How to Become a Smart City: Learning from Amsterdam

Luca Mora and Roberto Bolici

Abstract This exploratory study has been carried out to better understand the development process of strategies that allow large European cities to become smart. This aim is achieved through the analysis of the Amsterdam's smart city strategy. By using case study research with a descriptive approach, the activities undertaken during the implementation of this successful initiative have been mapped and organized in a step-by-step roadmap. This made it possible to obtain a detailed description of the entire development process, useful knowledge to consider for other similar initiatives, and a conceptual framework for future comparative research. All these results will support the construction of a holistic and empirically valid theory able to explain how to build effective smart city strategies in this type of urban area.

Keywords Smart city · Strategy · Roadmap · Development process · Amsterdam

1 Introduction

The first scientific publication to introduce the term smart city dates back more than 20 years ago (Komninos 2011; Schaffers et al. 2011), but a common definition capable of explaining its meaning is still missing. A multitude of interpretations can be found in scholarly literature (e.g., Allwinkle and Cruickshank 2011; Batty et al. 2012; Caragliu et al. 2011; Dirks and Keeling 2009; Giffinger et al. 2007; Harrison et al. 2010; Manville et al. 2014; Washburn et al. 2010), and this condition has generated an extremely confused scenario (Hollands 2008). However, by considering the comparative analyses proposed in recent studies (Chourabi et al. 2012; Nam and Pardo 2011a, b; Reviglio et al. 2013), despite some differences, these

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definitions seem to share a similar idea of what smart cities are: urban areas in which information and communication technologies (ICTs) are used as a tool for providing a solution to the multi-faceted problems that limit their sustainable development in social, economic, and/or environmental terms.

During recent years, transforming ordinary urban environments in smart cities has become a priority for a growing number of local governments and an ambitious aim that they are trying to achieve by launching specific strategies characterized by many different approaches (Angelidou 2014). In a short time, smart cities have become an expanding phenomenon in the real world. According to the data provided by Lee and Hancock (2012), more than 140 urban areas worldwide have launched a smart city strategy before 2013. Moreover, as reported by Manville et al. (2014), 240 of the 486 cities with a population above 100,000 inhabitants and belonging to the EU Member States were working in this field before 2014. This is a growth trend which is evident not only in the number of cases, but also in the production of scholarly literature dealing with smart cities.

However, even if smart city research is growing together with the interest of an ever broader scientific community, the level of knowledge concerning the possible ways in which smart city strategies can be implemented is very limited. In the literature produced to date, there is an evident lack of explicit and holistic procedures that can be used to guide the actors involved in the development of smart city strategies towards successful results (Abdoullaev 2011; Angelidou 2014; Chourabi et al. 2012; Frei et al. 2012; GSMA et al. 2011; Hollands 2008; Komninos 2011; Nam and Pardo 2011b). This consideration is valid for any type of city, whether small, medium, or large in size, precisely as observed by Kitchin (2014): "presently [research on smart cities] has four shortcomings [including] an absence of in-depth empirical case studies of specific smart city initiatives and comparative research that contrasts smart city developments in different locales". Only a few examples of procedures can be found in scientific publications, but they are characterized by a low level of detail and come mainly from the gray literature produced by the corporate sector (Dirks et al. 2010; Berthon and Guittat 2011; Clarke 2013). As a consequence, two relevant research questions call for a quick response: what are the essential steps to consider for developing successful smart city strategies? And how are they organized?

By focusing the attention on large cities,[1] this study makes a valuable contribution to fill this knowledge gap. Specifically, the activities undertaken during the implementation of the successful smart city strategy proposed by the City of Amsterdam have been mapped and organized in a step-by-step roadmap. This made it possible to obtain: a detailed description of the entire development process; useful knowledge to consider in other similar initiatives; and a possible conceptual framework for supporting future comparative research. This activity represents an

[1]Large cities are urban areas with a population of between 500,000 and 1.5 million inhabitants. This definition aligns with the classification system of urban areas proposed by the Organisation for Economic Co-operation and Development (OECD) (Brezzi et al. 2012).

important step towards the construction of an empirically valid theory able to explain how to develop smart city strategies in large European cities in the best way possible.

2 Methodological Notes

Descriptive case study research as defined by Yin (2009) has been employed for the qualitative analysis of the Amsterdam's smart city strategy. This case has been selected using a theoretical sampling approach (Yin 2009; Eisenhardt 1989). With a population of nearly 800.000 inhabitants, Amsterdam falls within the category of large cities (Gemeente Amsterdam 2014c), and its success in the field of smart cities makes its strategy an ideal sample to analyze. This success is demonstrated by the multiple awards that the city has received during recent years and its international positioning as a smart city (I amsterdam 2011, 2012, 2013; Collins 2013; Cohen 2012, 2014). One of the most important award comes from the European Parliament, which has included the Dutch capital among the six most successful smart cities in Europe (Manville et al. 2014).

Data for the analysis has been collected from multiple sources of evidence identified with a series of searches performed in various online databases during the period between July and August 2014. A total of 198 sources has been collected. Archive records and documents produced by organizations directly involved in the development of the smart city strategy have been considered as primary sources (e.g., agendas, minutes of meetings, press releases, news and newsletters, conference presentations and conference speeches, reports, brochures, videos, governmental acts, articles, and web-pages). Additional data has been acquired from documents produced by organizations not directly involved in the initiative of Amsterdam. These sources have been considered as secondary (e.g., reports, interviews, journal and online articles, books, as well as research project deliverables). This approach has enabled analysis of the case through the consideration of the different perspectives of multiple observers. Moreover, the final description of the process and the conceptual framework have gained greater strength thanks to the triangulation made possible by the use of multiple sources of evidence (Yin 2009; Eisenhardt 1989; George and Bennett 2005; Voss et al. 2002).

Coding analysis has been used to facilitate the management of the vast amount of data collected from the sources. This phase of the study has been developed considering the procedure described by Voss et al. (2002) and Strauss and Corbin (1990). Through the coding process, raw data has been reorganized and the activities which characterize the development process of the Amsterdam's smart city strategy have been listed in chronological order. This made it possible to build a step-by-step roadmap which has been described and illustrated through the production of a "story" (Bourgeois and Eisenhardt 1988): a detailed report in which the data associated with the case has been summarized and presented in a narrative form (within-case analysis) (Miles and Huberman 1994).

3 Results

The analysis has enabled the construction of a step-by-step roadmap that describes the development process of the Amsterdam's smart city strategy (see Fig. 1). The roadmap, which is composed by five main phases and 16 different activities, is presented in the following pages.

3.1 Phase 1: Starting

In the case of Amsterdam, the smart city strategy is called "Amsterdam Smart City programme" and the idea to start this initiative was developed in 2007 (Baron 2012c), thanks to the collaboration between the Amsterdam Innovation Motor

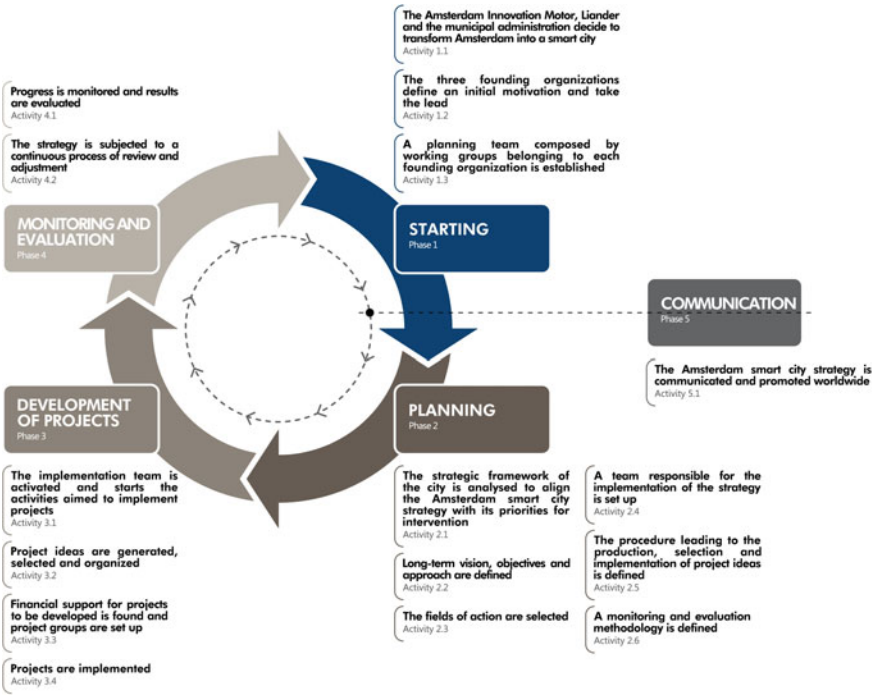

Fig. 1 The development process of the Amsterdam's smart city strategy

(AIM),[2] the energy-network operator Liander,[3] and the municipal administration (Amsterdam Smart City 2010, 2011a, b; Annen 2011; Baron 2010, 2012d; Bigliani and Gallotti 2009; Brinkman and Baron 2012; European Commission 2011; Turner et al. 2009; Velthausz 2011a; Vermast 2011a, b). Supported by the belief that "ICTs improve the way cities function" (Baron 2012b), these three organizations have become the initiators of a strategy which is currently underway, and the main driving force behind all the activities that are carried out to guarantee its progressive implementation.

Their decision to transform Amsterdam into a smart city has been supported by both political commitment and a clear motivation: the desire to use ICTs for helping the city to solve its environmental problems and build an urban environment that is "definitely sustainable" (Gemeente Amsterdam 2011a). Technology has been identified as "a key enabler to address climate issues" (Brinkman and Meuwissen 2010), and the smart city strategy has become an opportunity to achieve the strategic objectives defined by the City of Amsterdam in a faster way (Amsterdam Smart City 2011a). Moreover, despite the change in the municipal administration which occurred in 2010 (van der Laan 2014), the municipality's commitment to the use of information technologies for promoting environmental sustainability has remained stable over time and clearly emerges in many policy documents (Gemeente Amsterdam 2010, 2011b, 2012a, 2014a, b).

After clarifying the motivation for launching the smart city strategy, the three initiators have acquired full responsibility for its development, starting from the planning phase. The planning activities started in 2008 (Bigliani and Gallotti 2009; Turner et al. 2009) and have been implemented by a specific team composed by various working groups belonging to each founding organization (Brinkman and Meuwissen 2010). For example, the Climate Office of the municipality of Amsterdam and the ICT Cluster of the Amsterdam Innovation Motor (Brinkman and Meuwissen 2010; European Commission 2011), both established in 2008. The first is part of the Physical Planning Department (Guri et al. 2012) and has the task of undertaking projects and initiatives aimed at reducing carbon-dioxide emissions in the city of Amsterdam (Gemeente Amsterdam 2008). The second, instead, formed the core of the ICT activities in the AIM and was responsible for generating

[2]The AIM is a foundation established in 2006 that helps to preserve and strengthen the Amsterdam Metropolitan Area's authoritative position in the knowledge economy. By supporting new ideas and ventures that stimulate entrepreneurship, this foundation constantly develops new initiatives collaborating with universities, industries, local governments, and many other independent organizations. The initiatives developed by the Amsterdam Innovation Motor are connected to four strategic areas: creative industries and new media; information and communication technology (ICT); life sciences; and sustainability (Amsterdam Innovation Motor 2009, 2011; Amsterdam Smart City 2011a). Starting from 2013, the AIM has become part of the Amsterdam Economic Board (Amsterdam Economic Board 2014; The Technopolicy Network 2014).

[3]Liander is a Dutch energy-grid operator which forms part of Alliander, the largest energy company in the Netherlands. Its task is to build, maintain, and manage energy networks in order to distribute gas and electricity to large parts of the Netherlands, including the Amsterdam Metropolitan Area (Amsterdam Innovation Motor 2009).

and managing new projects linked to this sector (Amsterdam Innovation Motor 2009). Since 2013, when the AIM and the KennisKring Amsterdam (Amsterdam Knowledge Network Foundation) were merged to become the Amsterdam Economic Board,[4] this working group has been included in the new ICT/e-Science Cluster (Amsterdam Economic Board 2014; The Technopolicy Network 2014).

3.2 Phase 2: Planning

Different activities have been conducted during the planning phase. First of all, the Amsterdam's smart city strategy has been correctly included within the strategic framework of the city and aligned with its priorities for intervention, with particular reference to the need to contrast climate change through a significant reduction of carbon-dioxide emissions. This framework represents the result of the convergence of several strategies proposed at the local and European levels to address the problems reported in the initial motivation (Annen 2011; Baron 2010, 2012b; Brinkman and Meuwissen 2010; Schuurman 2011; Stahlavsky 2011; Velthausz 2011a, b; Vermast 2011a, b, 2012).

As pointed out by Joke van Antwerpen, Director of the Amsterdam Innovation Motor, "Amsterdam Smart City is closely linked to the New Amsterdam Climate programme, which states clear climate goals for the city of Amsterdam […] and encourage change in the energy consumption of citizens" (Smart Meters 2009). This program focuses attention on a specific goal to achieve and a long-term vision to realize: "in recent years it has become urgently clear that we must find an answer to the climate problem. The city executive of Amsterdam, together with many other parties in our city, wants to face this challenge. We have committed ourselves to reducing our CO_2 emissions by 40 % in 2025 (compared to 1990)" (Gemeente Amsterdam 2008). In this way, Amsterdam can be turned into "one of the most sustainable cities in the world" by 2025 (Gemeente Amsterdam 2009).

The smart city strategy has been aligned with the objectives, priorities, and vision proposed in the New Amsterdam Climate program. The strategy, indeed, looks forward to 2025 and its ultimate goals are: (1) to support the reduction of energy wastage and carbon-dioxide emissions in the metropolitan area of Amsterdam; (2) to promote sustainable economic growth based on technological innovation, taking advantage of the possibilities offered by ICTs and changing citizens' behaviors to induce more sustainable life styles (Annen 2011; Amsterdam Economic Board 2012; Amsterdam Smart City 2010, 2011a, 2014g; Brinkman

[4]The Amsterdam Economic Board is a foundation which performs the same functions of the AIM: "under the umbrella of the Amsterdam Economic Board, representatives from governmental agencies, research institutes and the business world have jointly taken responsibility to work towards strengthening the economy of the Amsterdam Metropolitan Area. The Board strives to stimulate and support sustainable collaboration, innovation and growth in the region, and strengthen international competitiveness" (Amsterdam Economic Board 2014).

2011; Brinkman and Meuwissen 2010; European Commission 2011; Schuurman 2011; Vermast 2011a, b). Moreover, the analysis of carbon-dioxide emissions included in the New Amsterdam Climate program has been used to select the fields of action, which correspond to "the largest CO_2 emitters in the city" (Turner et al. 2009): living spaces; working spaces; mobility; and public spaces. These fields "are estimated to account for a third of the city's emissions each" (Philipson 2009).

In order to achieve these goals, a specific approach has been defined based on the continuous and constant development of ICT-based projects. Each project and the technological solutions which characterize it are tested during an initial pilot phase. At the end of the test period, the results obtained are analyzed and the best initiatives are considered for a subsequent implementation phase on a large scale. Furthermore, four key principles have been selected for guiding the development of both the strategy and individual projects:

(1) Collective effort: a highly collaborative approach is considered fundamental for achieving results. For this reason, cooperation between the public and private sectors is constantly stimulated and supported in every project, together with the involvement of citizens (Public-Private-People Partnership);
(2) Economic viability: only the most advantageous projects can be considered for potential large-scale implementation;
(3) Tech push/pull demand: the action against the climate change has to be supported through technological innovation and the stimulation of behavioral change;
(4) Knowledge dissemination: sharing and spreading the knowledge acquired during the path towards the smart city transformation are considered as actions of crucial importance (Amsterdam Smart City 2011a; Brinkman 2011; Schuurman 2011; Stahlavsky 2011; Vermast 2011a, b, 2012; Velthausz 2011b; Schaffers et al. 2012; Turner et al. 2009).

To ensure high involvement of citizens during the development of projects and stimulate a change in their behavior, a Living Lab methodology has been chosen. In this way, technological solutions can be tested in a real-life environment through the active involvement of the city's inhabitants (Amsterdam Economic Board 2012; Baron 2012c, d; van Veen 2012; Vermast 2012). As suggested by Joost Brinkman, Manager of the Amsterdam Smart City programme between 2009 and 2011, "the essence of the Amsterdam approach is that Living Labs are being used for the projects […]. Involving […] citizens is essential […] since the tested technologies are useless without [their] acceptance and experience" (Brinkman 2011). This choice is consistent with the objectives of the strategy and its key principles.

Another important activity which has been carried out during the planning phase is the definition of a new organization able to ensure the proper implementation of projects, which is described as an "open platform […] that unites [public and private] parties and acts independently" (Annen 2011). This organization has been called Amsterdam Smart City (European Commission 2011) and structured as a foundation (Reviglio et al. 2013; Stahlavsky 2011). Moreover, it has been split into

various working groups with specific roles and responsibilities: Focus Group; Sponsor Group; Communication Group; Project Group; and Work Group (Brinkman 2011; Brinkman and Meuwissen 2010; Velthausz 2011a). All the groups have been activated during the third phase and are composed mainly of representatives from the AIM, Liander, and other external consultants. These include Accenture, which is one of the world's largest consulting firms in the fields of ICTs. As reported by Joke van Antwerpen: "we chose Accenture for its innovative thinking in helping city authorities and utilities come together in responding to climate change challenges, as well as its expertise in smart-grid and smart-metering technologies" (Smart Meters 2009). Along with Accenture, the independent research institute TNO has been selected as a strategic partner (Amsterdam Smart City 2014g; Annen 2011), but to play a different role: "to make sure that the research results would be recorded, underpinned, and shared based on a rigid scientific foundation" (Amsterdam Smart City 2011a).

Finally, the procedure leading to the production, selection, and implementation of project ideas has been precisely defined (Brinkman 2011; Brinkman and Meuwissen 2010; Velthausz 2011a), together with a methodology for monitoring and evaluating the results of projects (Amsterdam Smart City 2011a; Schaffers et al. 2012). Both are discussed in the next sections.

3.3 Phase 3: Development of Projects

The Amsterdam's smart city strategy is based on the continuous development of ICT-based projects that enable the introduction of new applications, services, devices, and technological infrastructures within the city in the short and medium term. To ensure their proper coordination and implementation, the Amsterdam Smart City Foundation has been activated. In this way, the strategy has moved "from the holistic view [of the planning phase] to concrete projects" (Baron 2012b).

To select and implement projects, the foundation uses the procedure defined during the planning phase. Each potential project starts with a Concept Development Phase during which the project idea is explored in detail. Ideas can be developed by the Amsterdam Smart City Foundation or submitted by external entities. Mainly considering feasibility, costs, and CO_2 reduction potential, the Focus Group has the task of approving or rejecting the proposal. If approved, the foundation identifies the most appropriate project partners and invites them to participate, collecting their applications. Once the working group is in place, the Execution Phase begins. In this second phase, roles and responsibilities of the various partners are specified in a Project Initiation Document which has to be signed by each of them. The project management activities have to be carried out by one of the partners. The foundation, instead, works transversally by providing support, monitoring, and general planning of all the project activities (Brinkman and Baron 2012; Bigliani and Gallotti 2009; Stahlavsky 2011; Velthausz 2011a).

"Projects are funded by the several companies and governmental organizations that are involved in [their implementation]" (Brinkman and Meuwissen 2010). The Amsterdam Smart City Foundation is assured of obtaining commitment and resources from a partner by signing an agreement in which the details of the collaboration are specified. The signature of the agreements and the Project Initiation Document by the working group's members allow a project to be started according to the priorities established by the foundation with an overall action plan (Brinkman 2011; Brinkman and Meuwissen 2010; Velthausz 2011a).

The development of projects is an activity that has continued to grow over time. Sixteen projects have been concluded between 2009 and 2011 (Amsterdam Smart City 2011a; Annen 2011; Brinkman 2011) but there are now more than 70 (Amsterdam Smart City 2014g). This growth has occurred in parallel with the increasing number of new public and private organizations interested in actively supporting the development of the Amsterdam's smart city strategy. In 2011, there were about 70 active partners (Annen 2011; van der Woude 2011; Velthausz 2011b; Vermast 2011b), and over the years, the number has increased to more than 160 (Amsterdam Smart City 2014g). These include mainly grid operators and utilities, governmental organizations, housing corporations, universities, financial institutions, telecom and ICT companies, transport and waste management companies, and technology start-ups (Schaffers et al. 2012).

3.4 Phase 4: Monitoring and Evaluation

The monitoring of progress and the evaluation of results are performed periodically, thanks to the collaboration between the Amsterdam Smart City Foundation and the project partners. These activities are carried out using the procedure established during the planning phase and allow to: establish if the actions taken have produced a positive result; review the distance to the final target in terms of CO_2 emissions reduction; and select which projects should be developed at the urban or regional level. All the results achieved through the individual projects in the period 2009–2011 have been published in a single report distributed through the website of the initiative. This report includes the value cases of each project and has also been used to present a comprehensive assessment of the work done in relation to the overall objectives of the strategy (Amsterdam Smart City 2011a, 2014g).

The value case is "an expanded business case" that is used to estimate the potential for saving energy and reducing CO_2 emissions offered by the technological solutions used in a project. They are based on four indicators: "(1) energy saving, per unit, in the pilot: depending on the pilot, a unit could be a household, a company, a school, or something else; (2) total reduction of CO_2 emissions: this express the total CO_2 emissions in tons that were prevented by the pilot; (3) realistic scaling up: […] the amount of CO_2 in tons that will be prevented if the pilot were to be done in the whole of Amsterdam [considering] less than optimistic assumptions; (4) maximum scaling up: same as realistic scaling up, but this time with somewhat

more naive assumptions, such as that everyone would participate in any given measure". Suppositions represent the expectations regarding "how effectively the implemented systems will work" and are usually defined by considering the data acquired during the pilot phase (Amsterdam Smart City 2011a).

Moreover, it is important to note that the Amsterdam's smart city strategy is managed with a dynamic approach. The various stages are never definitively closed but are subjected to a continuous process of review and adjustment aimed at improving the structure and functioning of the strategy. For example, the fields of action have been changed four years after the beginning of the initiative. They have now increased from four to seven: smart mobility, smart living, smart society, big and open data, smart areas, smart economy, and infrastructures (Amsterdam Smart City 2014g).

3.5 Phase 5: Communication

In the case of Amsterdam, "all gained knowledge and learnings are shared broadly" (Brinkman 2011). Knowledge sharing represents a transversal and continuous activity that is carried out by the Amsterdam Smart City Foundation from the beginning of Phase 3. The aim is not only to inform but also "to get free publicity" and encourage the creation of new alliances (Brinkman 2011).

Conference events are one of the main communication tools used to spread the knowledge associated with the strategy and promote the work done. The Amsterdam Smart City Foundation, indeed, has participated in more than 50 national and international conferences (Amsterdam Smart City 2011a). During these conferences, the features of the Amsterdam's smart city strategy have been described in-depth, namely: objectives; priorities for action; strategic principles; financial strategy; planning of activities; stakeholders; and results achieved with projects (e.g., Annen 2011; Baron 2010, 2012d; Schuurman 2011; van der Woude 2011; Vermast 2011a, b; Velthausz 2011a).

These data and information are also disseminated with the continual production of articles, news, press releases, and reports (e.g., Amsterdam Smart City 2011a, 2012b, 2014d; Baron 2012a, 2013; Brinkman 2011; Gemeente Amsterdam 2012b, 2013). These informative documents are incorporated mainly into a single web platform dedicated to the smart city strategy (Amsterdam Smart City 2014g). This interactive portal has been developed between 2009 and 2010, and continuously improved, expanded, and updated over the years (Amsterdam Smart City 2012a).

What is more, the following means are also used: a newsletter service (Amsterdam Smart City 2011d); presentations and guided tours for organizations that express an interest in becoming partners of the initiative (Amsterdam Smart City 2011a); meetings with all the partners (Amsterdam Smart City 2013e, 2014f); competitions, meetings and workshops organized to stimulate the active participation of citizens (Amsterdam Smart City 2013b, c, d, 2014a, b, c), as well as international conferences such as the Smart City Event, which is now in its fifth

edition (Amsterdam Smart City 2014e); social networks such as Facebook, LinkedIn, and Twitter (Amsterdam Smart City 2011a, 2014g); and finally, a dedicated YouTube channel used to release new videos periodically (Amsterdam Smart City 2010, 2011b, c, 2013a; Brinkman and Baron 2012).

4 Discussion and Conclusions

This exploratory study shows that Amsterdam is a pioneer in the smart city movement, and its success results from an approach closely linked to strategic urban planning principles (Santucci et al. 2011). To shape its smart city strategy, the city has chosen a way based on strategic thinking, collaboration, and inclusive criteria. The course to take has been accurately planned before acting, and the activities to perform have been organized within a strategic framework.

By using strategic urban planning, the municipal administration and the other funding partners have managed the complexity of smart city strategies by effectively combining the importance of new ICT infrastructures and digital services (Dirks and Keeling 2009; Gil-Castineira et al. 2011; Schaffers et al. 2011) with many other non-technological critical factors that are widely discussed in smart city research. For example: leadership and political commitment (Alawadhi et al. 2012; Chourabi et al. 2012; Hill et al. 2011); governance and funding capability (Washburn et al. 2010); coordination, sponsorship, and support across departments (Naphade et al. 2011); collaboration between stakeholders and organizations across multiple sectors (Beck 2011; Paskaleva 2009); innovative business and operating models (Belissent et al. 2010; Webb et al. 2011); long-term vision, performance metrics and commitment from the top (Moss Kanter and Litow 2009); the capability to connect short-term ICT-based projects and initiatives to real local needs (Komninos et al. 2014), and the benefits from "the enormous innovative potential of grass-roots efforts" (Ratti and Townsend 2011), avoiding the risks of an excessively top-down approach (Townsend et al. 2011; Deakin and Al Wear 2011).

Building on the lesson learned from Amsterdam, strategic urban planning seems to be an effective tool when used to govern the progressive transformation of cities in smart environments (Komninos 2014). However, this assumption is supported only by a single case analysis, and the relationship between strategic planning and smart cities is still a largely unknown field (Angelidou 2014). Considering this situation, future comparative research is required, not only to support a broader generalization of the results achieved but also to ensure the progressive construction of an empirically valid theory for explaining how to build smart city strategies in large European cities. However, this need to be done without forgetting that the absence of development methodologies is not an issue limited to large cities. On the contrary, it is extended to any type of urban area, and represents a serious shortcoming that needs to be overcome as soon as possible.

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