15 cities: Amsterdam, Barcelona, London, PlanIT Valley, Stockholm, Cyberjaya, Singapore, King Abdullah Economic City, Masdar, Skolkovo, Songdo, Chicago, New York, Rio de Janeiro, and Konza. The results are presented with respect to each smart city characteristic. As expected, most strategies emphasize the role of information and communication technologies in improving the functionality of urban systems and advancing knowledge transfer and innovation networks. However, this research yields other interesting findings that may not yet have been documented across multiple case studies; for example, most smart city strategies fail to incorporate bottom-up approaches, are poorly adapted to accommodate the local needs of their area, and consider issues of privacy and security inadequately.

KEYWORDS

Smart cities; strategy; policy; governance; urban development

Introduction

The approximately 20-year history of smart cities has been shaped by varying social, economic, and technological developments. These include visions about the cities of the future, the advancing knowledge and innovation economy, a booming market of smart city products and the urgent need of cities and societies to address problems of efficiency and sustainability (Angelidou, 2015). Smart cities have been studied not only by scholars in architecture and urban planning, but also by those in neighboring disciplines, such as the social sciences (economy, geography) and the technical ones (computer science, electrical and civil engineering). As a result, smart cities today stand for a multidisciplinary subject of interest, constantly shaped by thinking about urban development, economic growth, and urban technology.

There still is, however, a lot of confusion about what smart cities actually stand for, coupled with misunderstanding about how they can be realized. The theoretical literature on how smart cities can be planned strategically is inconclusive about major and vital questions, including the very essence of what a “smart” city actually is. Many researchers have acknowledged this situation (Hollands, 2008, 2015; Kitchin, 2015; Komninos, 2011; Wolfram, 2012; Mora et al., 2017). In addition, some have argued that smart city development should be planned and implemented with the use of strategic processes and tools

(Komninos et al., 2013; Schaffers, 2012; Wolfram, 2012; Angelidou, 2015; Mora and Bolici, 2016, 2017).

What is needed, then, is a clearer view of the defining characteristics of smart city strategies. Inspired by the above situation, this paper identifies and reviews the characteristics of smart city strategies on the basis of smart city literature exclusively.¹

After this introduction, the next section commences by briefly explaining the idea of “smart cities.” It then presents the characteristics of smart cities as they were detected in the smart city literature. The following section provides information about the paper’s research methodology. Then, the results of the case study analysis with respect to each characteristic are presented. The paper closes with conclusions and recommendations about strategic planning for the development of smart cities. The paper is supplemented by detailed tables of empirical data that are included in an Appendix (Tables 1 to 10).

The Characteristics of Smart Cities: A Literature Review

Recent advances in information and communications technologies (ICT), such as the Web 2.0, Cloud Computing, and sensor networking, have been making it easier to acquire, organize, and process vast amounts of information. This information can be used to monitor and control the function of urban systems and advance the efficiency and outreach of urban services; it can also be used to help a city’s stakeholders become more informed and involved. These new capabilities create unprecedented opportunities to advance human and collective intelligence and develop urban knowledge ecosystems. Within this framework, smart cities represent a conceptual urban development model on the basis of the utilization of human, collective, and technological capital for the enhancement of development and prosperity in urban agglomerations (Angelidou, 2014).

An important remark to make at this point is that smart cities convey an idea for the *ideal* future of an urban settlement. In the best case scenario, smart city projects are supported by integrated, forward-looking strategic plans, useful in defining a vision and a methodology for the future development of a city, as seen through the prism of digital technologies and knowledge ecosystems. As technologies and societies are in constant and dynamic change, the smart city has to redefine itself and experiment with new ways of thinking about ICT and use it to advance the common good and social welfare.

Given the conceptual ambiguity and the fast-paced, socio-technical environment in which smart cities evolve, there lies a major challenge in deconstructing the smart city conception into explicit characteristics. These characteristics could offer an overview of available options and guiding lines for policymakers who engage in smart city development. Inspired by this challenge, what follows is an attempt to identify the major characteristics of the smart city.

Technology, ICTs, and the Internet

All smart city definitions and concepts are based on the idea of leveraging technology and digital tools for the enhancement of a city’s “smartness.” ICTs undergird networked infrastructures to improve economic and political efficiency and enable social, cultural, and urban development (Hollands, 2008). According to Stratigea et al. (2015), the currently available tools and technologies that are commonplace in smart cities fall within three

distinct categories: (1) tools and technologies for city-wide, geo-data collection and management (location-based services, cloud computing, the Internet of Things, sensor networks, data warehouses, Geographic Information Systems, geo-visualization, mapping, etc.); (2) tools and technologies for public participation (web-based participatory tools, crowdsourcing platforms, Living Labs, social media), and (3) sectoral applications (e.g., transport, energy, environment, etc.). ICT-based initiatives are capable of tackling a very broad range of urban challenges (Nijkamp and Cohen-Blankshtain, 2013). Tsarchopoulos et al. (2017) suggest that a combination of already tested applications with cloud computing can significantly accelerate smart city uptake. Komninos (2011) provides an inclusive overview of the areas that are addressed through smart city applications: (1) *economic activity*: manufacturing, commerce, businesses and finance, education, research, health, and tourism, (2) *city infrastructure and utilities*: transport, energy, water, waste, ICTs, (3) *quality of life*: social inclusion, social care, safety and security, environmental alert, (4) *city governance*: city hall services, citizen participation, informed top-level decision-making, monitoring, and benchmarking. To track this characteristic, we acquired data on:

- *tools and technologies*: data management (e.g., location-based services, cloud computing, the Internet of Things, sensor networks, data warehouses, Geographic Information Systems, geo-visualization – mapping), public participation (web-based participatory tools, crowdsourcing platforms, Living Labs, social media), smart city sectoral applications (e.g., transport, energy, environment, etc.)
- *applications and e-services*: economic activity, city infrastructure and utilities, quality of life, city governance

Human and Social Capital Development

An outlook towards developing the human and social capital of cities is also a characteristic of “smartness” in a city context. Knowledge, intelligence, and creativity are the pillars of human and social capital. Thus, informed, educated, and involved citizens, a high quality of life, and the creation of a “citizenry” space are considered basic ingredients of the smart city (Hollands, 2008; Paskaleva, 2011; Komninos et al., 2013; Nam and Pardo, 2011; Angelidou et al., 2012). Besides, technology underpins the development of knowledge and vice-versa; the two of them together fuel urban development and help realize smart cities (Angelidou, 2015). According to Giffinger et al. (2007) “smart people” are those who possess a level of qualification and an affinity to life-long learning; are flexible, creative, and cosmopolitan/open minded; and engage in public life. It has also been observed that already “smart” cities with a strong human capital base tend to become smarter over time (Glaeser and Berry, 2006). To track this characteristic, we acquired data on:

- *objectives*: environmental sustainability/sustainable lifestyles, digital inclusion, knowledge-based development, social innovation, enhanced public services, transparency, democracy
- *means*: initiatives for awareness/education/digital inclusion, initiatives for civic innovation, educational and social facilities, industrial/ business complexes.

Entrepreneurship Promotion

Entrepreneurship is also a defining characteristic of a smart and competitive economy (Giffinger et al., 2007). It represents a highly relevant feature of strategic planning for smart city development, because it is thought to be necessary for sustainable business ventures. In smart cities, this objective is predominantly realized through the development of pro-business environments, offering advanced services to new and expanding businesses. These environments nurture social and entrepreneurial innovation, attract creative, talented, and skilled workers, and serve as testing grounds for innovative business models and “smart” and “green” technology products (Hollands, 2008; Davies et al., 2015; Angelidou and Psaltoglou, 2017). Physical characteristics may play a determining role in the layout and success of the included services (Asprogerakas and Ioannou, 2007). To track this characteristic, we acquired data on:

- *development of pro-business environments*: attraction of Foreign Direct Investment (FDI), financial incentives and services, operational services, business incubation, knowledge and technology transfer, business showcasing and networking, labor force upskilling, high-end infrastructure development and improvement
- *business-intensive physical areas*: physical size and density.

Global Collaboration and Networking

Global collaboration and networking are characteristics of smart cities, too, as cities well positioned to observe, learn, and collaborate—especially with neighboring cities—are expected to benefit the most from economies of scale and scope. The benefits of partnerships and collaboration with other cities and communities include (1) knowledge and experience exchange, (2) economies of scale, pooling of common resources, and sharing infrastructure, and (3) complementarity in weak and strong points and joint addressing of challenges (Bélissent, 2010; Hodgkinson, 2011; Schulte, 2012; Townsend et al., 2011; Tranos and Gertner, 2012). Besides, there already exist several intra-city collaboration networks and peer groups for cities facing similar challenges (Hodgkinson, 2011). Some fields that may hold mutual concerns for cities and could be suitable for collaboration include housing, resource management, infrastructure, health, and security (Townsend et al., 2011). To track this characteristic, we acquired data on:

- *degrees of participation in partnerships and networks*: to connect, share, and learn from other innovative municipalities and government technologists from around the world.

Privacy and Security

Privacy and security are two other interrelated topics, which are so closely tied together that they could be regarded as a single, inclusive issue to be addressed in the context of smart cities. They are both related to how user and sensor-generated data are used in a smart city (Kitchin, 2015; van Zoonen, 2016). Privacy, on the one hand, is not only a very subjective, but also a situation-specific matter; consequently, it is expected that successful smart city

services will operate within flexible frameworks (Townsend et al., 2011; Streitz, 2011) and offer a variety of configuration options (Net!Works Expert Working Group, 2011; Townsend et al., 2011; Batty et al., 2012). On the other hand, a sense of security against physical, general, and cyber security threats enhances confidence in privacy and builds acceptance towards the penetration of computing technologies in everyday life (McNerney and Zhang, 2011). To track this characteristic, we acquired data on:

- *explicitness in addressing privacy and security issues.*

Locally Adapted Strategies

Another characteristic of smart city strategies is their capability to be locally adapted, i.e., to consider local characteristics and the identity of place, as well as local challenges, needs, and opportunities. Although in many cases it is wrongly assumed that the needs of cities are disconnected from their physical setting, the physical amenities of the place, its people, and their culture matter a great deal for the sustainability of a city (Paskaleva, 2011). In addition, each city is in a different stage of development and has different needs (Schulte, 2012), thus becoming “smart” in one city may not have the same meaning in another one, rendering one-size-fits-all solutions irrelevant (Kitchin, 2015). Besides, local characteristics can constitute a comparative advantage for cities, attracting footloose enterprises, investors, tourists, and capital (Giffinger et al., 2007). Therefore, 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 (Angelidou, 2014). To track this characteristic, we acquired data on:

- *degree of adaptation:* not adapted (international/global city), accommodating national priorities, or adapted to the city’s development targets, culture, and policy history.

Participatory Approach

A participatory approach, engaging stakeholders in a bottom-up fashion in planning and implementing smart city projects, is also a defining characteristic of smart city strategies. Arguably, bottom-up approaches in public policymaking are not novel at all.³ In the smart city context, however, the city’s users, be they citizens, entrepreneurs, or communities, can be engaged on a real-time and large-scale basis, acquiring different roles (Angelidou and Psaltoglou, 2017). Web 2.0 platforms, smart devices, and networks provide an unprecedented opportunity for broad user engagement and codification of input and information, enabling improved operations and the opening of new channels for social dialogue and civic innovation. This aspect of smart cities has been cited repeatedly as a basic ingredient of successful smart city strategies (Bakici, 2012; Evans-Cowley, 2011; González and Rossi, 2012; Greenfield, 2013; Hollands, 2015; Kominos et al., 2013; Paskaleva, 2011; Townsend, 2013). To track this characteristic, we acquired data on:

- *involved actors:* citizens, businesses, academia
- *stage of involvement:* strategy development and/or strategy implementation.

Top-Down Coordination

Top-down coordination also plays a central role towards smart city development. Smart city ventures, as large and costly projects that affect the whole of society, are both intensely ethical and political, challenged to accommodate short-term political interests in contexts of long-term community interests (Cugurullo, 2013; Shwayri, 2013; Angelidou, 2014; Günel, 2014; Watson, 2014). In this sense, leaders need to be capable of inspiring the pursuits of economic, social, and environmental sustainability, embracing changing roles and championing the smart city vision (Hodgkinson, 2011; Nam and Pardo, 2011), but they are also required to be well-positioned to create long-lasting knowledge ecosystems that foster collaboration among government, industry, cities, and citizens (Townsend et al., 2009). To track this characteristic, we acquired data on:

- *initiating and driving authorities*: National government, state-owned companies, municipality/local governments, privately-owned company, public/private sector alliance
- *leading figures*: mayor, Chief Executive Officer (CEO), Chief Technology Officer (CTO), Chief Data Officer (CDO).

Explicit and Workable Strategic Framework

An explicit strategic framework, reflecting a clearly defined architecture of smart city initiatives and considering strategic priorities and complementarities, also emerges as a characteristic of a smart city. Clearly, explicitness contributes to cost-effectiveness, ease-of implementation, potential for scaling further, and keeping investment risks low. Hence, the issues to be addressed by a smart city strategy need to be carefully scrutinized, assessed, and prioritized (Angelidou, 2014) and smart city investments should be considered both in terms of their long and their short-term implications (Bélissent, 2011; Caragliu and Del Bo, 2012). On the other hand, however, cities should be wary of engaging too extensively with piecemeal initiatives (Bélissent, 2011). To track this characteristic, we acquired data on:

- *architecture*: initiatives assorted under development-related sectors, technology areas and/or strategic priorities,
- *prioritization*: ongoing project / finite duration, number of phases.

Interdisciplinary Planning

Finally, as smart city initiatives span a wide spectrum of development-related fields and tackle pressing urban challenges (Nijkamp and Cohen-Blankshtain, 2013), their development should be a product of interdisciplinary planning. Despite the fact that smart cities address horizontal issues of social, economic, and technological development, urban development specialists (urban planners, transport/utility engineers) are often not included in their design (Aurigi, 2006). This to-be-avoided practice results in an incomplete approach to urban problems as a whole and generates strategic deficits. To track this characteristic, we acquired data on:

- *disciplines by sector:* academia, businesses, and entrepreneurs
- *disciplines by profession:* planners, engineers, transportation and utilities specialists, economists, and financiers.

Research Design

In order to explore whether and how the above 10 distinctive characteristics of smart cities have been incorporated in actual smart city projects from all over the world, a rigorous field research process took place from January 2014 to January 2015. The data sources included academic articles published in scientific journals and conferences, academic and corporate research reports, government documents, corporate documents, and non-scientific articles published online, on technology websites, in online newspapers, and on blogs. This breadth of information sources allowed for a collection of sufficient qualitative and quantitative information that facilitated the extraction of integrated conclusions.

In selecting the case studies for this research, a number of criteria were set:

- *The existence of an integrated strategy or at least a part of a strategy:* the city should have—as much as possible—an integrated strategy for becoming “smart,” including as many strategic planning levels as possible (analysis, design, implementation, control) and smart city levels (physical, institutional, digital), in order to constitute a high added value to the survey.
- *The degree of data availability:* there should be enough data available in order to allow for an integrated analysis.
- *The degree of diversity:* strategies should represent diverse development cultures and styles in order to allow for a wealth of information and a comparison across extreme cases (Eisenhardt, 1989)

After reviewing a large number of cases of smart city strategies that could be useful and assessing them against the above criteria, the final cases of smart city strategies that were selected to be surveyed, included:

1. **Amsterdam Smart City (The Netherlands)**, a partnership among businesses, authorities, research institutions, and the people of Amsterdam to reduce CO₂ emissions and improve the environmental record of the city (Amsterdam Smart City official website, 2014; Angelidou, 2016; Baron, 2012; Bolici and Mora, 2015; Lee and Gong Hancock, 2012; Mora and Bolici, 2017).
2. **Barcelona Smart City (Spain)**, a strategy focusing on “international promotion,” “international collaboration,” and “local projects.” The number of local projects is more than 100. The strategy is structured around the collaboration among government, industry, academia, and citizens (Angelidou, 2016; Bakici et al., 2012; Barcelona Smart City official website, 2014; Calzada, 2017; Capdevila and Zarlenga, 2015; Decoding the New Economy, 2013; March and Ribera-Fumaz, 2016; Mora and Bolici, 2016; Townsend, 2012).
3. **Smart London Plan (United Kingdom)**, a smart city plan created in 2013. It revolves around seven key themes in the domains of services for citizens, citizen engagement,

- development of businesses, smart infrastructure, and networking among stakeholders (Greater London Authority, 2013, 2014).
4. **PlanIT Valley (Portugal)**, a private, planned smart city to be developed in Portugal, to showcase the “Urban Operating System” which was developed by the software company Living PlanIT. This system will accumulate information from sensors placed throughout the city, which it will then feed to the applications that monitor and control the city’s systems (Living PlanIT SA official website, 2013; Carvalho, 2015; Carvalho et al., 2014; Alusi et al., 2010; Eccles et al., 2010).
 5. **Stockholm Smart City (Sweden)**, a strategy whereby environmental and information technologies are tested and used extensively throughout the city’s infrastructure, with the purpose of creating a flourishing ecosystem that involves the city’s inhabitants, private industry, and the public sector (Buscher and Doody, 2013; Shahrokni et al., 2015; Stockholm smart city official website, 2014).
 6. **Cyberjaya (Malaysia)**, a planned smart city that is part of a broader government policy for advancing the country’s innovation and knowledge economy. The city is expected to become a global ICT hub by attracting world-class multimedia companies, professionals, and students. ICT-wise, seven flagship applications are offered to citizens and businesses (Cyberjaya official website, 2011; Brooker, 2008; Nordin, 2012).
 7. **Singapore Intelligent Nation 2015 (iN2015) (Singapore)**, standing for a 10-year masterplan based on innovation, integration, and internationalization. It spans the digital media and entertainment sector, education and learning, financial services, healthcare and biomedical sciences, manufacturing and logistics, tourism, hospitality and retail, land and transport, and government and society (Infocomm Development Authority of Singapore, 2015; Hoe, 2016; Low, 2014; Hua, 2012).
 8. **King Abdullah Economic City (Saudi Arabia)**, a planned smart city focusing on manufacturing and logistics, shipping, light and processing industry and financial services. It will be wired with high-speed broadband infrastructure and all urban operations will be managed through Integrated Operation Centers, meant to act as the “brain of the city” (Emaar The Economic City, 2013; Komninos, 2015; Oxford Business Group, 2013; Reisz, 2010; Swiss Business Hub GCC and Green Destinations LLC, 2010).
 9. **Masdar City (United Arab Emirates)**, another planned smart city close to Abu Dhabi, designed on the basis of sustainable urban design. Its economy revolves around cleantech research and development, pilot projects, technology, and materials testing (Masdar City official website, 2013; Günel, 2014; Cugurullo, 2013; Crot, 2013).
 10. **Skolkovo (Russia)**, also a planned city to be built close to Moscow, expected to contribute to the modernization of the Russian economy. It will forge a knowledge-and-innovation ecosystem by developing collaboration channels between industry and academia in five clusters: ICTs, biomedical, energy efficiency, space and nuclear technology (Cox, 2011; Saltykovsky, 2013; Skolkovo Innovation City official website, 2014; Trelewicz, 2012).
 11. **Songdo International Business District (South Korea)**, an already developed (again planned) city which is a model of sustainable, city-scale development and innovation and aims to become a central business hub in Northeast Asia (Alusi et al., 2010; Benedikt, 2016; Carvalho, 2015; Lee and Oh, 2008; Shin, 2016; Shwayri, 2013; Songdo I.B.D. official website, 2013; Yigitcanlar and Lee, 2014).

12. **Chicago Smart City (USA)**, a strategy for leveraging technology in order to promote opportunity, inclusion, engagement, and innovation. It foresees the collaboration of the public, the private, and the “third” sector to develop the city’s infrastructure, “smart” communities, governance, civic innovation, and the technology business sector (Buscher and Doody, 2013; City of Chicago, 2013; Smart Chicago official website, 2014; O’Neil, 2014).
13. **New York Digital City (USA)**, a strategy for the city of New York to become “the world’s most digital city,” developed with the engagement of residents, city employees, and technologists. Its four core areas are Access, Open Government, Engagement, and Industry, comprising altogether 40 initiatives (City of New York Official Website, 2014; City of New York, 2011, 2013; Chief Digital Officer Club official website, 2014).
14. **Rio de Janeiro Smarter City (Brazil)**, a smart city initiative that was a collaboration of the city with technology vendor IBM to become a “smarter city” for the 2014 World Cup and the 2016 Olympics. Rio is now equipped with a citywide Emergency Response System that collects sensor-and-camera-generated data that enables informed decision making in policing, traffic, and energy management (Buscher and Doody, 2013; Rio de Janeiro Centre of Operations official website, 2014; Web Foundation and International Development Research Centre, 2014).
15. **Konza Technology City (Kenya)**, a planned smart city close to Nairobi, designed on the basis of sustainable design principles and expected to advance technology growth in Kenya. Its economy will focus on four sectors: education, life sciences, telecom, and Information Technology Outsourcing and Business Process Outsourcing (Adeya and Munywoki, 2012; Konza City official website, 2014; Watson, 2014).

The detailed tables of empirical data that were created during the field research stage are included in the [Appendix](#) of this paper. Ten tables are provided, each corresponding to one of the identified smart city characteristics.

Findings

The first characteristic for smart city development is “**Technology, ICTs and the Internet**” (See [Table 1](#), [Appendix](#)); in terms of technology application areas, the most popular one is by far “city infrastructure and utilities” (5/15). Next come “economic activity” (4/15), “city governance” (4/15), and “quality of life” (3/15). More specifically, the most frequently used applications of smart city technologies aim for a better function of ICT infrastructures, education in cities, businesses and finance, research, and transport management and city hall services. Next, and also very frequently encountered, come applications for commerce, health, energy, and informed top-level decision-making. On the other hand, the least popular applications are in tourism and social care. Vertically speaking, there is (1) a group of highly integrated, all-encompassing smart city strategies, including the ones of London, Stockholm, and Barcelona, (2) another group of moderate variability in terms of smart city applications, including PlanIT Valley, Singapore, King Abdullah Economic City, Masdar, Skolkovo, Songdo, Chicago, New York and (3) some smart city strategies with a very targeted—technologically speaking—strategic focus, namely Amsterdam, Cyberjaya, Rio, and Konza.

Regarding the second characteristic, “**Human and Social Capital Development**” (See [Table 2, Appendix](#)), about half of the strategies (7/15) seek to advance human and social capital through education and digital inclusion programs aimed at improving awareness and accessibility of citizens towards smart city-related goals. The same group of strategies also seeks to foster civic innovation as a means for developing human and social capital within the city. Also, many smart city strategies (9/15) seek to develop human and social capital by developing hard infrastructure in the form of educational and social facilities and/or developing hard infrastructure in the form of industrial/business complexes. In planned cities, this approach is realized by means of dedicated business and industrial complexes and university areas, whereas in existing cities, it is mostly realized in dedicated areas where academia and industry collaborate and/or engage in innovative activities. Five of the 15 smart city strategies seek to develop human and social capital by combining soft and hard infrastructure developments.

About the third characteristic for smart city development, “**Promotion of Entrepreneurship**” (See [Table 3, Appendix](#)), it was observed that high-end infrastructure (specifically broadband connectivity) is seen as the overarching way to promote entrepreneurship; in the majority of the studied smart city strategies (11/15) it is seen as an indispensable tool enabling access to information, knowledge exchange, and the provision/consumption of networked services. Physical proximity and transport connections to transport hubs and nearby sites of interest (mostly cities) is also very important for promoting entrepreneurship. Business incubation is a prominent component of smart city strategies, too, as it assists startups to develop and enter the market (10/15 strategies); the same is valid for knowledge and technology transfer among businesses, academia, and government (10/15 strategies). Moreover, of importance are financial incentives and services (9/15 strategies), which range from tax exemptions, foreign ownership, and freedom of repatriation of capital and profits, to research and real estate grants for “technopreneurs” and banking services/venture capital. Attracting FDI is a central goal of many smart city strategies, too (8/15); multinational companies and world-class startups are expected to grow within and invest in the smart city ecosystem, resulting in the creation of “global business hubs.” Other than the previous, the development of business environments in smart cities is promoted through the provision of operational services to businesses (e.g., facilitation of permits and procurement through “one-stop agencies,” intellectual property protection), platforms for showcasing and networking of businesses, and labor force upskilling initiatives (training in digital literacy and entrepreneurship). Many strategies involve the development of business-intensive physical areas, such as areas devoted to Research and Development (R&D); there is a clear prevalence of medium (neighborhood) size areas of that sort. About half of the strategies (8/15) do not provide special areas for promoting entrepreneurship (entrepreneurial activity is dispersed throughout the entire city). Two of the 15 involve the development of small (size of one or a few city blocks) business-intensive facilities.

Only four of the 15 smart city strategies include extensive “**Collaboration and Networking Activities**” (See [Table 4, Appendix](#)) the fourth characteristic for smart city development, which ranges from collaborating with other smart cities to participating in international networks and forums. These already exist in global cities that have experience in international networking. The rest of the strategies include all the planned cities and four existing ones that include limited or no collaboration and networking activities.

“Privacy and Security” (See [Table 5, Appendix](#)) is the fifth characteristic for smart city development. Most strategies only vaguely address privacy and security issues. A few smart city strategies make a general (but still ambiguous) reference to security and privacy (2/15), while only three strategies exhibit a more sophisticated level of managing security issues. It is worthy of mention that in Cyberjaya, King Abdullah Economic City, and Masdar there have been concerns and an ongoing discussion about the protection of privacy of the inhabitants of the cities.

Regarding the next characteristic, “**Locally Adapted Strategies**” (See [Table 6, Appendix](#)), most smart city strategies (8/15) were found to be completely disconnected from their surrounding context. These cities are seen as international cities or global business hubs, which are geared towards enhancing economic development/diversification in their country. In this sense, internationalism has a pivotal role to play, with the cities expected to attract businesses, workers, and residents from all over the world. A closer inspection of the cases, however, reveals that this is an affair exclusive to greenfield cities. On the contrary, smart city plans for already existing cities are generally highly adapted to the local needs of their area. They are also part of broader long-term plans, visions, and goals; they reflect existing policy culture; they seek to solve local problems; and some of them have been formed in a substantial bottom-up manner.

Overall, six of the 15 smart city strategies have been shaped through comprehensive “**Participatory Approaches**” (See [Table 7, Appendix](#)), actively promoting the involvement of citizens and businesses in the policy implementation stage. The only strategy which, apart from having been implemented, was also planned through participatory processes from the outset was the one in New York. However, about half (8/15) of the 15 smart city strategies are characterized by a low performing or no participatory approach whatsoever. In these cities, citizens and other users of the city’s services are only monitored in terms of their activity; they do not interact with the city in meaningful ways.

“**Top-Down Coordination**” (See [Table 8, Appendix](#)) was the eighth characteristic for smart city development. It was found that the overwhelming majority of smart city ventures are driven by the public sector and predominantly local administrative authorities (9/15). Fewer smart city ventures are driven by governments (3/15) and state-owned companies (2/15). Only one smart city venture is an outcome of private initiative (PlanIT Valley). Still, however, the private sector has an active role in partnering with the public sector to advance the smart city by providing policy advice and connecting smart city solutions with the market. The academy appears to have a weak role in smart city strategy development, with only one case of academics being substantially involved in it (London Smart City). In terms of leading figures, most smart city strategies (11/15) are led by one or two people, usually the city’s mayor and/or a Chief Executive Officer (CEO), a Chief Technology Officer (CTO) or a Chief Data Officer (CDO). The few remaining ones are led by groups of executives, namely boards specifically commissioned to advance the smart city venture. Most smart city strategies also reflect a prevalence of social and common interest over the political one, although the latter is not completely absent. Their majority also has a far looking vision, comprising multiple and long-term initiatives, and targeting broader economic, social, and environmental sustainability, rather than focusing on incremental and quickly attainable goals. A final interesting observation is that state-driven strategies tend to have a strong political element—

those national smart city initiatives are promoted as exemplars that are expected to produce a transformative effect for their national economies as a whole.

Most smart city strategies are characterized by “**Explicit Strategic Frameworks**” (See [Table 9, Appendix](#)), which is the ninth identified characteristic for smart city development. In terms of the strategies’ architecture, there is a clear prevalence of initiatives assorted under various strategic priorities, such as improving government services, increasing bottom-up engagement, stimulating the growth of the technology industry, etc. Other smart city strategies are structured on the basis of development-related sectors, for example, economy, society, and transport, while some others are structured along technology areas, for example, urban operation systems, smart buildings, and smart grids. A significant number of strategies (5/15) have an ambiguous and/or unclear architecture of initiatives—a closer look at those smart city ventures reveals that this phenomenon concerns primarily large scale, greenfield, and highly complex developments. A significant number of strategies (6/15) systematically incorporate pilots and use cases of varying types, scales, and reference areas with the purpose of making a business case for innovative solutions. For example, some pilots are implemented in real environments, while others are implemented in safe and controlled environments. Some concern technology interventions only, while others combine those interventions with physical developments. Finally, some are tested on entire urban areas and neighborhoods, while others are tested on areas of a limited size, such as public buildings, commercial streets, and communal parks. In terms of prioritization, we encountered mixed approaches, with many initiatives having a definitive start/end and others seen as ongoing. Most smart city strategies are single phased or include a small number of phases (2–3).

With regard to the last characteristic for the development of smart cities, “**Interdisciplinary Planning**” (See [Table 10, Appendix](#)), 10 of the 15 smart city strategies leverage multi-layer expertise to develop an integrated and concrete smart city initiative. Rio de Janeiro missed the opportunity to leverage the potential of interdisciplinary planning altogether, as its strategy was designed only by a technology vendor in collaboration with city government officials.

Integration and Conclusions

As observed, a primary objective of smart city strategies is to enhance citizen participation and civic innovation. Stakeholders are gradually regarded more as agents of change, rather than mere collaborators; they are required to not just concede to smart city strategies, but rather determine their own needs and address them in partnership with governments through citizen-driven participatory approaches. The process of empowering citizens is not a simple one, however, and it seems that for the time being the social aspects and namely the welfare of people and communities have a secondary role in smart city strategies. For example, it is alarming that smart city applications for improving the “quality of life” in cities lag behind in matters of priority and ingenuity. It is also alarming that most smart city strategies are completely disconnected from their surroundings and that most address issues of privacy and security vaguely. It is then necessary that smart city strategies include measures for raising citizens’ awareness, improving digital skills, and providing access to digital resources. Funding opportunities for civic startups and social entrepreneurs might also be considered. A wide range of social and demographic groups should

be included, ranging from primary and secondary school students to the elderly and socially excluded classes of the population. Measures and actions might also be place specific, for example focused on low-income neighborhoods.

In the researched smart city strategies, the growth of the knowledge and innovation economy is usually realized on the basis of hard and soft infrastructure and facilities that will allegedly foster this kind of growth. Relevant facilities include educational institutions and business complexes/clusters where the government, industry, academia, and citizens/communities are called to collaborate, exchange knowledge, and create innovation ecosystems of various forms (for example, Kista Science City in Sweden and 22@Barcelona in Spain). These area-specific complexes and clusters are meant not only to act as catalysts for human and social capital development, but also as demonstrators of how innovation ecosystems can be developed in real life; they benefit from economies of scale and scope, tacit knowledge exchange, vibrant entrepreneurial communities, and social entrepreneurship activity. Specific services include business incubation, provision of operational and financial instruments, as well as networking and showcasing platforms.

In addition, networking can take place both on the physical and the digital level. Working together with other cities and participating in networks for knowledge and experience exchange, as well as sharing of resources is a practice adopted mainly in smart city strategies of existing cities with an established international character. In planned cities, however, there seems to be a fragmented approach towards internationalism and global connectivity, meant to be realized through physical designs that incorporate high and international design standards and by being in proximity to other commercial, business, or knowledge intensive clusters. In the same line of thinking, a prominent characteristic of the envisaged smart cities is their efficient transport connection with regional and global transportation hubs. Nevertheless, the cities that actually do participate in collaboration networks seek to leverage both the networks they are already parts of (e.g., networks focused on improving urban sustainability and governance) and other smart-city and community-focused networks.

Another interesting observation is that smart city technology does not appear to be an insurmountable challenge in itself anymore; there is actually a very broad variety of tools, solutions, and applications—especially open source—that can be used in many different combinations in smart city contexts. As data management, knowledge codification, and information exchange are essential characteristics of smart cities, networking technologies have a fundamental role in all smart city strategies. And not surprisingly, it was found that in most smart city strategies, high-end infrastructure, and particularly broadband connectivity is seen as the foremost enabler of smartness, social innovation, and entrepreneurship. Given the fact that technology solutions abound, the current challenge lies in devising the appropriate mix of those technologies and selecting the smart city applications that will complement each other and build a highly effective and demand-responsive smart city platform.

Moreover, there is a broad spectrum of available paths and choices towards the smart city. A rising challenge, then, lies in developing and implementing the right policy mix to promote all those strategic goals in a balanced and synergistic way. The number of available options here is endless, as strategies could be sector-based, technology area-based, and priority-based; they could be inclusive of many priorities or focus on a few selected areas; they could concern only digital interventions or combine those interventions with physical

developments. It is virtually impossible, however, to address all issues at once. Inevitably some bargaining among the scope, quality, and cost of each initiative will take place. The only principle to follow is that smart cities should be developed on the basis of explicit strategic frameworks, reflecting clearly articulated architectures and considering priorities and synergies among the included initiatives. In this process, the use of case studies is valuable for investigating the prospects for success of smart city initiatives and making the necessary adjustments. In addition, as smart city strategies span a broad spectrum of development areas (society, economy/entrepreneurship/innovation, spatial development, infrastructure development), it is important to involve professionals from different disciplines in smart city planning. A sophisticated degree of adaptation to their local context is also required; smart city strategies need to be part of broader long-term plans, visions, and goals; must reflect and advance each city policy heritage; and seek to solve local problems.

A final, but equally significant challenge lies in securing and managing the necessary resources (funds, human capital) that are needed to realize smart cities. Leadership and top-down coordination have a significant role here; the driver(s) of the smart city venture, be they national/local governments, privately-owned companies, or a combination, need to balance short-term interests with the long-term objectives of social and economic development. Furthermore, the private sector has a substantial role to play in realizing smart cities, by contributing high-level expertise as well as financial resources. New governance and business models can be leveraged to this end, and there is an ongoing discussion about innovative schemes of collaboration and funding with the participation of the public, private, and civic sectors.

At the end of the day, smart city strategies are employed to make decisions on a series of contradicting or complimentary issues, depending on the approach that is adopted. For example, should entrepreneurial environments and the knowledge economy be advanced by means of hard or soft infrastructure? What is the appropriate level of intervention by local and national governments, and which is the desired amount of freedom and self-regulation that entrepreneurs and social innovators need in order to achieve success? How can spatial design compliment smart city strategies? As with strategic planning for public purposes, there is no one best way to plan a smart city and each strategy depends on the situation. The best strategy is the one that accounts for the organizations' mission and characteristics, while keeping previous experience under consideration. It is the one that manages to create a meaningful direction for the organization and that maximizes its potential for influencing its environment in a positive way.

Notes

1. This paper does not generalize from broader fields, such as e-government or innovation management. This paper is a product of the author's doctoral research thesis about "Strategic Planning for the Development of Smart Cities," which was concluded at URENIO Research, Aristotle University of Thessaloniki, Greece in 2015. The record of this thesis is available at: <http://ikee.lib.auth.gr/record/268771?ln=en>. The thesis includes, an extensive review of the available scientific smart city literature (approximately 500 bibliographic sources), followed by empirical research on 15 cases of smart city strategies. Inevitably, the work presented in this paper includes only a fraction of this research.
2. See, for example, Arnstein (1969)'s "Ladder of Participation."



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Appendix

Table 1. Collected data for Characteristic 1: Technology, ICTs, and the Internet (Author's elaboration).

Name of Venture	Characteristic 1: Technology, ICTs, and the Internet (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Tools and solutions for data management (broadband and sensor networks, smart meters), public participation and applications for economic activity (education), quality of life (social inclusion), city infrastructure and utilities (energy, transport, ICTs), city governance (citizen participation, informed top-level decision-making)
Barcelona Smart City	Data management tools (broadband and sensor networks, optical fiber infrastructure, Wi-Fi, Cloud, Internet of Things, smart grid) are used as means for improving urban services, mobility, and sustainability and enhancing connectivity and public participation. Over 100 horizontal projects, spanning solutions for data management, public participation, and applications for economic activity (businesses and finance, education, research, health), city infrastructure and utilities (transport, energy, water, waste, ICTs), quality of life (social inclusion, safety and security, environmental alert), city governance (city hall services, citizen participation, informed top-level decision-making)
Smart London Plan	Tools and solutions for data management (broadband and sensor networks, smart grid, 3D visualizations), public participation and applications for economic activity (manufacturing, commerce, businesses and finance, education, research, health, tourism), city infrastructure and utilities (transport, energy, water, waste, ICTs), quality of life (social inclusion, safety and security, environmental alert), city governance (city hall services, citizen participation, informed top-level decision-making, monitoring, and benchmarking)
PlanIT Valley	Tools and solutions for data management (sensor networks, cloud, city analytics) and applications for economic activity (manufacturing, commerce, education, research, health, primary sector), city infrastructure and utilities (transport, energy, water, waste, ICTs), quality of life (safety and security, environmental alert), city governance (monitoring, and benchmarking)
Stockholm Smart City	Tools and solutions for data management (broadband networks, optical fiber infrastructure), public participation and applications, economic activity (manufacturing, commerce, businesses and finance, education, research, health, primary sector), city infrastructure and utilities (transport, energy, water, waste, ICTs), quality of life (social inclusion, social care), city governance (city hall services, informed top-level decision-making)
Cyberjaya	Tools and solutions for data management (broadband and sensor networks, optical fiber infrastructure, citywide Wi-Fi access, Cloud computing) and applications for economic activity (businesses and finance, education, health), city governance (city hall services, monitoring and benchmarking, informed top-level decision-making)
Singapore Intelligent Nation 2015	Tools and solutions for data management (broadband and sensor networks, citywide free Wi-Fi, Grid Computing, Cloud Computing, National Authentication Framework, Business Analytics, Geographic Information Systems) and applications for economic activity (manufacturing, commerce, businesses and finance, education, research, health, tourism), city infrastructure and utilities (transport, ICTs), quality of life (social inclusion, social care, safety and security), city governance (city hall services)
King Abdullah Economic City	Tools and solutions for data management (broadband and sensor networks) and applications for economic activity (commerce, businesses and finance, education, research), city infrastructure and utilities (transport, energy, ICTs), quality of life (safety and security), city governance (city hall services, informed top-level decision-making)
Masdar City	Tools and solutions for data management (sensor networks, 'smart' meters) and applications for economic activity (manufacturing, commerce, businesses and finance, education, research, primary sector), city infrastructure and utilities (transport, energy, water, waste, ICTs), city governance (city hall services, informed top-level decision-making)
Skolkovo	Tools and solutions for data management (sensor networks, city analytics, Geo-visualization – Mapping) and applications for economic activity commerce, businesses and finance, education, research, primary sector, city infrastructure and utilities transport, energy, water, waste, ICTs), quality of life safety and security), city governance city hall services, monitoring and benchmarking)
Songdo International Business District	Tools and solutions for data management (sensor and RFID networks) and applications for economic activity (businesses and finance, education, health, tourism), city infrastructure and utilities (transport, energy, water, waste, ICTs), quality of life (safety and security), city governance (city hall services)

(Continued)

Table 1. Continued.

Name of Venture	Characteristic 1: Technology, ICTs, and the Internet (sources mentioned in the main document, Research design section)
Chicago Smart City	Tools and solutions for data management (broadband and sensor networks, optical fiber infrastructure, free Wi-Fi in public spaces) and applications for economic activity (commerce, businesses and finance, education, research, health), city infrastructure and utilities (ICT), quality of life (social inclusion, safety and security), city governance (city hall services, citizen participation, informed top-level decision-making, monitoring and benchmarking)
New York Digital City	Tools and solutions for data management (broadband networks, optical fiber infrastructure, free Wi-Fi in public spaces, visualization tools) and applications for economic activity (commerce, businesses and finance, education, research, health), city infrastructure and utilities (transport, energy, waste, ICTs), quality of life (social inclusion), city governance (city hall services, citizen participation, informed top-level decision-making)
Rio de Janeiro Smarter City	Tools and solutions for data management (sensor and CCTV networks, GPS devices, radar, City analytics), information of public (social media) and applications for city infrastructure and utilities (transport, ICTs), quality of life (safety and security, environmental alert), city governance (informed top-level decision-making, monitoring and benchmarking)
Konza Technology City	Tools and solutions for data management (broadband networks, optical fiber infrastructure) and applications for economic activity (commerce, businesses and finance, education, research, health), city infrastructure and utilities (ICTs)

Table 2. Collected data for Characteristic 2: Human and social capital development (Author's elaboration).

Name of Venture	Characteristic 2: Human and Social Capital Development (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Objectives: environmental sustainability/sustainable lifestyles Means: initiatives for awareness/education/digital inclusion and civic innovation
Barcelona Smart City	Objectives: digital inclusion, enhanced public services, social innovation, transparency, democracy Means: initiatives for awareness/education/digital inclusion and civic innovation, educational and social facilities, industrial/ business complexes
Smart London Plan	Objectives: digital inclusion, enhanced public services, social innovation Means: initiatives for awareness/education/digital inclusion and civic innovation
PlanIT Valley	Human and social capital development not a priority
Stockholm Smart City	Objectives: enhanced public services, environmental sustainability/sustainable lifestyles, ICT uptake Means: initiatives for awareness/education/digital inclusion and civic innovation, educational and social facilities, industrial/ business complexes
Cyberjaya	Objectives: knowledge-based development Means: educational and social facilities, industrial/ business complexes
Singapore Intelligent Nation 2015	Objectives: enhanced education and training, digital inclusion, enhanced public services Means: initiatives for awareness, education and digital inclusion
King Abdullah Economic City	Objectives: knowledge-based development Means: educational and social facilities, industrial/ business complexes
Masdar City	Objectives: environmental sustainability/sustainable lifestyles Means: educational and social facilities
Skolkovo	Objectives: environmental sustainability/sustainable lifestyles Means: educational and social facilities, industrial/ business complexes
Songdo International Business District	Objectives: enhanced education and training, enhanced public services, transparency Means: educational and social facilities, industrial/ business complexes
Chicago Smart City	Objectives: digital inclusion, enhanced public services, civic innovation Means: initiatives for awareness/education/digital inclusion and civic innovation
New York Digital City	Objectives: digital inclusion, enhanced public services, democracy Means: initiatives for awareness/education/digital inclusion and civic innovation, educational and social facilities
Rio de Janeiro Smarter City	Human and social capital development not a priority.
Konza Technology City	Objectives: knowledge-based development Means: educational and social facilities, industrial/ business complexes

Table 3. Collected data for Characteristic 3: Promotion of entrepreneurship (Author's elaboration).

Name of Venture	Characteristic 3: Promotion of Entrepreneurship (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Financial incentives and services, operational services, business incubation, knowledge and technology transfer, business showcasing and networking ('Amsterdam Connects' program), labor force upskilling. Business-intensive physical areas of small size (one or some city blocks). Entrepreneurial activity also dispersed through entire city.
Barcelona Smart City	Knowledge and technology transfer, business showcasing and networking, business incubation, high-end infrastructure (broadband). Business-intensive physical areas of medium size (22@Barcelona). Entrepreneurial activity also dispersed through entire city.
Smart London Plan	Knowledge and technology transfer, business showcasing and networking, business incubation, labor force upskilling. Business-intensive physical areas of small size (one or some city blocks). Entrepreneurial activity also dispersed through entire city.
PlanIT Valley	Attraction of FDI, business showcasing and networking, knowledge and technology transfer, business incubation, high-end infrastructure. Entrepreneurial activity dispersed through entire city.
Stockholm Smart City	Financial incentives and services, knowledge and technology transfer, business incubation, labor force upskilling, high-end infrastructure (broadband). Business-intensive physical areas of medium size (Kista Science City, Hagastaden). Entrepreneurial activity also dispersed through entire city.
Cyberjaya	Attraction of FDI (multinational companies), financial incentives and services (tax exemptions), operational services (unrestricted employment of local and foreign knowledge workers and no Internet censorship), business incubation, labor force upskilling, high-end infrastructure (broadband). Business-intensive physical areas of medium (neighborhood) size.
Singapore Intelligent Nation 2015	Attraction of FDI (multinational companies and world-class startups), financial incentives and services, operational services (electronic transactions, technology commercialization and exploration of new business models), labor force upskilling (ICT-augmented education and training), high-end infrastructure (broadband). Entrepreneurial activity dispersed through entire city.
King Abdullah Economic City	Attraction of FDI (multinational companies). Not much information available. Business-intensive physical areas of medium size.
Masdar City	Attraction of FDI, financial incentives and services (100 percent foreign ownership, 100 percent tax exemption, 0 percent import tariffs, freedom of repatriation of capital and profits, cost effective licensing and office space), operational services ('One-Stop Shop' for registration, government relations and visa processing), business incubation, knowledge and technology transfer, business showcasing and networking ('The Future Build' platform connects smart product suppliers with building industry professionals), high-end infrastructure. Business-intensive physical areas of small size (one or some city blocks).
Skolkovo	Attraction of FDI, financial incentives and services (tax breaks, research grants, venture funds), operational services ('Startup Visa' for foreign entrepreneurs, intellectual property protection), business incubation, knowledge and technology transfer, high-end infrastructure. Business-intensive physical areas of medium (neighborhood) size.
Songdo International Business District	Attraction of FDI (Free Economic Zone – global business hub, governmental support, easements in transactions and tax incentives), financial incentives and services (banking), operational services (subsidiary facilities to support R&D functions), knowledge and technology transfer, high-end infrastructure. Business-intensive physical areas of medium (neighborhood) size.
Chicago Smart City	Financial incentives and services (venture capital), operational services (permits, procurement), business incubation, knowledge and technology transfer, business showcasing and networking, labor force upskilling (technical skills, certification and advanced coursework, internships, mentorship), high-end infrastructure. Entrepreneurial activity dispersed through entire city.
New York Digital City	Financial incentives and services (real estate grants for technology companies), business showcasing and networking ("Made in N.Y." initiative), labor force upskilling (training in digital literacy and entrepreneurship), high-end infrastructure. Entrepreneurial activity dispersed through entire city.
Rio de Janeiro Smarter City Konza Technology City	Promotion of Entrepreneurship not a priority. Attraction of F.D.I. (Information Technology Outsourcing, Business Process Outsourcing, real estate and other urban services), financial incentives and services (tax breaks), business incubation, knowledge and technology transfer. Business-intensive physical areas of medium (neighborhood) size.

**Table 4.** Collected data for Characteristic 4: Global collaboration and networking (Author's elaboration).

Name of Venture	Characteristic 4: Global Collaboration and Networking (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Partnerships and networks have a prominent role in the smart city projects. The city is also part of international sustainability networks
Barcelona Smart City	"International promotion" and "international collaboration" are key axes of the strategy
Smart London Plan	Strategic collaboration for knowledge and innovation through the "Smart London Innovation Network," to establish collaboration channels with other smart cities and develop demonstrators
PlanIT Valley	No known initiatives
Stockholm Smart City	No known initiatives
Cyberjaya	No known initiatives
Singapore Intelligent Nation 2015	No known initiatives with the exception of IDA offering ICT masterplanning services to foreign governments
King Abdullah Economic City	No known initiatives
Masdar City	No known initiatives
Skolkovo	No known initiatives
Songdo International Business District	No known initiatives
Chicago Smart City	No known initiatives
New York Digital City	"Digital Cities Symposium," to connect, share, and learn from other innovative municipalities and government technologists from around the world
Rio de Janeiro Smarter City	No known initiatives
Konza Technology City	No known initiatives

Table 5. Collected data for Characteristic 5: Privacy and security (Author's elaboration).

Name of Venture	Characteristic 5: Privacy and Security (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Ambiguous/undefined
Barcelona Smart City	Ambiguous/undefined
Smart London Plan	General reference to privacy and security
PlanIT Valley	Host of safety and security solutions for emergency response. Ambiguous management of privacy.
Stockholm Smart City	Ambiguous/undefined
Cyberjaya	Explicit management of security issues. Concerns about the protection of privacy
Singapore Intelligent Nation 2015	ICT Security Masterplan developed in 2008
King Abdullah Economic City	Ambiguous/undefined. Concerns have been expressed
Masdar City	Ambiguous/undefined. Criticism: Students in Masdar live in uncomfortable social conditions and are forced to endure "malfunctioning infrastructures"
Skolkovo	General reference to security. Ambiguous management of privacy.
Songdo International Business District	Ambiguous/undefined
Chicago Smart City	Ambiguous/undefined
New York Digital City	Ambiguous/undefined
Rio de Janeiro Smarter City	Ambiguous/undefined
Konza Technology City	Ambiguous/undefined

Table 6. Collected data for Characteristic 6: Locally adapted strategies (Author's elaboration).

Name of Venture	Characteristic 6: Locally Adapted Strategies (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Strategy adapted to the city's environmental targets (reduction of 1990 carbon emissions by 40 percent by 2025), as well as its culture and policy history.
Barcelona Smart City	Serving local needs and the City's strategic priorities in an all-inclusive manner.
Smart London Plan	Accommodating local needs but with a "global" outlook
PlanIT Valley	Designed as an international city. Accommodating national priorities. No connection with surrounding area.

(Continued)

Table 6. Continued.

Name of Venture	Characteristic 6: Locally Adapted Strategies (sources mentioned in the main document, Research design section)
Stockholm Smart City	Strategy serving the city's long-term vision, environmental targets, culture
Cyberjaya	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
Singapore Intelligent Nation 2015	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
King Abdullah Economic City	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
Masdar City	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
Skolkovo	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
Songdo International Business District	Designed as an international city. Accommodating national priorities. No connection with surrounding area.
Chicago Smart City	Serving local needs and the city's strategic priorities in specific areas (government services, entrepreneurship, civic innovation, etc.)
New York Digital City	The strategy was formed after a 90-day research effort to assess the needs and requests of the city's citizens, entrepreneurs, and other constituents.
Rio de Janeiro Smarter City	The strategy addresses the city's major physical environment-related problems (floods and landslides, traffic congestion).
Konza Technology City	Designed as an international city. Accommodating national priorities. No connection with surrounding area.

Table 7. Collected data for Characteristic 7: Participatory approach (Author's elaboration).

Name of Venture	Characteristic 7: Participatory Approach (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Broad involvement of citizens and businesses in test-driving new technologies. Twenty percent of offered smart city services is participatory. Crowdsourcing.
Barcelona Smart City	Broad involvement of businesses, academia, and citizens in crowdsourcing and co-creating innovative products or services
Smart London Plan	Broad involvement of businesses and citizens in crowdsourcing innovative solutions to urban challenges.
PlanIT Valley	No known bottom-up initiatives. Citizens contribute their data to feed the smart city system, but their innovation capability or knowledge is irrelevant
Stockholm Smart City	Broad involvement of businesses, the public sector and citizens in crowdsourcing and co-creating innovative products or services
Cyberjaya	No known bottom-up initiatives
Singapore Intelligent Nation 2015	Participative processes were used for the development of the strategy but were discontinued throughout the implementation stage
King Abdullah Economic City	No known bottom-up initiatives
Masdar City	No known bottom-up initiatives. Citizens contribute their data to feed the smart city system, but their innovation capability or knowledge is irrelevant
Skolkovo	No known bottom-up initiatives
Songdo International Business District	No known bottom-up initiatives
Chicago Smart City	Broad involvement of citizens, businesses, and academia in crowdsourcing and co-creating innovative products or services
New York Digital City	Broad involvement of citizens, city employees, and entrepreneurs in developing and implementing the strategy, crowdsourcing
Rio de Janeiro Smarter City	No known bottom-up initiatives. Citizens contribute their data to feed the smart city system, but their innovation capability or knowledge is irrelevant
Konza Technology City	No known bottom-up initiatives

**Table 8.** Collected data for Characteristic 8: Top-down coordination (Author's elaboration).

Name of Venture	Characteristic 8: Top-Down Coordination
Amsterdam Smart City	Initiating and driving authority: local government /private sector (Amsterdam Smart City foundation). Leading figure: Chief Technology Officer (CTO). Socially determined (long-term outlook).
Barcelona Smart City	Initiating and driving authority: local government (Urban Habitat Department). Leading figure: mayor. Socially determined (long-term outlook).
Smart London Plan	Initiating and driving authority: local government (Greater London Authority). Leading figures: mayor, local government/academia/private sector (Smart London Board). Socially determined (long-term outlook).
PlanIT Valley	Initiating and driving authority: privately-owned company (Living PlanIT S.A.). Leading figure: Chief Executive Officer (CEO). Business oriented (long-term outlook).
Stockholm Smart City	Initiating and driving authority: local government (City of Stockholm). Leading figure: Chief Executive Officer (CEO). Socially determined (long-term outlook).
Cyberjaya	Initiating and driving authority: state-owned companies, local government, privately-owned companies. Socially and politically determined (long-term outlook).
Singapore Intelligent Nation 2015	Initiating and driving authority: national government (Infocomm Development Authority of Singapore-IDA). Leading figures: IDA's Senior Leadership Team. Socially determined (long-term outlook).
King Abdullah Economic City	Initiating and driving authority: national government. Leading body: Economic Cities Authority. Socially and politically determined (long-term outlook).
Masdar City	Initiating and driving authority: local government owned company (Abu Dhabi Future Energy Company). Leading figure: Chairman and Chief Executive officer (CEO). Socially and politically determined (long-term outlook).
Skolkovo	Initiating and driving authority: state-owned companies (Skolkovo Foundation and sister companies). Leading figure: President of Skolkovo Foundation. Socially and politically determined (long-term outlook).
Songdo International Business District	Initiating and driving authority: local government, national government. Leading figure: mayor. Socially and politically determined (long-term outlook).
Chicago Smart City	Initiating and driving authority: local government. Leading figures: mayor, Chief Technology Officer (CTO), Chief Data Officer (CDO). Socially determined (long-term outlook).
New York Digital City	Initiating and driving authority: local government (N.Y.C. Digital). Leading figure: Chief Digital Officer (CDO). Socially and politically determined (short-term outlook).
Rio de Janeiro Smarter City	Initiating and driving authority: local government. Leading figure: mayor. Socially and politically determined (long-term outlook).
Konza Technology City	Initiating and driving authority: national government (Konza Technopolis Development Authority). Socially and politically determined (long-term outlook).

Table 9. Collected data for Characteristic 9: Explicit and workable strategic framework.

Name of Venture	Characteristic 9: Explicit and Workable Strategic Framework (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Initiatives are assorted under development-related sectors (smart mobility, smart living, smart society, etc.). Some are first tested on pilot level. Initiatives have a definitive duration and are developed over four phases: Visioning, Roadmapping, Pilot Project (Business Case), Full scale roll out
Barcelona Smart City	Initiatives are assorted under development-related sectors (public and social services, environment, mobility, companies and business, research and innovation, etc.). Some are first tested through pilots and Living Labs. Initiatives are ongoing.
Smart London Plan	Initiatives are assorted under strategic priorities (e.g., increase accessibility, enhance network connectivity, leverage research/technology and creative talent). Some are first tested through pilots and demonstrations. Initiatives are ongoing.
PlanIT Valley	Initiatives assorted under technology areas (Urban operation system, Xtreme construction platform, sensor network technologies). The whole city is seen as city-scale test bed. Initiatives have a definitive duration and will be developed over 25 phases.
Stockholm Smart City	Initiatives assorted under strategic priorities (use green IT, provide efficient public services, become one of the world's most connected cities etc.). Initiatives are ongoing.

(Continued)

Table 9. Continued.

Name of Venture	Characteristic 9: Explicit and Workable Strategic Framework (sources mentioned in the main document, Research design section)
Cyberjaya	Ambiguous structure of smart city initiatives. Initiatives have a definitive duration and will be developed over three phases.
Singapore Intelligent Nation 2015	Initiatives assorted under strategic priorities (e.g., development of ICT infrastructure, development of ICT industry, workforce development) and development-related sectors (e.g., Digital Media, Education, Financial Services, Healthcare, Manufacturing and Logistics, Land & Transport, Tourism, Government, Society). Initiatives have a definitive duration and were developed over a 10-year period.
King Abdullah Economic City Masdar City	Ambiguous structure of smart city initiatives. Initiatives are ongoing. Initiatives assorted under technology areas (Smart Buildings/Smart Grid, Green Supply Chain, Clean Transportation, Geothermal Cooling etc.). Initiatives are ongoing and will be implemented in phases (unknown number).
Skolkovo	Ambiguous structure of smart city initiatives. Initiatives are ongoing and will be implemented in phases (unknown number).
Songdo International Business District Chicago Smart City	Ambiguous structure of smart city initiatives. Initiatives are ongoing and will be implemented in three phases. Initiatives assorted under strategic priorities (next-generation infrastructure, smart communities, open government, civic innovation, technology sector growth). Some are first tested through pilots. Initiatives are ongoing.
New York Digital City	Initiatives assorted under strategic priorities (Access, Education, Open Government, Engagement, and Industry). Some technology pilots were used. Initiatives have a definitive duration.
Rio de Janeiro Smarter City	Initiatives assorted under strategic priorities (traffic management, weather forecasting, urban safety/weather alerts). Initiatives are ongoing.
Konza Technology City	Ambiguous structure of smart city initiatives. Initiatives are prioritized and will be implemented in four phases.

Table 10. Collected data for Characteristic 10: Interdisciplinary planning (Author's elaboration).

Name of Venture	Characteristic 10: Interdisciplinary Planning (sources mentioned in the main document, Research design section)
Amsterdam Smart City	Amsterdam Innovation Motor (businesses, knowledge institutes, and government authorities) and Grid operator Liander
Barcelona Smart City	Little/no information
Smart London Plan	Smart London Board including academics, businesses, and entrepreneurs
PlanIT Valley	Engineers, town-planners, and computer scientists
Stockholm Smart City	Little / no information
Cyberjaya	Little / no information
Singapore Intelligent Nation 2015	Private and public sector, academia
King Abdullah Economic City	Little / no information
Masdar City	Little / no information
Skolkovo	Planners, engineers, transportation and utilities specialists, economists, and financiers
Songdo International Business District	Little / no information
Chicago Smart City	Little / no information
New York Digital City	Government & city employees from 52 agencies, residents, and technologists
Rio de Janeiro Smarter City	Government and Technology & Consulting company IBM
Konza Technology City	Architects, planners, engineers, strategy consults