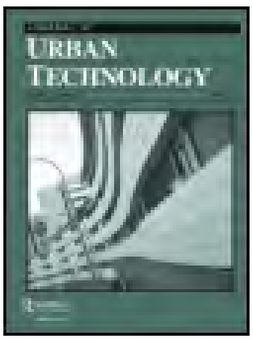

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ABSTRACT

In the theory of urban development, the evolutionary perspective is becoming dominant. Cities are understood as complex systems shaped by bottom-up processes with outcomes that are hard to foresee and plan for. This perspective is strengthened by the current turn towards smart cities and the intensive use of digital technologies to optimize urban ecosystems. This paper extends the evolutionary thinking and emerging dynamics of cities to smart city planning. It is based on recent efforts for a smart city strategy in Thessaloniki that enhances the economic, environmental, and social sustainability of the city. Taking advantage of opportunities offered by the IBM Smarter Cities Challenge, the Rockefeller 100 Resilient Cities, the World Bank, and the EU Horizon 2020 Program, Thessaloniki shaped a strategy for an inclusive economy, resilient infrastructure, participatory governance, and open data. This process, however, does not have the usual features of planning. It reveals the complex dimension of smart city planning as a synthesis of technologies, user engagement, and windows of opportunity, which are fuzzy at the start of the planning process. The evolutionary features of cities, which until now were ascribed to the working of markets, are now shaping the institutional aspects of planning for smart cities.

KEYWORDS

Smart cities; intelligent cities; smart city planning; evolutionary planning; participatory governance; open data; resilience

Smart Cities from an Evolutionary Perspective: Frame of Reference

Masdar City is a landmark in twenty-first-century urban development as it is the first zero carbon city, opening up an era of technology-led sustainability and green growth. But, is Masdar a city? According to *The Guardian* (Goldenberg, 2016) only 300 people so far live on the site and all are students at the Institute of Science and Technology. In fact, Masdar is actually a group of buildings, a large physical complex; more an engineering construct than a city. It will become a city in the future, when people and human activities, culture, institutions, and behaviors give purpose and use to infrastructures and buildings. Masdar will evolve into a city, as all cities do; they evolve and become cities rather than being constructed as cities from scratch. This idea of "cities becoming cities" rather than "cities planned as cities" is a core premise of evolutionary thinking about urban development. Cities are extremely complex and chaotic systems; many forces work simultaneously in their making and even small variations in the outcome interact and produce huge changes in results. Economic and political forces create numerous constraints on cities, yet there is room for genuine development that is not bound by deterministic conditions.

CONTACT N. Komninos komninos@urenio.org
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Evolutionary thinking holds a preeminent position in urban and regional development theory. Cities and regions offer resources that are actualized by selective mechanisms that drive change and growth. Lambooy (2002) argues that urban regions offer effective contexts for development through an evolutionary process where cognitive, innovative, and organizational competencies are influenced by a selection environment composed of institutions, markets, and spatial structure. This environment drives the choice between alternative planning ideas and designs for new investments in city services and infrastructures. Here there is an analogy to the way Nelson and Winter (1977) have described innovation as a purposive, but inherently stochastic activity, which is guided by an external selection environment that determines how different technologies are selected and change over time. The innovation selection environment is shaped by market and non-market forces, consumer preferences, investment, and imitation processes, as well as political and regulatory control over firms. Simmie and Martin (2010) widen this understanding of how innovation in cities is produced, connecting the development of cities and regions to four conceptual frameworks that offer an evolutionary account of resilience and adaptation: (1) generalized Darwinism which places emphasis on variety, novelty, and selection; (2) path dependence theory that underlines historical continuity "lock-in" and new path creation; (3) complexity theory with its emphasis on self-organization, bifurcations, and adaptive growth; and (4) panarchy that links resilience and "adaptive cycles." Boschma (2004) points out the uniqueness of urban and regional growth paths from an evolutionary perspective, since the competitiveness of a region depends on intangible, non-tradable assets resting on a knowledge base embedded in the region's specific institutional setting. Transferring growth models from one region to another is questionable as there is no "optimal" development model, and new successful trajectories and developmental paths emerge spontaneously and unexpectedly in space. Bettencourt et al. (2010) argue that agglomeration non-linearities connect most urban socioeconomic indicators with population size, making larger cities centers of innovation, wealth, and crime. They find that local urban dynamics display long-term memory, so cities under- or out-perform their size expectation and maintain such advantage for decades.

All the above statements are meaningful for smart city planning: a process that highlights the uniqueness of each city trajectory, is based on rapidly changing digital technologies, and is ready to value opportunities offered over time rather than copycat planning, locked-in optimal models and one-size-fits-all solutions. The case study we discuss in this paper presents a decision-making environment in a state of constant change, which is discontinuous and non-linear, but offers unexpected windows of opportunity; a complexity that has few commonalities with spatial planning as an ordered process that guides actions from an existing situation to an envisaged future (See also De Roo and Silva, 2016). The scientific ambition of the paper is to reveal the evolutionary dimension of smart city (or intelligent city)[1] planning, due to rapidly changing digital technologies and opportunities that in many cases do not exist at the start of the planning process, which justify the need to replace rigid and well-defined city plans with roadmaps that enable them to integrate evolving technologies and initiatives.

Thus, in this paper, we expand the evolutionary perspective of urban growth to smart city planning. We argue that due to the complexity of smart city development processes and the multi-disciplinary character of smart city technologies, smart city planning is shaped by evolutionary processes too. Evolutionary processes are characterized and

affected by essential diversifications in the capacity of societies to generate technical innovations that are suitable to their needs (Rosenberg, 1982). These differences also relate to higher complex systems of policy design that form pools of opportunities for funding and research. Cities and urban planning processes are affected by these dynamic environments, when trying to efficiently exploit existing opportunities for policy formation, in order to achieve a leading position within the global context, to attract more funds and inward investment. It is important to understand that urban and regional developmental evolutionary paths depend on the nature of selection environments, such as public funding, administrative rules, policy frameworks, and others. In this case, the selection process is shaped by political, economic, and cultural factors and the competencies of carrying actors and institutions (Lambooy, 2002). Urban contexts influence the ways in which local governments can create and shape opportunities for innovation.

Planning for smart cities—or the use of digital technology to innovate and improve urban ecosystems—has become a major strand of contemporary urban planning literature. Since the beginning of 2017, publications on smart cities have accounted for close to 50 percent of all publications related to urban planning (Google Scholar data). Yet, major aspects of this new planning model are not well understood, especially the interaction between and integration of long-term, top-down plans and short-term, bottom-up initiatives.

The planning objectives and the type of smart city projects that cities implement are also highly diverse (Yigitcanlar, 2016). Take for instance, three well-known cases of smart city strategy: Singapore Intelligent Nation, Amsterdam Smart City, and Smart Santander. A sector-focused approach in Singapore is implemented using web-based platforms in the domains of digital media, financial services, manufacturing, logistics, and others, compared to projects focusing on sustainability, energy savings, CO_2 reduction, and user participation in Amsterdam, and the deployment of numerous sensors and Internet of Things infrastructure in Santander over which technology providers are asked to develop applications and e-services. These cases illustrate very diverging approaches both in terms of planning priorities and the understanding of how smart cities work.

To our mind, smart city planning defines a distinct phase in the evolution of urban planning, a new planning paradigm that differs substantially from the Twentieth Century and mainly the post-WWII schools of planning (Hall, 1988). This perspective nurtured the discussion about a new science of cities (Batty, 2013; Bettencourt and West, 2010) with cities seen as entities that enable communication and networking, and therefore producing externalities for wealth and the saving of infrastructure, regardless of the economic and geographical context. However, the critical factors that clearly differentiate smart city planning from previous planning perspectives are the knowledge base and the mode of operation. The City Beautiful movement and the plans of Haussmann in Paris, Burnham in Chicago, Lutyens and Baker in New Delhi, Griffin in Canberra, and Hébrard in Thessaloniki were based on knowledge supplied by engineering sciences, architecture, and landscape design. Later, throughout most of the Twentieth Century, the modernist movement for the rebuilding of urban centers and/or suburban sprawl was based on understanding the role of the state in urbanization, regulations and policy incentives for urban development and building, control of land uses, creation of large-scale infrastructure for mobility, social housing, and welfare economics; in sum, a knowledge base provided by social sciences, theories of location, land and traffic management, and strategic planning. Currently, the making of digital, smart, and intelligent cities, uses

different materials, such as broadband communication networks, sensors, big datasets, software applications, and e-services. Their knowledge base is offered by programming languages, algorithms, mining large datasets, analytics, software design and development, and user engagement and co-design. This historical expansion of city planning's knowledge base has been cumulative and interdisciplinary with each subsequent field of knowledge adding new elements to the previous one, but also retaining most of the previous theoretical construction.

Planning for smart cities starts with the creation of the urban digital space, an agglomeration of digital hardware and software, datasets from the public administration, sensors and smart meters, social media, and new e-services in every domain of the city. This new layer of digital space and technologies has the capacity to change and optimize all aspects of cities: the economy, life, utilities, and governance. We have called this process "innovation circuit 1" (IC1) which creates the digital space of cities. The overall smart urban system is made of heterogeneous and uncoordinated initiatives by the public administration, global social media companies, national telecom companies, IT developers, e-service providers, and users; each actor adding some digital component to a common pool of resources, and each one offering new modes of user engagement, participation, and empowerment. In parallel to the formation of the urban digital space, two other processes of innovation emerge: more informed decision-making and governance of public and private investments that drive the change of cities ("innovation circuit 2" [IC2]); and more efficient citizen behavior based on urban awareness that guides the use of urban space and infrastructure through intelligent systems, GPS, and sensor-based solutions ("innovation circuit 3" [IC3]) (Komninos, 2014, 2016b). These three circuits, taken together, define smart city planning and describe the operation of smart or intelligent cities as complex cyber-physical systems of innovation. Innovation circuits 2 and 3 are based on and become possible thanks to the digital space of cities. Innovation circuits IC1, IC2, and IC3 work in tandem; there is no evolution among them. They occur simultaneously; the moment IC1 is introduced, depending on its functionality, it enables better decision-making and / or optimized user behavior. When IC1 relies on web 2.0 technologies, collaboration platforms or crowdsourcing solutions, decision-making becomes participatory with the engagement of users. They constitute forms of citizen empowerment and data awareness, either by the city producers or the city users.

Understanding the planning and making of smart cities through the juxtaposition of digital elements, which are heterogeneous, uncoordinated and usually not integrated, and through novel producer and user behavior, which is also fragmented and diverse, is far from the usual concept of urban planning we have been used to. Thus, smart city planning, as control and guidance of the entire interaction between innovation circuits 1, 2, and 3, is "planning without a plan," and the making of cities through evolution rather than through detailed design and rigid plans. It is planning under uncertainty, chaotic interaction of concurrent actions by many organizations, each one having its own rationality and plan. Or, planning by the same organization guided and shaped by opportunities that appear over time, with the overall outcome being unpredictable and uncontrolled at the beginning. Smart city technologies and their impact on innovation systems are the main causes for this trajectory.

The ambition of the present paper is to bring up and reveal the uncertain aspect of smart city planning, as an agglomeration of initiatives and actions, and windows of

opportunity, which are uncoordinated and unpredictable. To our mind, this feature is not a side effect of some ill-designed planning process, but a structural result of the core drivers of smart cities, namely, the modalities of digital/smart space, the availability of large datasets, extended citizen empowerment in city decision-making and design, and the creation of cyber-physical systems of innovation (Komninos, 2016a).

Following this introduction on the topic and frame of reference, the rest of the paper consists of four sections. The next section refers to the evolution of smart city technologies, outlining the main stages and milestones. Technologies from broadband to sensors, datasets and applications, and their interdependencies constitute a critical dimension of smart city complexity. Then, we focus on a case study: smart city planning in the city of Thessaloniki over the last five years, guided by local and global initiatives, such as the Rockefeller 100 Resilient Cities, the IBM Smart Cities Challenge, Horizon 2020 research, and others, which illustrate the evolutionary character of smart city-making. The last two sections discuss findings from the technology landscape and the case study as instances of an evolutionary model for smart city planning, its core features, and their implications for the future of cities.

Evolution of Digital Technologies: The Foundation of Smart City Complexity

Understanding the operation of intelligent cities *through* the three innovation circuits (IC1, IC2, and IC3) mentioned above, places the origin of smart cities in the digital space that sustains citizen innovative behavior, and more informed investment and governance practices. The digital space of cities is created by a large variety of elements, such as broadband networks, sensor networks, urban operating systems, web spaces, datasets, and urban informatics. It can be described by a series of layers or rings, each one having specific characteristics and functionality: (a) broadband networks, wired and wireless infrastructure, and communication protocols enabling communication and the connectivity of various devices embedded into the urban space; (b) data creation and collection technologies, such as sensors, smartphones, actuators, (c) databases, algorithms, and programming languages, which allow for dataset creation and processing, data visualization, and analytics; (d) web and smartphone technologies enabling the creation of applications with functionality targeted to different domains of the city; at least 20 different domains of cities can be identified as potential fields of applications related to the economy, city infrastructure and utilities, quality of citizen life, and city governance (see the ICOS software repository at icos.urenio.org); and (e) e-services addressed to citizens and organizations, based on applications adopted by the market and offered on a regular basis as a service via viable business models. In a condensed and articulated form, all these elements can be found in the so-called "urban operating systems" which integrate network infrastructure, sensors, devices, software applications, and people across different domains and urban systems (Marvin and Luque-Ayala, 2017; Living Plant, 2016).

This complex digital edifice of cities has been created gradually *through* the accumulation of technologies, smart systems and solutions, and to a large degree it follows and depends on the progress of the Internet and the world-wide-web. We can identify three

successive phases or waves of development, each one linked to specific technologies and features of the corresponding digital space.

The first wave of smart city solutions concerned the representation of the city, in early forms via portal-type webpages, panoramic and 3D representations of cities, and later via augmented reality technologies, and urban tagging. Digital cities are connected communities that combine "broadband communications infrastructure; a flexible, service-oriented computing infrastructure based on open industry standards; and, innovative services to meet the needs of governments and their employees, citizens and businesses" (Yovanof and Hazapis 2009: 446). Digital cities tried to link the physical and digital space by offering a metaphor of the city; an understanding of the city through its virtual representation. Such digital cities were described as "mirror-city metaphors" or "virtual cities," as their logic was to offer "a comprehensive, web-based representation, or reproduction, of several aspects or functions of a specific real city, open to non-experts" (Couclelis, 2004: 5). Differences in representation models resulted in differences in functionalities, which ranged from simple, informative webpages, to communication spaces with forums and chatrooms, and finally to interactive spaces with virtual agents. The spatial intelligence of cities related to digital solutions of this type was based on the advantages of representation and visualization. The expression "one picture is worth a thousand words" reflects this idea that complex environments can be described and understood better by a virtual representation or metaphor. In the field of theory, the digital city literature benefited from the work of Ishida and Isbister (2000), Hiramatsu and Ishida (2001), and Van den Besselaar and Koizumi (2005). The solutions mentioned above were content-intensive and required fast Internet connections; thereby they encouraged the adaptation of broadband access by the city's population. Telecommunication companies started creating new backbone networks for data exchange using fiber optics and xDSL technologies, while the city authorities began to build local wireless networks.

Advances in broadband connectivity (wired and wireless) combined with the arrival of the Web 2.0 concept (O'Reilly, 2007) catalyzed the evolution of smart city solutions. In the second wave of smart city solutions, the focus shifted from the representation of the city to solutions that enabled citizen participation and engagement in smart city creation. The rise of the social web led to the creation of digital spaces that harnessed citizens' collective intelligence to organize the development of technologies, skills, and learning, and to engage citizens to become involved in creative community participation (Deakin and Allwinkle 2007). Co-creation and crowdsourcing were the most common forms of collaboration in the second wave of smart city solutions. City intelligence came onto the scene with the understanding that digital spaces improve urban ecosystems by processing information, sustaining learning, and innovation produced by user engagement and networks of collaboration. It emerges from a combination of the creative capabilities of the population, knowledge-sharing institutions, and digital applications organizing collective intelligence. Within cyber-physical urban agglomerations, forms of distributed intelligence connect (a) the inventiveness, creativity, and human intelligence of the city's population, (b) the collective intelligence of the city's institutions and social capital for innovation, and (c) the artificial intelligence of public and city-wide smart infrastructure, virtual environments, and intelligent agents (Komninos, 2008). From this perspective, in the second wave of smart city solutions, the spatial intelligence of cities was built on collective intelligence and social capital for collaboration, combined with a people-driven innovation

introducing principles of openness, realism, and empowerment of users in the development of new solutions (Bergvall-Kåreborn and Ståhlbröst 2009). The ever-increasing participation of citizens in smart city solutions has been facilitated by the adoption of cloud computing, which disengages city authorities from resource constraints, whether they are technical, managerial, or financial. Cloud computing has a higher impact and greater effect at the city level, as it enables city authorities to create a highly efficient, scalable, and elastic computing environment for smart city service provisioning (Kakderi et al. 2016).

In a third and more recent turn, the interest in smart cities is sustained by two new concerns: on one hand there is the rise of new Internet technologies promoting real-world user interfaces via mobile phones, smart devices, sensors, RFIDs, the semantic web and the Internet of Things, and on the other there is the concern for sustainability and how smart cities can support a more inclusive, diverse, and sustainable urban environment, green cities with less energy consumption and lower CO_2 emissions (Caragliu et al., 2011). Currently, the smart city literature focuses on the latest advancements in mobile and pervasive computing, wireless networks, middleware, and agent technologies as they become embedded into the physical spaces of cities and are fed with data round the clock. Smart city applications—with the help of instrumentation and interconnection of mobile devices and sensors that collect and analyze real-world data—improve the ability to forecast and manage urban flows and push city intelligence forward (Chen-Ritzo et al., 2009). Within this technology stack, spatial intelligence moves out of applications and enters into the domain of data: the meaning of data becomes part of data, data are provided just-in-time, and real-time data enable real-time response. Artificial Intelligence (AI) is a perfect fit for this new situation of smart city systems. As smart cities gather a significant amount of data, AI can provide tools and techniques to analyze them and get insights hidden into data. It can detect emergent patterns. It enables multiple systems to be optimized together, and provides entirely new capabilities that traditional analytics tools cannot. Moreover, through deep learning and natural language processing techniques, it enables new modes of human–machine interactions, making access to smart city solutions easier and in real time.

These changes were extremely rapid and the outcomes take us closer to Ambient Intelligence Environments. From a technology perspective, Ambient Intelligence combines broadband and sensor networks, processing power, reasoning mechanisms, applications and e-services embedded into the surrounding environment. It represents a vision for the future where intelligent or smart systems interact with citizens in an adaptive way that sustain humans living and working within urban environments (Streitz, 2017).

Smart City Planning in Thessaloniki: Taking Advantage of Windows of Opportunity

But technology is not sufficient on its own to explain the evolutionary making of smart cities, which is also guided by user engagement, flexible governance, business models, investment opportunities, and other initiatives for city improvement. The case study on the city of Thessaloniki that we discuss in this section shows how technologies and planning complement each other in valorizing opportunities for smart city development, which appeared gradually, without coordination, both locally and globally.

Thessaloniki is the second largest city in Greece with a population of over 1,100,000 (in the metropolitan area). The city has made significant efforts to implement a number of activities that contribute to its journey towards becoming a smart city. In terms of strategic design, the first comprehensive plan for creating a smart city in Thessaloniki was prepared by URENIO Research, a lab of the Aristotle University, in cooperation with the Regional Government of Central Macedonia in 2009. "Intelligent Thessaloniki" was a strategy to strengthen the city's innovation ecosystems through the deployment of open public broadband networks and the development of web applications and smart environments. The strategy focused on selected city districts and production ecosystems (CBD, port area, university campus, innovation zone) in which broadband networks and a wide range of digital applications and e-services, tailored to each district's characteristics, were proposed to improve innovation capabilities and entrepreneurship (Komninos and Tsarchopoulos, 2013).

In the years that followed, the Intelligent Thessaloniki strategy was not implemented. A change of government and an overwhelming financial crisis were the main reasons for this project being abandoned. But, digital Thessaloniki continued to emerge bottom-up as an agglomeration of commercial and community broadband networks and web-based services for government, education, business, mobility, quality of life and other activities of the city. These were fragmented and independent efforts made not only by large telecommunication companies, Internet service providers, and ICT companies, but by civic communities, small IT companies, and individual developers.

Since 2013, the Municipality of Thessaloniki has taken the lead as the implementing agency for efforts to create a smart and resilient city. The Municipality agreed to become an active partner of Aristotle University of Thessaloniki and managed to garner strong support from all stakeholders in the city. The first outcome of that collaboration was the STORM CLOUDS project (Surfing Towards the Opportunity of Real Migration to cloud-based public services); a research project that was partly funded by the European Commission in the context of the Competitiveness and Innovation Framework program (CIP PSP).[2] The project, which started in February 2014 and ended in March 2017, aimed to accelerate the pace at which public authorities move to cloud computing. Thessaloniki was among the four pilot cities, with an emphasis on the smart economy. The project introduced the concepts of smart cities and cloud computing as a disruptive model for the uptake of smart city services to the Municipality's administration and personnel. Subsequently, the Municipality began to take similar initiatives, with the most noteworthy being participation in the European Commission's "Innovation Partnership on Smart Cities and Communities"[3] and the Smart Cities MoU with the largest Greek cities (Athens and Heraklion).

The collaboration between the Municipality and Aristotle University had already begun earlier with the organization of the first smart cities app contest in Greece, named "Apps for Thessaloniki,"[4] jointly with the Greek Chapter of the Open Knowledge Foundation (OKF Greece). The competition ran for five months (November 2013–March 2014) and aimed to stimulate the local ICT ecosystem to create new smart city solutions. Thirteen applications were developed, covering a wide range of city domains and activities. The following year (November 29–30, 2014) another smart city contest took the form of a "hackathon" in which 10 teams of developers participated.[5] The concept has evolved into a thematic competition targeting specific city domains (i.e., tourism, energy,

environment, etc.). The Apps for Thessaloniki––Tourism edition (November 2015–January 2016) produced 12 web and mobile applications.

Open Data

The involvement of the Municipality of Thessaloniki in apps contests and hackathons, as well as the collaboration with OKF, resulted in the creation of a movement for open data and open government within the Municipality. The newly established Department for e-Government released the first open datasets in November 2013. Over the years that followed, the open data movement has strengthened. Regarding open government, a dedicated portal was released in 2015, which allows citizens and businesses to access most of the Municipality's services through web or mobile applications.[6] "Improve my City" (Tsampoulatidis et al., 2013), the portal's flagship application that allows citizens to submit and comment on non-emergency problems related to the urban environment is used by thousands of people, who in this way contribute to improving the city while also engaging with the Municipality. In May 2017, this application received an Award from the Council of Europe at the "European Label of Governance Excellence" opening event for digital services provided by the Municipality of Thessaloniki.

The commitment to open data has paid off as the City of Thessaloniki was selected through a competitive process as one of 16 cities to be awarded a Smarter Cities Challenge grant in 2015 to 2016 by IBM.[7] With IBM's support, the city seeks to integrate diverse open data sources across the fields of governance, mobility, education, environment, and economy. In February 2017, the IBM Smarter Cities Challenge team published a report containing recommendations and a roadmap that will help the city to achieve this goal.

Establishing Thessaloniki as a leader in open data is a priority for the City's Mayor Yiannis Boutaris. To that end, the Municipality entered into a strategic partnership with OKF. Initially, the Municipality released a few datasets containing spatial data to support the smart city app contests and hackathons. Currently, the portal contains 74 datasets in eight categories: Urban Planning (36), Public Administration (13), Environment (13), Tourism (6), Education (5), Culture (4), Public Security (1) and Economy (1).[8] Moreover, the city publishes open data regarding budget spending. Citizens can monitor implementation of the city's budget in real time and use visualization tools to have a better understanding of the budget data.

Thessaloniki participated in the IBM Smarter Cities Challenge with a proposal in this field. The challenge for the city was to "develop a strategy and tactics that will help the City utilize open data to encourage further transparency, benchmarking, key performance indicators (KPIs) and data-sharing between public departments, businesses, universities, non-governmental organizations (NGOs) and citizens" (IBM, 2017). Following the award of the grant, during a three-week period in November 2016, a team of six IBM experts worked in Thessaloniki to deliver recommendations on open data infrastructure and organization. The team conducted more than 40 interviews with various stakeholders (public office holders, City employees, university faculty members, local entrepreneurs, and leaders of NGOs) across the City's ecosystem. In February 2017 IBM's team presented strategic recommendations to advance open data adoption under the following five themes:

(1) Reorganize IT-related departments to enable open data policies and practices.
(2) Establish an open data strategy and consistent understanding across City departments and stakeholders.
(3) Foster an environment that supports collaboration.
(4) Establish a publishing process and maturity model that put open data into practice.
(5) Address resource constraints through investments, strategic partnerships, and change management.

Moreover, IBM proposed the development of an open data dashboard combining data from different stakeholders and providing citizens, public sector employees, and companies with real-time information, time-series data, and interactive maps about all aspects of city life. The city dashboard will enable users to gain detailed, up-to-date intelligence about the city for daily decision-making and evidence-informed analysis.

Currently the City of Thessaloniki is the leader among Greek cities regarding open data and administration transparency. It ranks in first place in the Greek Cities Open Data Census run by the Open Knowledge Foundation.[9] With the creation of the city data dashboard, the city will put open data to work for its residents.

Collaborative Economy

Over the last decade Thessaloniki has been hit by the economic crisis while its image has been affected significantly by attempts at corruption in various departments of the Municipality. A change in local government was accompanied by efforts to rebuild trust but also to improve the economic environment for business and investments in the city. The municipality participated in various projects funded by the Horizon 2020 Program for the development of digital services related to entrepreneurship and the promotion of tourism.

By adopting a user-driven methodology through meetings and workshops with stakeholders and municipal services, the city launched two popular applications: the "Virtual City Market" and the "City Branding." The Virtual City Market is an application that, on the one hand, enables every commercial enterprise located in the city to create its own virtual shop and, on the other, enables customers to access a variety of retailers using a shared site. In its simplest form, the service provides a list of existing shops located in the city (and their location on a map) as well as what they offer. The Virtual City Market enhances collaboration schemes between retailers, offering the opportunity to create open malls and organize the shops per street or district.

City branding is an application that promotes the identity of a city to different target groups using virtual tours and presentation of points of interest, while being connected to the local economy and entrepreneurship. The application allows a city to focus on different target groups that are associated with various aspects of the city's identity (history, culture, economic environment, etc.) by supporting the differentiation of commons according to target groups of visitors. Both the above applications have been funded by the STORM CLOUDS project.[10]

Moreover, in collaboration with the city's universities and business associations, in 2016 the Municipality launched the "OK!Thess" initiative. OK!Thess is an innovation ecosystem for startups that offers a temporary working space to newly established enterprises

together with activities such as training, consultation, organization of networking activities, the search for funding, and the promotion of product and services.

Sustainable and Resilient Infrastructure

Another major international distinction for the city was its participation in the Rockefeller Foundation 100 Resilient Cities initiative (100RC)[11] dedicated to helping cities around the world become more resilient in the face of physical, social, and economic challenges. Thessaloniki was selected in 2014 as part of the second cohort of cities to join the 100RC network.

Over a period of two years, more than 2,000 people and 40 organizations from across the city were engaged in the design of the strategy, participating in workshops and filling in questionnaires expressing their views on Thessaloniki's resilience. In addition, to maximize its added value, there was research on more than 1,000 actions undertaken by the Municipality and a comparative study of more than 700 completed or institutionalized plans in the Municipalities that comprise the Thessaloniki Metropolitan area. In line with the main problems faced by the city, the focus was on issues related to the local economy and mobility.

In 2016 a Deputy Mayor of Urban Resilience and Development Planning and Chief Resilience Officer was appointed. The Resilience Strategy for Thessaloniki, published in March 2017, is the first city-wide collaborative strategy and at the same time is a roadmap in the city's effort to guarantee the well-being of its citizens, to nurture its human talent, and to strengthen the urban economy while respecting its natural resources. The strategy is built on four main goals, 30 objectives, and more than 100 actions (Thessaloniki, 2017). The goals of the strategy are: (a) shaping a thriving and sustainable city with mobility and city systems that serve its people; (b) co-creating an inclusive city that invests in its human talent; (c) building a dynamic urban economy and responsive city through effective and networked governance; and (d) re-discovering the city's relationship with the sea—integration with Thermaikos Bay.

At present, the Municipality is in the process of implementing the strategy leading a new round of consultation with the city's stakeholders to get support and encourage engagement in different aspects of the implementation process (leverage funding, selection of KPIs, collection of open data, etc.). As Thessaloniki has a huge reserve of youth (with more than 100,000 students in the three higher education institutions located in the metropolitan area), a dialogue has also opened with young people living in the city[12] and with the academic community through various initiatives, workshops, and events.

In pursuit of this goal, the Municipality signed a memorandum of understanding (MoU) with the World Bank in May 2017. The MoU describes the offer of technical assistance by the World Bank in the strategic design and development of policies and programs related to issues of mobility and transport, resilience and crisis management, economic and urban development, and investments attraction, etc.

Participatory Governance

Participatory governance is also a core concern of the current administration, fostering the efforts for sustainability and a place-based governance model. Given the efforts that have

been made towards a resilient Thessaloniki, the development of a participatory governance infrastructure emerged as a natural outcome. In this context, the *ImproveMyCity* and *CloudFunding* applications were developed to strengthen the effectiveness of the local governance framework, resulting in *more informed decision-making processes* (in innovation circuit 2), aiming to drive changes within cities towards a sustainable urban space and towards local social inclusion.

ImproveMyCity is an application driven by the intriguing concept that every citizen can act as a living sensor in the city. The participatory governance concept is the cornerstone of this application; a concept which has been developed under the CIP project PEOPLE.[13] Overall, the platform provides a user-friendly interface where citizens can directly report non-emergency issues about their city, indicating the exact location on the map, as well as the nature of the problem. Users can add photos and comments. In this way, citizens can become local actors themselves, suggesting solutions about how to improve the environment of their neighborhood (Tsampoulatidis et al., 2013).

In terms of administration, this application helps local authorities organize the reported cases for further action and resolution. There is live information regarding the time frame for resolving the reported issue, while the person who originally submitted the request is directly informed about the outcome. Another additional feature of the application offers the administrator the opportunity to visualize data and identify specific areas with a high share of dissatisfied citizens or under-performing administrative departments. Overall, the *ImproveMyCity* application works as a means for strengthening governance procedures via citizen participation and thus, urban sustainability, through the improvement of public space. Citizens are an active part of this process, defining the main issues that need to be solved at a local level, thereby reinforcing the participatory governance of the city.

CloudFunding is different. It is a platform that supports civic crowdfunding and has been developed under the STORM CLOUDS project. Through this application, local authorities can support communities in collecting money for social and charitable purposes. Supported projects refer to urban sustainability and three types of initiatives related to: (a) improvement of the city's physical environment (i.e., the creation of parks and playgrounds, restoration of monuments, expansion of cycle lanes, etc.), by combining private and public funding; (b) social entrepreneurship (i.e., creation of non-profit enterprises to promote objectives that improve urban life or strengthen the city's social capital), in which case local authorities will act as a mediator of the initial effort; and (c) knowledge-intensive and technology-based youth entrepreneurship. In all cases, the user has to define a minimum and an optimum target for the desired co-financing, as well as the period over which this project will run. Each project has to make clear what the benefits to the local community will be, and this must be clearly shown on the platform.

In both these cases, participatory governance is expressed through the ability of citizens to engage and provide information about specific issues related to their local communities. Citizens define and become aware of local actions, a fact that enables them to significantly contribute to the overall sustainability of the city. Projects and local issues are classified based on public opinion, and thus, their implementation is driven by the overall social benefit for the local community.

Discussion: Smart City Planning without a Plan

The case study of Thessaloniki indicates the multidimensional character of actions that are deployed to transform a city into a smart and sustainable place. Smart city sustainability refers to a set of dimensions, including socioeconomic, environmental, and governmental dimensions, which can be enhanced through the use of smart city applications, networks, and integration of digital, social, and institutional elements. Given the fact that the Municipality of Thessaloniki has taken the lead as the main agent for promoting and implementing efforts to create a smart and resilient city, its active collaboration with Aristotle University of Thessaloniki has established an effective channel to accumulate support from a large number of stakeholders in the city.

There have been many parallel efforts and initiatives to promote this vision, including ICT solutions fostered by civic communities and individual developers. Starting from EU co-funded projects, such as the PEOPLE and STORM CLOUDS projects, and moving on to the organization of hackathons and OK!Thess, and collaboration with organizations such as IBM and the Rockefeller Foundation, all attempts have tried to stimulate the local ICT ecosystem in order to create a new set of smart city services and synergies. These work as accumulative forces towards a collaborative resilience-building process, thereby fostering urban sustainability.

At the same time, openness and inclusion have been strengthened through the development of applications related to local economic activities. City Branding and Virtual City Market are both perceived as ways to enhance the links between citizens and local opportunities, in terms of activities and of market infrastructure. This leads to the development of a sustainable urban economic environment, where people are well informed about existing opportunities.

ImproveMyCity and *CloudFunding* are two cases highlighting the efforts of the Municipality of Thessaloniki to promote and encompass participatory governance throughout the decision-making processes. Citizen participation in defining requests and priorities, as well as assessing possible benefits from funding place-based projects, provides a valuable source of information. This enriches urban sustainability, as it offers local authorities the opportunity to strengthen their effectiveness, by incorporating public opinion in their planning processes.

Open data initiatives are also at the core of the city's strategic efforts, making it the leader among Greek cities in this regard. The open data portal of the Municipality of Thessaloniki is considered to have been a focal point throughout this overall transformative process, reinforcing data openness and transparency in a wide set of categories. The IBM Smarter Cities Challenge has also been a milestone for Thessaloniki during this process, leading to an open data city dashboard, combining input data from different stakeholders.

The case study on Thessaloniki presented here clearly shows that the strategy and actions guided by the vision for an open, global, smart, and resilient city, have been largely shaped by a series of opportunities that appeared gradually over the last few years, both at global and local levels: the Rockefeller Initiative for 100 Resilient Cities, the IBM Smarter Cities Challenge, the collaboration with the World Bank, the collaboration with Aristotle University in Horizon 2020 projects, the need for digital strategies for getting access to European Structural and Investment Funds (ESIF) funding, as well

as collaboration with the OKF in hackathons and software competitions. These initiatives have defined the framework for guidance, know-how, funding and citizen engagement, and have shaped a smart city planning approach which was neither top-down nor defined in advance. Actually, there is a strategy and an action plan for a smart city (Thessaloniki, 2017; IBM, 2017; Municipality of Thessaloniki, 2017), but they were formed gradually, in an evolutionary way, through the convergence of independent initiatives and the specific frameworks and goals of those initiatives.

Conclusions: Towards an Evolutionary Perspective of Smart City Planning

This smart city strategy and action plan formation process challenges not only the concept of top-down planning, but also the capacity for smart city plans being formulated exclusively by state authorities. Smart city planning as a complex process was discussed by Leydesdorff and Deakin (2011) and Deakin (2015). The authors link smart city planning to the rise of triple helix governance and attribute its neo-evolutionary character to three functions that shape the selection environments of the smart city knowledge economy: organized knowledge production, economics of wealth creation, and reflexive control. Reflexivity is not a given, but socially constructed by evolving communication systems and cultural settings.

No doubt, the triple helix is a driver of complexity. All the more so is quadruple helix governance with the wide participation of users and multi-actor decision-making. The evolution of technologies and the case study discussed earlier reveal that strong drivers of complexity are also the innovation push created by initiatives launched by global organizations, bottom-up innovation introducing applications and e-services, and the changing urban behavior of users due to real-time information and participation through social media. Cities take advantage of initiatives, partnerships, and policy frameworks at regional and national levels also, which evolve over time, appear as windows of opportunity, and disappear after a while to give way to other opportunities. At a regional level, for instance, the search for investment opportunities is expressed by the concept of "entrepreneurial discovery" in the context of smart specialization strategies, which is to define a policy mix and actions through a process of discovery and innovation driven by the engagement of companies, closer to "choosing races and placing bets" rather than "picking the winners" (Landabaso, 2014; McCann, 2015).

Most important is a change in the understanding of cities as the outcome of chaotic market transactions and coordinated, well-planned state interventions. This concept, which was a landmark of city planning throughout the Twentieth Century, is changing towards an understanding in which complex and chaotic forces operate on both the market and on the policy sides. The making of city plans comes closer to the concept of a laboratory of ideas and a roadmap of open innovation and entrepreneurship (Cohen et al., 2016) than meticulous elaboration and implementation of plans by central and local authorities. The notion of "planning without a plan" is about a smart city plan that is formed gradually, taking advantage of evolving technologies and opportunities for action. Both master plans and action plans of strategic planning are forms of top-down planning with well-defined plans and actions, in contrast to smart city planning which is shaped bottom-up, gradually, by user engagement and the capabilities offered by volatile technologies.

To better illustrate this understanding of city planning as an evolutionary process composed of urban laboratories and taking advantage of global and local opportunities, we consider it necessary to revise the roadmap of smart city planning that we presented in a previous publication (Komninos, Tsarchopoulos, and Kakderi, 2014). The ideas of "governance and feedback loops" between implementation, the focus on ecosystems, the selection of which challenges to address, and strategy development, which are added in Figure 1, express an open-minded management approach, which is non-linear, enabling cities to seize opportunities continuously and set up large-scale participation of citizens and organizations in city labs operating in various domains of the urban system.

The event horizon of this evolutionary smart city planning goes far beyond the physical space of cities, addressing all the grand challenges of twenty-first-century life in cities: the growth, employment, and poverty nexus; sustainability and its aspects, ranging from the use of land and nature-based solutions, to management of ecosystems, air quality, CO_2 emissions, climate adaptation, energy savings and the transition to renewable energy, water, waste recycling of materials, and the circular economy; and the urban safety nexus with man-made or natural threats, such as crime, terrorism, attacks on infrastructure, vandalism, natural catastrophes, urban accidents, and other types of emergencies. In sum, it addresses all aspects of cities, not just the physical space, land uses, and infrastructures addressed in nineteenth- and twentieth-century city planning.

Empowerment is the main pillar of strategy development, enabling intense information flows and knowledge sharing among users; easiness of collaboration; large-scale citizen engagement over crowdsourcing platforms; data creation, big datasets, and analytics; the rise of a sharing economy; few forms of production, such as demand-driven production, distributed collaborative production, customer co-production, and various other forms of network-based work and exchange.

Then, on the implementation and technology side, very competitive business models are based on open-source technologies, provided that they are carefully selected and supported by large and active communities of developers; cloud computing platforms, also developed with open source software, which disengage city authorities from technical and internal resource constraints; and open data initiatives offered via hackathons and competitions for the development of software and smart city solutions.

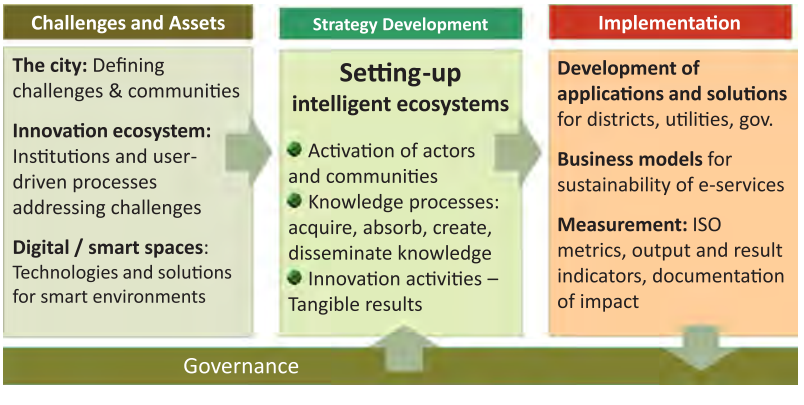

Figure 1. A roadmap for smart city planning. Source: Adapted from Komninos, Tsarchopoulos, and Kakderi, 2014.

Notes

1. The terms "smart city" and "intelligent city" are used interchangeably to mean the deployment of digital technologies, smart environments, and user engagement to optimize urban systems, and the economic and social life of cities. Some differences between these terms may be found in the way optimization takes place, as a direct outcome of technology or as an outcome of better decision-making. Thus, in our view, smart cities are related to solutions that optimize urban systems and user behavior through smart devices, ICT-based automation, sensors and instrumentation; while intelligent cities are related to solutions that enable people-driven innovation, improve decision-making through wider user engagement and datasets, advancing human intelligence and problem-solving capabilities (Komninos, 2014: 20–21).
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10. "STORM CLOUDS: Surfing Towards the Opportunity of Real Migration to cloud-based public services" is a project co-funded by the CIP-ICT-PSP program of the European Commission.
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12. Thessaloniki Youth Resilience Challenge.
13. Project "PEOPLE: Pilot smart urban Ecosystems leveraging Open innovation for Promoting and enabLing future E- services" partly funded by the European Commission under contract No. 271027.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Notes on Contributors

Nicos Komninos is a professor at the Faculty of Engineering, Aristotle University of Thessaloniki, and director of URENIO Research. He has coordinated numerous projects under EU research programs and published extensively on innovation systems and strategies, urban planning, smart and intelligent cities, including the trilogy *The Age of Intelligent Cities* (Routledge 2002; 2008; 2014).

Christina Kakderi is a regional economist and a researcher focusing on systems of innovation and smart innovation environments (national and regional innovation systems, technology policy, social networks, intelligent cities/districts). Working as a researcher since 2005, she has been involved in many EU- and national-funded projects related to spatial development and innovation ecosystems.

Anastasia Panori is an electrical and computer engineer. Since 2012, she has participated in various research projects funded by the European Union and is currently a researcher at URENIO. Her main research interests are urban and regional development, data science, and how smart environments improve city and regional development and inclusion.

Panagiotis Tsarchopoulos is a senior researcher at URENIO Research. He has extensive research experience and has participated in numerous projects dealing with digital, smart, intelligent cities, and innovation ecosystems.

ORCID

A. Panori http://orcid.org/0000-0002-2551-2032
N. Komninos http://orcid.org/0000-0002-4656-1263
C. Kakderi http://orcid.org/0000-0001-6499-3919

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