Progress in IS

Renata Paola Dameri
Camille Rosenthal-Sabroux *Editors*

Smart City

How to Create Public and Economic Value with High Technology in Urban Space

Springer

Progress in IS

For further volumes:
http://www.springer.com/series/10440

Renata Paola Dameri · Camille Rosenthal-Sabroux
Editors

Smart City

How to Create Public and Economic Value with High Technology in Urban Space

Springer

Editors
Renata Paola Dameri
Department of Economics
University of Genova
Genova
Italy

Camille Rosenthal-Sabroux
Université Paris IX Dauphine
Paris
France

ISSN 2196-8705 ISSN 2196-8713 (electronic)
ISBN 978-3-319-06159-7 ISBN 978-3-319-06160-3 (eBook)
DOI 10.1007/978-3-319-06160-3
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014942273

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Today, the smart city is a red-hot topic on the urban strategy agendas of governments worldwide. This is especially so in the advanced countries, where fast-paced urban growth has thrown open the door to a mounting number of complex infrastructural and social issues.

Smart cities are being piloted in Europe, the Americas and Asia, from London to Boston to Hong Kong, from Barcelona to Amsterdam to Sau Paulo do Brazil, as citizens across the globe demand their local governments provide urban spaces designed to improve their quality of life. Yet another challenge to the citizens' quality of life is the environmental impact of these ever-larger, more technologically endowed cities, which can only be addressed by reducing pollution levels and through the wise management of natural resources; in other words, by investing in sustainable economic development.

The smart city issue is complex because it straddles several domains, from the city's physical capital to its intellectual and social capital. City planning is not just a question of urban design, but also brings into play social studies, political science, and economics. Further, the concept of smart city is underpinned by its technological core, which in turn is driven by the advances made in the fields of computer science and engineering.

The sharp increase in the number of scientific papers and empirical reports on smart cities forms a loud chorus that underscores the great interest and appeal of this new topic. The book surveys hundreds of scientific contributions on smart cities and affinity concepts, such as digital cities, intelligent cities, and green cities, published since 2010. In addition, the smart city trend has led hundreds of aspiring smart city players to upload their smart city plan to the Internet, making them accessible to all.

The advent of the smart city has sparked great fizz and bang all round, raising public interest to considerable heights, but also sowing confusion. Indeed, an analytical review of the literature reveals several theoretical roadblocks that need to be leaped before we can chart a roadmap that is as smart as the smart city we aspire to live in. Definition, governance, planning, and evaluation are the key steps that need to be addressed on the theoretical and design path that will lead to the best practices, which makes *Smart City—Using High Technology in Urban Spaces to Create Public and Economic Value* edited by Renata Paola Dameri and Camille

Rosenthal-Sabroux a welcome initiative, one that will consolidate our extant knowledge on the complex and multifaceted nature of the smart city.

The book sets out to collate the most important studies written on Europe's smart cities in an attempt to understand whether a smart city truly has the potential to create public value for citizens.

To date, the assumption of all the reviewed smart city studies and implementer reports is that the smart city is a good thing but, strangely, these provide no empirical evidence to support the claims that it helps to improve the quality of life of its citizens. These studies and reports assume that a city is smart exclusively thanks to the technology that is its core component, pointing to it as a winning card, but neglect to study the outcome and impact of the technology on the everyday life of the smart city's people, i.e., the relationship forged by the user with the technology.

As a result, this book dedicates several chapters to the debate on how to measure the impact of smart city initiatives on the creation of public value for the people who live, work, study, and visit a city. To date, studies that explore how to define and measure smart city performance are few and far between, mostly because not only is it difficult to measure a phenomenon that is still embryonic and, hence fuzzy, but also because of the subjective and nuanced view that each citizen has of the quality of life.

Nevertheless, no matter how high the hurdle, it must be leaped if we want solve the crux of how to measure smart city performance and, hence, chart an effective and practical roadmap to achieve the goal of a comprehensive smart city.

The smart cities that exist at present are mainly pilot projects that rely on the use of ICT to transform the traditional city into a better, more liveable place. However, to implement the smart city concept on a global scale takes significant resources, investments, time, and effort, not to mention political commitment. Therefore, if we really want to design and implement projects that create value and generate high returns on investment we need to develop a smart city framework that enables us to gain intelligence and traction on all the gaps in our current knowledge.

We are facing what is called a "grand challenge," meaning that the issue will keep us engrossed for several years to come and, while we are unlikely to arrive at the perfect solution, we still need to explore, investigate, analyze, question, debate, and discuss the smart city to arrive at part-solutions that can put a better and brighter spin on the way we live in our cities.

Rome Marco De Marco

Contents

Smart City and Value Creation

Renata Paola Dameri and Camille Rosenthal-Sabroux

Abstract During the latest five years, the label smart city has been spreading all over the world, impacting on urban strategies in both large and small towns. To face the increasing problems of urban areas, local public government, companies, not-for-profit organizations and the citizens themselves embraced the idea of a smarter city, using more technologies, creating better life conditions and safeguarding the environment. However, today the smart city panorama appears very confused. No acknowledged smart city definition exists till now and several cities defining themselves smart completely lack of a strategic vision about their smart future. This first chapter is the introduction of this book collecting several contributes from different academic studies all over Europe. The aim of this work is to offer a large vision about the smart city phenomenon and to compare researches and considerations regarding how to define a smart city, how to design a smart strategy and how to measure if smart actions really are able to create public value for citizens and a better quality of life in urban spaces. This chapter introduces the most important themes regarding the smart city and further deepened in the ten chapters of the book.

Keywords Smart city • Smart strategy • Smartness • Performance measurement • Public value

1 Searching for a Shared Smart City Idea

During the latest five years, the label smart city has been spreading all over the world, impacting on urban strategies in both large and small towns [1]. To face the increasing problems of urban areas, local public government, companies,

R. P. Dameri (✉)
Department of Economics, University of Genoa, Genoa, Italy
e-mail: dameri@economia.unige.it

C. Rosenthal-Sabroux
Université Paris IX Dauphine, Paris, France
e-mail: camille.rosenthal-sabroux@dauphine.fr

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_1,

not-for-profit organizations and the citizens themselves embraced the idea of a smarter city, using more technologies, creating better life conditions and safeguarding the environment.

However, the smart city idea has more ancient roots [2]. A large literature survey about smart city and digital city scientific papers, realized by Annalisa Cocchia and extensively debated in the next chapter of this book, observes that these themes have been studied from twenty years ago [3]. Therefore the idea of a city able to be smart and digital, that is, to use technology and especially ICT to improve the quality of life in urban space, is quite old [4]. But only during the latest years the attention about this topic has a peek. There are several reasons about this evidence: the larger diffusion of mobile devices and the Internet among citizens, the higher and higher dimensions of cities, the need to safeguard the environment from pollution and energy consumption [5].

Today smart city is in the mood, not only in academic or scientific researches, but especially in public government choices and projects. Looking for smart city web sites, the results are millions. It seems that every city all over the world, across continents and independently from dimension, culture, economic situation, considers important to be smart [6].

For these reasons, the panorama is very confused. A deeper analysis of the literature survey, presented by Cocchia and also by Dameri in their work "Smart and Digital City: A Systematic Literature Review" [3], considering not only the number of papers or their geographical distribution but also their content, shows that a shared and sound definition of smart city still lacks. Even if there are some most cited definitions, their meaning is quite different each other. Moreover, owing to the continuous and fast innovation regarding the smart city enabling technologies, it is difficult to compare definitions written in a time elapse of three/four years [7].

Also the smart city empirical implementation shows the same heterogeneity. Cities have been starting to implement their own smart projects. Both citizens, companies and public governments have very high expectations from the positive impact of smart actions on the quality of life or on the appeal of their city. Sometimes a smart city project is seen like a panacea able to solve all the urban problems, such as pollution, local public transport difficulties, inequalities between people, economic crisis, and so on. But these expectations are often not supported nor by a clear smart vision of the city nor by effective smart programs and initiatives [8].

The smart city implementation generally rises like a bottom up phenomenon, that is, several actors independently each others start to realize a smart initiative, using some public infrastructures or technological solutions. For example, a public hospital realizes an on-line health record access, a company supplies electric cars to its employers and the municipality replaces old buses with new ones, with a lower impact on air pollution. Three smart actions, using technology to improve the quality of life in urban spaces and to reduce pollution and energy consumption, but not included into a comprehensive vision able to define goals, expected results and scheduled time for project realization. Moreover, the lack of a framework to collect all these initiatives prevents to realize important synergies and also to communicate to the citizens the improved smartness of their city [9].

One of the primary defects of this smart city first wave is the excessive stress on the pivotal role of the technology. Indeed, technology is certainly the core aspect of a smart city, but it is not enough to create public value for citizens. The human contribute is necessary, to really embody the smart actions into the daily life of people living, studying, working in the city or also visiting the city for one or a few days for work or tourism. It should be therefore necessary to speak about smart people in smart city and to consider people, technology and strategic vision like indispensable components of a successful smart program [10, 11].

Till now, the lack of a smart strategic vision negatively impacts on the performance obtained by smart projects and initiatives. But, moreover, no city till now has developed and applied a set of key performance indicators and a measurement framework to evaluate the real effectiveness of smart actions. Perhaps it is not severe when smart city is a pioneering project, but it becomes a real obstacle in obtaining success when the smart city project wants to deliver sustainable returns to large public and private investments [12].

The mosaic emerging from the smart city panorama is colorful and rich of suggestions to support both further studies and better implementation plans. It clearly emerges that smart city is a complex challenge, because it involves several dimensions: technology, citizens, public and private bodies, urban vision [13]. Moreover it interests cities all over the world, with very deep differences each other: cultural, economic, social. Each city wants both to apply a shared smart city idea and to pursue its own specific goals.

This complexity requires the development of a governance framework of smart cities, built upon a shared smart city definition, but flexible to be adapted to different and specific needs; it should include all the steps of the governance activity, that is: to define a strategic vision, to design long term strategies, to prioritize and schedule projects and to measure the obtained results for different stakeholders.

In this book, several points of view are collected, to put the theoretical basis for a comprehensive, agile and flexible Smart City Governance Framework.

2 Smart City Definitions and Strategic Vision

We said that a generally accepted definition of smart city still lacks. Why is it so difficult to define a smart city? There are several reasons.

As Cocchia and Dameri show in their chapters in this book, the emerging of smart themes is originally strictly joined with the digital city idea. Indeed, examining the most cited definitions of smart city and digital city listed by Cocchia in the next chapter, several elements are the same in both the topics. But an important reason to explain the difficult to define the smart city should be found in its bottom-up nature.

Rising from the empirical application, the concrete smart city is especially a collection of several projects, initiatives and actions, carried out both by public and by private organizations. Therefore, as these initiatives are the result of spontaneous choices by different actors, depending on their own interests but also on the specificity of a city, the collections are very heterogeneous. To design a definition observing one or several case studies means to write a definition describing a specific smart city, and not a standard [14].

Giffinger, one of the most cited authors in the smart city field of study, examines also the different topics involved in the smart city implementation [15]. Certainly, all these themes are included in smart cities, but not in each smart city and not only these themes are included. Moreover, some of these themes sometimes overlap each other and the clearness of the Giffinger's definition is not satisfying. It says: “A Smart City is a city well performing built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens”.

This definition is broad enough to include all the good initiatives carried out to improve the city quality, no matters which instruments, outcomes or actors are involved. This definition could be interesting for a theoretical debate about what a smart city is, but it is not very useful to drive its implementation and to measure the obtained results.

Examining also other smart city definitions, as listed in the chapter written by Cocchia, it emerges that there is a large disagreement between the academic view and the empirical view about smart cities. This disagreement regards the main component of a smart city: in the academic debate, it is the intellectual capital, in the empirical vision expressed by large companies such as IBM, Cisco and so on, the main component is the technology.

This different vision impacts on all the further aspects regarding the smart city: strategy definition, implementation, evaluation and performance measurement.

The academic vision considers the intellectual capital the most important resource to increase the smartness of a city. The label intellectual capital is to be interpreted in the broader meaning. It includes the culture of citizens, their educational level, their intellectual capability; but also the culture of companies, that is, trade marks, patents, know how, reputation on the market; and finally the city culture, represented by museums, theatres, cinemas, cultural events and everything could animate the cultural life in the city [16].

Depending on this vision, the smarter city is the one that has the larger cultural capital and is able to use its knowledge to choice the better solutions for the further development of the city quality. Investments in cultural initiatives are therefore welcome, but especially the city should use its awareness to promote sustainable development, equal economic growth and environmental quality in the urban areas.

Also the evaluation system is consequently designed depending on this intangible vision. Indicators regarding the cultural aspect of the city, the citizens and the public and private bodies resident in the city are the main proxy of the city smartness. To increase the cultural level—and by this way the smartness—of the city is the main instrument to further attract the best people and companies: more educated, more innovative, more profitable [17].

The business vision of a smart city is strongly based on the pivotal role of technology, especially the ICT. It derives from both the previous idea of digital city, and from the strong need to solve several concrete problems strongly affecting the life in large metropolis, such as traffic, pollution, energy consumption, waste treatment, water quality. These aspects are also near to the idea of green city and the environmental themes are an important part of the smart city goals.

In this smart city vision, initiatives to improve the city smartness are especially focused on some lines such as:

- energy production from renewable sources, to reduce energy cost, CO_2 emissions and to satisfy the increasing energy demand in urban areas;
- building efficiency, to reduce energy demand and consumption;
- local transport quality and greenness, to reduce pollution deriving from transport in cities;
- and so on.

The evaluation system to be applied to this different smart city vision is more tangible and based on physic indicators such as CO_2 emissions, greenhouse gases, waste tons, megawatts produced by renewable sources and so on [18]. It is important to outline that, even if the ultimate goal is to improve the citizens' quality of life, they are scarcely considered in this smart city vision and smart initiatives are often planned without their involvement. They are seen like the final addresser in the smart city value chain, but this value is not compared with their own expectations about the quality of life in city.

Even if these two smart city visions are quite clear in both academic papers and empirical studies or surveys about smart city, they are scarcely applied when a smart city plan is designed. As Thorne and Griffith explains in their chapter about the London Smart City development, and as it emerges from large literature surveys conducted by several authors in this book, the different smart city souls are merged each other and are not able to distinguish themselves in a smart strategy. Technological, cultural and environmental aspects are the core elements of a smart city, but their role is not the same and it is important to explicitly declare which aspect is the more important, what has the leading role and how this component interacts with the main stakeholders of the smart city strategy, that is, the citizens. To explicitly define the smart city vision and to align it with smart initiatives and desired outcomes is the first step to implement a successful smart city program.

3 Smartness, Public Value and Smart City Performance

What makes a city smart? And how it is possible to define the smartness of a city, and to measure it?

Even if a shared definition of a smart city still lacks, it is possible to describe which are the main characteristics of a smart city, which initiatives could improve its smartness and the most important goals to be reached. To measure created public value and smartness performance, all the goals and processes should be clearly defined and quantified. It requires a city strategic vision (that too often lacks) to sustain all the programs and projects carried out by a city to become smarter [19].

Dameri in chapter "Smart and Digital City: A Systematic Literature Review" tries to put the basis to define the smartness of a city starting from its core components: land, infrastructures, people and government.

Land means the territory, that is, the geographical area upon which the city rises up. Infrastructures are a large element, including all the physical, material components of a city such as buildings, streets, transport facilities, and so on. People includes all the citizens, not only the city inhabitants but also who works, studies or visits the city. Government means the local political bodies which have the power to govern the administrative aspects of the city.

For the first, to become smarter a city should improve the smartness of its core components. What do we mean with smartness? All the authors contributing to this volume agree to consider three main aspects of a smart city: effectiveness, environment consideration, and innovation [20, 21].

- Effectiveness means the capacity of a city to supply effective public and private services to several subjects, such as citizens, companies, not-for-profit organizations; and in detail to different categories of citizens such as students, workers, elder men and women, and so on. It requires to include the subjective role of several stakeholders in the smartness definition. Therefore, a smart city is not smart for itself, but if it creates public value for people.
- Environmental consideration regards the increasing impact that large cities have on the environmental quality of urban areas. One of the main pillars of smarter cities is to prevent a further environmental degradation. The main impacts regard energy consumption, air and water pollution, traffic congestion, land consumption. A smarter city therefore acts to reduce all these aspects to preserve the environmental quality.
- Innovation means that a smart city should use all the new and higher available technologies to improve the quality of its core components, to deliver better services and to reduce its environmental impacts. Technology is therefore a central aspect of smarter city, used at the service of smart initiatives for the quality of life in city.

To improve the smartness of its core components, a city should transform them into more effective, environmental and innovative ones [22].

Therefore, a smarter land means cleaner territory, water and air, a reduced consumption of land for new buildings, environmental reclamation and so on. Smarter infrastructures should be cleaner, more effective in serving the citizens and answering to their needs, using high technology, ICT and mobile devices to spread e-services and information. Smarter people means citizens more informed, more aware about the city goals and the role of technologies in improving the quality of urban land, infrastructures and services, a easier access to the Internet and all the mobile and on-line services and finally a strong decreasing of the digital divide. A smarter government uses ICT and all the new technologies to implement e-government and e-democracy, improving the quality and accessibility of supplied public services and the people satisfaction for the local administration [23, 24].

However, all these activities to improve the smartness of a city are not enough to realize public value to be enjoyed by citizens. Indeed, the creation of public value should be the final goal of a smarter city, but it requires that all the projects and initiatives would be addressed to the citizens [25, 26]. Public value is a complex idea, as it includes several different dimensions [27]:

- it requires to create both economic and social values, that are difficult to merge and sometimes in conflict each other;
- it requires to create value for different stakeholders, that have different expectations not ever compatible each other;
- it requires to create value respect to different dimensions of the life in city, and it further requires to understand which are the real needs and the priorities to carry on.

To create public value in a smart city program means therefore to put together a large set of variables and to compose them into a well-defined general framework, able to collect the needs, the expectations and the perception of citizens respect to the smart city for their daily life [28, 29].

To measure the public value created and supplied thanks to a smart city program is therefore a complex task, but such important as the implementation of the smart initiatives. Indeed, examining some smart city cases all over the world it emerges that often:

- smart city benefits are not defined,
- they are not measured,
- and furthermore they are not communicated.

Even if the smart city program produces improvement in the daily life of the citizens, they are not informed about that, nor involved in the definition of their priorities and not aware about the impact of smart projects in the quality of their own city [30].

To measure the smart city performance, that is, the capacity of a smart city program to really create and spread public value, is the major challenge to be faced, to grant the transparency and the awareness about the smart wave in city, and to prevent that this trend would finish before it starts to create real benefits in urban areas. The importance of this topic emerges also from this volume, as five chapters are explicitly devoted to this aspect of smart city implementation [31].

Negre and Sabroux face the problem of prioritizing smart initiatives. In their chapter, several possible smart actions have been briefly described. Each city has a enormous set of possible actions to be carried out, but… which to choice? Considering that not all the cities have the same characteristics and problems, nor their citizens have the same needs and expectations, and that financial resources are not enough to implement all of the desired smart projects.

Fontana examines how some cities already committed in a smart city plan are defining their own strategies and linking them with the creation of public value in a sustainable way. It requires to include into the smart city strategic vision all the stakeholders, such as, citizens, companies, public authorities, not-for-profit organizations. Each of them rightly wants a part of the created public value, but the expectations of all of them are not easy to harmonize.

The importance of citizens is outlined also by Palumbo and Cossetta. In their chapter regarding social innovations, they introduce the idea that social and open innovations are very important to create novel solutions able to improve the quality of life in cities. Using Living Labs to explore the needs, the expectations and the ideas of citizens abut smart city, it is possible to obtain better performance, more aligned with the co-production of public value.

Zuccardi Merli and Bonollo introduce the crucial topic of performance measurement. Performance is not only the smartness of a city, but a more complex concept: it means to measure the advances of a city towards its capacity to deliver a better quality of life to everybody. Also these authors outline the importance of the citizen involvement, the role of different stakeholders and the need to build a model able to measure smart city performance. They also test their theoretical model on a set of Italian and European smart city cases.

Baccarne, Mechant and Schuurman analyse created value in a smart city case, Ghent Smart City in Belgium; they face an important aspect, that is, the sustainability of smart programs over the time. Indeed, all the smart city projects implemented till now are pioneer implementations, especially aiming at testing new solutions to find best practices in smart city realization. However, it is time now to overcome this phase and to transform demonstrators towards real sustainable value.

4 Specific Smart Projects

It emerges from both all the chapters in this book and the international literature that the final aim of a smart city program is to improve the quality of the city and in the meantime the quality of life in city. These two aspects—city quality and life quality in city—are not the same thing, but they are strictly linked. What especially links these two different way to understand the smart city benefits are the specific smart projects [32].

The smartness of a city is indeed composed by several dimensions. Giffinger, one of the most cited authors, indentifies six different dimensions of smart city, as showed in Fig. 1: Smart mobility, smart environment, smart people, smart living, smart governance, smart economy [15].

However, it is difficult to use this schema to classify the specific smart projects, and furthermore to use this classification to build an evaluation framework, because some of these aspects are linked each other or are overlapped in some aspects. For example, a new public local transport system, based on low carbon emissions, impacts on both smart mobility and smart environment. It is moreover difficult to find projects not impacting on smart living, as this dimension seams to summarize all the benefits deriving from smart initiatives [33].

Therefore, it is perhaps better to use a descriptive framework, based on the core components of a smart city—land, infrastructure, people, government—composed by a project portfolio and aiming at a better quality of life and/or of city, measured by a set of key performance indicators representing the different benefits created

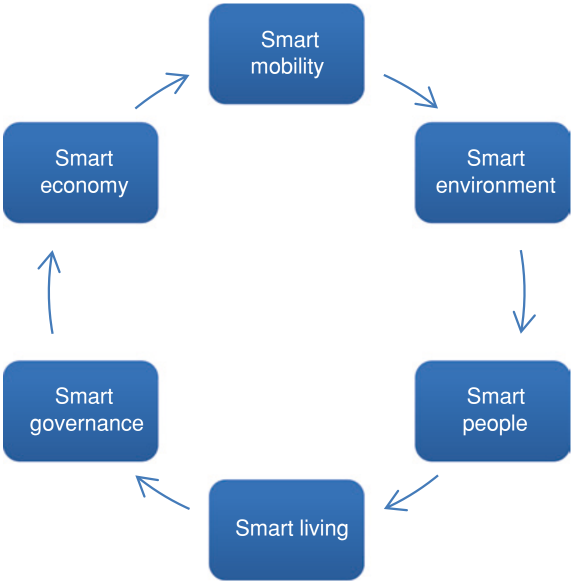


Fig. 1 The Smart city dimensions (*Source* [15])

by each project. It is very difficult to separate the benefits produced by a project in different streams: it is better to describe and to measure the numerous benefits generated by a sole project.

We can imagine that:

- the core components should become more and more smart;
- the smart initiatives are actions planned to both improve the smartness of the core components of a city and impact on the quality of life;
- the quality of life depends on both the smartness of the core components and the capacity of single smart projects or set of smart projects to impact on one or more dimensions of the daily life in city [34].

Therefore, single projects are the instrument to realize the smart city. These projects should have some characteristics, such as use advanced technological solutions, harmonize environment and economy, and address the needs and expectations of citizens. Till now, smart projects are mainly focused on some themes such as buildings energy efficiency, greenhouse gases reduction, broadband diffusion, e-services delivery, mobile government and so on. It would be more and more important to offer technical solutions to city problems, but also to include each project into a comprehensive smart framework [35].

In this book, two chapters regard crucial topics for smart city realization. Di Bella et al. analyze the so-called smart security systems, that is, applications using ICT to improve the safety and security in urban areas, especially the more degraded. This is indeed a good example of a smart project, aiming at improving both the citizens' quality of life and the city quality tout court: the safety of neighborhoods is a real benefit for citizens and in the meantime the reputation of a city increases.

Carrabs, Cerulli and Sciomachen apply the smart city framework to a logistic problem, regarding goods distribution inside the city boundaries. The aim of their study is to suggest a mathematical programming model to face and solve the inconveniences deriving from business to consumer goods deliver in city centre. Optimizing the vehicle routing, it is possible to reduce traffic and pollution, just two main goals of a smart city strategy.

5 Conclusions and Further Works

Smart city is one of the most interesting research themes in the latest few years. One of the main reasons is that Smart city is a multidisciplinary topic, impacting on human, social, economic and technical research fields. The need to face with the harder and harder problems deriving from increasing dimension cities, along with the desire to gain the higher benefits from the urban life, are formidable engines that sustain the research about smart city.

Till now, this topic has been a pioneering field, both in theoretical research and in empirical applications. Academic researchers are still trying to understand what exactly a smart city is, and local governments are trying to realize prototypes of smart city or, at least, of smart projects. But to realize the expected returns from smart city projects, it is necessary to overcome the first stage of smart city study and realization and to increase the maturity level of this promising urban strategy.

This book is the result of a series of writings from all over Europe; researchers give their contribution about this topic, searching to clarify the concepts still dark and confused. They agree about the most important themes to be deepened and interesting also for further works:

1. The definition of a smart city, to be shared and useful to clarify which initiatives are included into a smart city strategy;
2. The smart city goals and the measurements needed to evaluate its success or failure;
3. The collection of best practices, the repeatability of prototypes and the financial sustainability of smart initiatives.

The definition of a smart city is indispensable to trace its perimeter and to understand which initiatives can be considered smart and which can not. Moreover, a standard definition is also the first step for each city to specify its own vision of a smart city strategy and to build a comprehensive smart city framework able to link together all projects and initiatives.

The definition and the comprehensive smart city framework are the necessary basis on which to build the smart city goals system. The multisciplinarity of a smart city program requires to define a set of objectives to be reached. To support the monitoring of projects and initiatives, all the goals should be measurable and key performance indicators are the instrument to evaluate the progress of a smart strategy. Citizens should even be involved, both in the plan phase and in the smart city implementation steps; communication is at the centre of a shared participation in defining smart city goals and in spreading awareness about the smart city role and benefits for people.

Finally, smart cities are now leaving their youngness, but they need to reach their maturity, to extend best practices collected in smart city pioneering implementation all over the world and increase the return on investments—financial, but also political, social, human—of smart projects. Local governments, together with businesses, universities, not-for-profit organizations and the citizens themselves should share their work to grant the maximum of benefits delivery to everybody, so that a smart city could also be considered an inclusive city.

All these topics are examined in this book, establishing sound basis for further studies about all of them.

References

1. Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology, 18*(2), 65–82. Routledge.
2. Toh, M. H., & Low, L. (1993). The intelligent city: Singapore achieving the next lap: practitoners forum. *Technology Analysis & Strategic Management, 5*(2), 187–202.
3. Dameri, R. P., & Cocchia, A. (2013). Smart city and digital city: twenty years of terminology evolution. *Proceeding of ITAIS conference*, Milano, December.
4. Tokmakoff, A., & Billington, J. (1994). Consumer services in smart city Adelaide. In Bjerg and Borreby (Eds.), *Home-oriented informatics, telematics and automation.*
5. Oberti, I., & Pavesi, A. S. (2013). The triumph of the smart city. *TECHNE: Journal of Technology for Architecture & Environment 5*.
6. Mainka, A. et al. (2014). Government and social media: a case study of 31 informational world cities. arXiv preprint arXiv:1401.4533.
7. Dameri, R. P. (2013). Searching for smart city definition: a comprehensive proposal. *International Journal of Computers & Technology, 11*(5), 2544–2551.
8. Mulligan, C. E. A., & Olsson, M. (2013). Architectural implications of smart city business models: an evolutionary perspective. *IEEE Communications Magazine, 51*, 6.
9. Paroutis, S., Bennett, M., & Heracleous, L. (2013). A strategic view on smart city technology: the case of IBM smarter cities during a recession. *Technological Forecasting and Social Change*.
10. Suppa, A., & Zardini, A. (2011). The implementation of a performance management system in the Italian army. *Communications in Computer and Information Science, 210*(3), 139–146.
11. Vakali, A., Angelis, L., & Giatsoglou, M. (2013). Sensors talk and humans sense towards a reciprocal collective awareness smart city framework. *IEEE International Conference on Communications Workshops* (ICC).
12. Kourtit, K. et al. (2013). 11 An advanced triple helix network framework for smart cities performance. *Smart Cities: Governing, Modelling and Analysing the Transition 196*.
13. Pardo, T., Taewoo, N. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Conference on Digital Government Research* (pp. 282–291). ACM, New York.
14. Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City, 12*(3), 303–320.
15. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovi, N., & Meijers, E. (2007). Smart cities: ranking of European medium-sized cities. Centre of Regional Science (SRF), Vienna University of Technology, Vienna, Austria, from http://www.smart-cities.eu/download/smart_cities_final_report.pdf.

16. Leydesdorff, L., & Deakin, M. (2011). The triple-helix model of smart cities: a neo-evolutionary perspective. *Journal of Urban Technology, 18*(2), 53–63.
17. Paskaleva, K. A. (2009). Enabling the smart city: the progress of city e-governance in Europe. *International Journal of Innovation and Regional Development, 1*(4), 405–422.
18. Al-Hader, M., & Rodzi, A. (2009). The smart city infrastructure development and monitoring. *Theoretical & Empirical Researches in Urban Management, 2*, 11.
19. Zygiaris, S. (2013). Smart city reference model: assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the Knowledge Economy, 4*(2), 217–231.
20. Casalino, N., Buonocuore, F., Rossignoli, C., Ricciardi, F. (2013). Transparency, openness and knowledge sharing for rebuilding and strengthening government institutions. *IASTED Multiconferences—Proceedings of the IASTED International Conference on Web-Based Education*, WBE, pp. 866–871.
21. Dameri, R. P. (2012) Defining an evaluation framework for digital cities implementation. *IEEE International Conference on Information Society* (*i-Society*).
22. Chourabi, H. et al. (2012). Understanding smart cities: an integrative framework. *IEEE 45th Hawaii International Conference on System Science* (*HICSS*).
23. Alawadhi, S., et al. (2012). *Building understanding of smart city initiatives "Electronic Government"* (pp. 40–53). Berlin: Springer.
24. Nam, T., & Pardo, T.A. (2011). Smart city as urban innovation: focusing on management, policy, and context. *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance*. ACM.
25. Moore, M. H. (1995). *Creating public value: Strategic management in government*. Cambridge: Harvard University Press.
26. Sorrentino, M., & Niehaves, B. (2010). Intermediaries in E-inclusion: a literature review. Paper presented at the *43rd Hawaii International Conference on System Sciences* (HICSS-43, 2010), Kauai, Hawaii, USA, IEEE.
27. Benington, J., & Moore, M. H. (Eds.) (2010). Public value: Theory and practice. Basingstoke: Palgrave Macmillan.
28. O'Flynn, J. (2007). From new public management to public value: paradigmatic change and managerial implications. *Australian journal of public administration, 66*(3), 353–366.
29. Walravens, N., & Ballon, P. (2013). Platform business models for smart cities: from control and value to governance and public value. *IEEE Communications Magazine, 51*, 6.
30. Anttiroiko, A. V., Valkama, P., & Bailey, S. J. (2013). Smart cities in the new service economy: building platforms for smart services. *AI & Society* (2013), 1–12.
31. Bowerman, B. et al. (2000). The vision of a smart city. *2nd International Life Extension Technology Workshop*, Paris.
32. Al-Hader, M. et al. (2009). Smart city components architicture. *IEEE International Conference on Computational Intelligence, Modelling and Simulation*, CSSim'09.
33. Glaeser, E. L., & Berry, C. R. (2006). Why are smart places getting smarter. Rappaport Institute/Taubman Center Policy Brief 2.
34. Shapiro, J. M. (2006). Smart cities: quality of life, productivity, and the growth effects of human capital. *The Review of Economics and Statistics, 88*(2), 324–335.
35. Lee, J. H., Phaal, R., & Lee, S Ho. (2013). An integrated service-device-technology roadmap for smart city development. *Technological Forecasting and Social Change, 80*(2), 286–306.

Smart and Digital City: A Systematic Literature Review

Annalisa Cocchia

Abstract The concept of Smart City embraces several definitions depending on the meanings of the word “smart”: intelligent city, knowledge city, ubiquitous city, sustainable city, digital city, etc. Many definitions of Smart City exist, but no one has been universally acknowledged yet. From literature analysis it emerges that Smart City and Digital City are the most used terminologies in literature to indicate the smartness of a city. This Chapter explores the literature about Smart City and Digital City from 1993 to the end of 2012 in order to investigate how these two concepts were born, how they have developed, which are the shared features and differences between them. To accomplish with these goals, three steps were followed: (1) to set up a search strategy for systematic literature review to collect a representative subset of papers about Smart City and Digital City using Google Scholar; (2) to store the selected subset in an ad-doc database to synthesize the literature review; (3) to organize the literature review subset to extract quantitative and qualitative data and information about Smart City and Digital City evolution. The author proposes a literature review taxonomy through five specific analysis: (1) time analysis, to explore the causes of the trend of Smart City and Digital City literature in the latest twenty years; (2) terminology analysis, to examine how and where these two ideas were born and what have been the main events influenced their development; (3) definitions analysis, to select and compare the most cited and validated definitions of Smart City and Digital City trying to identify similarities, differences or overlaps between these two concepts; (4) typology analysis, to investigate if Smart City and Digital City are included into a specific urban strategy pursued by government or if they face specific urban problems without a comprehensive framework; (5) geographic analysis, to understand where are the largest concentrations of Smart Cities and Digital Cities in the world and which are their main characteristics and best practices.

A. Cocchia (✉)
Department of Economics, University of Genoa, Genoa, Italy
e-mail: cocchia@economia.unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_2,

Keywords Smart city • Digital city • Literature review • ICT • Urban strategies

1 Introduction

During the latest years of XX century, two important phenomena have been emerging: urbanization and information and communication technologies (e.g. ICT). Eighties' and nineties' technological advancement and economic growth contributed to increase well-being, mainly in the greater urban centers. This fostered the urbanization leading to a progressive abandonment of rural areas towards greater cities and metropolis, which can offer many opportunities in terms of work, education, social life and so on. People strong inclination to concentrate in cities generated both positive and negative effects at global level [1]. On one hand it causes the increasing of cultural level, the creation of new job opportunities and an improvement of economic conditions. On the other hand, concentration in cities increased traffic jam, carbon dioxide, greenhouse gases emissions and waste disposal with consequences on health conditions. City dimension drives energy and natural resources demand, the need of territory redevelopment and adequate infrastructures availability. In this scenario, to save the earth and people health, the idea of smart cities emerges, that is, cities able to solve urban issues paying attention to the environment. For this reason, in the nineties, the concept of smart growth has begun to spread: it implies a community-driven reaction to solve traffic congestion, school overcrowding, air pollution, loss of open space and skyrocketing public facilities cost [2].

In the international context, in order to achieve the objectives established in the Kyoto Protocol, the Smart City concept was born and has been adopted by many institutions (e.g. European Commission, Setis-EU, OECD, etc.) which labeled as "smart" initiatives and projects relevant to cities sustainability. Indeed, if we "google" the term "smart city", we can find more and more results about: city sustainable initiatives, institution road-maps to enhance green growth and quality of life, the usefulness of ICT infrastructures, the involvement of citizens in public life, the need to reduce digital divide, and so on. But giving a comprehensive definition of Smart City is far to be done. A major hurdle in identifying such definition is the ambiguity of meanings attributed to the word "smart" and to the label "Smart City". Some examples of these several meanings are: Digital City, Wired City, Knowledge City and Green City, "which often link together technological informational transformations with economic, political and socio-cultural change" [3]. All those meanings are somehow part of the fuzzy concept Smart City and they cannot be regarded as mere correlated themes of it. Especially Smart City and Digital City are often used without specifying their similarities and differences. A brief analysis of scientific literature and paper title shows that smart city and digital city are most recurrent terms, but their meaning is rarely clarified.

This paper aims to light the shared features and dissimilarities between Smart City and Digital City concepts looking at a sound definition of both. To lead this study, the author inquires about the beginnings of Smart City and Digital City phenomena, considering the time frame 1993–2012. In this context, the author organized the research in the following steps:

- paragraph 2 defines the research method, aiming to identify and organize a subset of papers relevant for the literature review analysis;
- paragraph 3 examines the collected data trying to answer to the specific questions through five analysis:

  1. *time analysis* answers to the Research Question 1: “How and when Smart City and Digital City concepts were born?”. This analysis aims to show the trend of papers about Smart City and Digital City in the time frame 1993–2012 and to investigate about the drivers of this trend;
  2. *terminology analysis* answers to the Research Question 2: “Which events mainly influenced the development of Smart City and Digital City ideas?”. This analysis aims to show the time distribution of papers regarding Smart City and Digital City during the latest twenty years, highlighting the most important causes which influenced the widespread of these two concepts; definitions analysis answers to the research Question 3: “Which are the main shared features, differences and overlaps between Smart City and Digital City contents?”. This analysis aims to compare each other the most recurrent and acknowledged definitions about Smart City and Digital City, identifying their similarities and differences;
  3. *typology analysis* answers to the Research Question 4: “Are Smart City and Digital City included into a comprehensive urban strategy? Or are they the sum of standalone projects? In this context do they follow a top-down or a bottom-up approach?”. This analysis uses papers labeled as “empirical study” or “theoretical study” regarding smart/digital cities/initiatives during the time frame 1993–2012 to understand if their origin is more theoretical and top-down, or more empirical and bottom-up;
  4. *geographic analysis* answers to the Research Question 5: “How these two types of city strategies are widespread in the world?”. This analysis aims to show the location of empirical studies regarding Smart City or Digital City implementation, highlighting the concentration of these concepts per continents;

- paragraph 4 addresses concluding remarks.

2 Methods: Search Strategy for Systematic Literature Review

The literature review about Smart City and Digital City has been carried out using the methodological model proposed by Vom Brocke et al. [4] in their study about the importance of rigor in documenting the literature search process. This methodological model is based on a five phases framework for the literature search process. These phases are: (1) definition of the review scope, (2) conceptualization of topic, (3) literature search, (4) literature analysis and synthesis, (5) research agenda.

In the following paragraphs these phases are introduced referring to the literature review about Smart City and Digital City.

2.1 Definition of Review Scope

In order to clearly define the scope of this literature review, the author refers to an established taxonomy presented by Cooper [5] that includes six characteristics for literature review: (a) focus; (b) goal; (c) organization; (d) perspective; (e) audience; (f) coverage.

a. *Focus* is the central area of interest to the reviewer. This area could concern: research outcomes, research methods, theories, practices or applications; this literature search focus regards all types of papers, from theoretical to application-centered ones;
b. *Goal* regards what the author hopes the review will fulfill. The aim of literature review could regard: integration (such as, to clarify contradictory ideas or to bridge the gap between theories and practices), criticism (such as, to critically examine the literature to demonstrate the unwarranted previous theories), central issue (such as, what has been studied in the past, what researchers will study in the future, what has hindered the development of some topics, and so on); the aim of this study is to synthesize past literature and to identify the central issue of the literature review about Smart City and Digital City, that is to investigate how these two concepts were born, how they have developed, what are their similarities, differences and overlaps;
c. *Organization* concerns how the reviewer organizes his search study. The literature review could be organized by: chronological order, conceptual order (that is, to group the same ideas), methodological order (that is, to group the same methods of work); this literature is sorted by chronological order first and by conceptual order after;
d. *Perspective* is the point of view of reviewer in discussing the literature. The reviewer could lead the study with: a neutral position (he plays the impartial role as an honest "judge") or an espousal of position (he plays the role of an "advocate"); the author considers worthwhile to adopt an essentially neutral literature search perspective, because there is no interest to foster a specific position or policy about the topic;
e. *Audience* concerns groups of people (such as specialized researchers, general researchers, practitioners, policy makers, general public and so on) whom the review is addressed; the audience of the literature review are specialized scholars and industry makers.

Table 1 The Cooper's taxonomy applied to the smart city and digital city literature review

	Characteristic	Cooper's options	Author choice
a	Focus	Type of papers involved (methodological, theoretical, practices, applications, outcomes)	All types of paper
b	Goal	Integration, criticism, central issue	Central issue
c	Organization	Chronological, conceptual, methodological	Chronological first, conceptual after
d	Perspective	Neutral, espousal of a position	Neutral
e	Audience	Groups of people whom the review is addressed	Specialized scholars and industry makers
f	Coverage	Exhaustive, with selective citation, representative, central, pivotal	Representative

f. *Coverage*, it regards how the reviewer searches the literature and how he makes decisions about the suitability and quality of documents. The coverage could be: exhaustive, exhaustive with selective citation, representative, central or pivotal; the author decided to choose a reasonably representative coverage.

Table 1 summarizes the choices made by the author, regarding the Cooper's taxonomy about the review scope.

2.2 Conceptualization of Topic

Vom Brocke et al. [4] suggest that "a review must begin with a broad conception of what is known about the topic and potential areas where knowledge may be needed". Therefore, in order to choose the key concepts on which to base the literature review, the author began the study on Smart City by looking:

- several papers about the meaning of the word "smart" (in particular the paper of Hollands [3] and the IBM report [6]), because Smart City is a broad concept including many aspects of urban life, such as urban planning, sustainable development, environment, energy grid, economic development, technologies, social participation, and so on; therefore, also the word smart assumes a large range of meanings, linked with its different field of application;
- several papers about the different terminologies which identify a "smart" city, because it is not clear if these different terms want to say the same thing or if they define different cities, strategies and technologies (especially the paper of Pardo and Nam [2], Dameri [7], Su et al. [8]);
- several papers about the Smart City definitions (especially the paper of Pardo and Nam [2, 9], Chourabi et al. [10]).

However, exploring these papers, we cannot find a comprehensive definition accepted by academics, businesses and institutions about what Smart City is and which are its key elements and boundaries are. The difficulty to define Smart City regards mainly two aspects:

1. the adjective “smart”, because it depends on the meaning we attribute to this word. In literature, several typologies of city refer to Smart City concept, such as Intelligent City, Knowledge City, Wired City, Digital City, and so on [4];
2. the label “smart city”, because it is a fuzzy concept and it is used in ways that are not always in accordance each other. There are many cities that define themselves as Smart City when they identify some own characteristics as “smart”, but without referring to a standard meaning.

For these reasons, nowadays, a unique definition of Smart City does not exist yet [2]. Moreover, from this first literature review it emerges that there are many terminologies of Smart City, but to understand if each of them could be considered as synonymous of Smart City, it is necessary to clearly define if they have some shared features, overlaps or differences. To achieve this goal, the author analyzed and compared different definitions of city linked to the label “smart city”. Table 2 shows this comparison, listing the definition and the reference. For each definition, there are in evidence some words to highlight the meaning of these concepts: the bold character is used to outline the human component of different city concepts; while the italic character is used to outline the applied technologies.

From the literature analysis, it emerges that all these concepts are not in contradiction with each others and they disclose some shared features and are partially overlapped [7].

Pardo and Nam [2] organizes these definitions in dimensions depending on some recurrent shared characteristics, in order to define the most used terms. These dimensions are:

1. *Technology dimension*; it is based on the use of infrastructures (especially ICT) to improve and transform life and work within a city in relevant way. This dimension includes the concepts about Digital City; Virtual City, Information City, Wired City, Ubiquitous City and Intelligent City;
2. *Human dimension*; it is based on people, education, learning and knowledge because they are key drivers for the smart city. This dimension includes the concepts about Learning City and Knowledge City;
3. *Institutional dimension*; it is based on governance and policy, because the cooperation between stakeholders and institutional governments is very important to design and implement smart city initiatives. This dimension may include the concepts about Smart Community, Sustainable City and Green City.

Finally, we can see that Digital City also embraces several meanings of “smart”, such as virtual city, cyber city, wired city, ubiquitous city and so on [11, 12–14]. Moreover, Digital City is sometimes considered as a Smart City based on ICT infrastructures, because one of the most important technologies used to support Smart City strategies is ICT [7]. Therefore, from this analysis, it appears that Digital City is the most recurrent terminology linked to the meaning of Smart City.

Table 2 The different meanings of smart city

Concept	Definition	Reference
Wired city	"Wired cities refer literally to the laying down of *cable and connectivity* not itself necessary smart"	Hollands [3]
Virtual city	"Virtual City concentrates on *digital representations* and manifestations of cities"	Schuler [11]
Ubiquitous city	"Ubiquitous city (U-City) is a further extension of digital city concept. This definition evolved to the ubiquitous city: a city or region with *ubiquitous information technology*"	Anthopoulos et al. [39]
Intelligent city	"Intelligent cities are territories with high capability for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their *digital infrastructure* for communication and knowledge management"	Komninos [40]
Information city	"Digital environments collecting official and unofficial information from local communities and delivering it to the public via *web portals* are called information cities"	Anthopoulos et al. [39]
Digital city	"The digital city is as a comprehensive, *web-based representation*, or reproduction, of several aspects or functions of a specific real city, open to non-experts. The digital city has several dimensions: social, cultural, political, ideological, and also theoretical"	Couclelis [41]
Smart community	"A geographical area ranging in size from neighborhood to a multi-county region whose residents, organizations, and governing institutions are using *information technology* to transform their region in significant ways. Co-operation among government, industry, educators, and the citizenry, instead of individual groups acting in isolation, is preferred"	California Institute [42]
Knowledge city	"A Knowledge City is a city that aims at a knowledge-based development, by encouraging the continuous creation, sharing, evaluation, renewal and update of knowledge. This can be achieved through the continuous interaction between its citizens themselves and at the same time between them and other cities' citizens. The citizens' knowledge-sharing culture as well as the city's appropriate design, *IT networks and infrastructures* support these interactions"	Ergazakis [43]
Learning city	"The term 'learning' in 'learning cities' covers both individual and institutional learning. Individual learning refers to the acquisition of knowledge, skills and understanding by individual people, whether formally or informally. It often refers to lifelong learning, not just initial schooling and training. By learning, individuals gain through improved wages and employment opportunities, while society benefits by having a more flexible and technological up-to-date workforce"	OECD [44]

(continued)

Table 2 (continued)

Concept	Definition	Reference
Sustainable city	"Sustainable city uses *technology* to reduce CO_2 emissions, to produce efficient energy, to improve the buildings efficiency. Its main aim is to become a green city"	Batagan [45]
Green city	"Green City follows the Green Growth which is a new paradigm that promotes economic development while reducing greenhouse gas emissions and pollution, minimizing waste and inefficient use of natural resources and maintaining biodiversity"	OECD [46]

For these reasons, the author decided to focus on Smart City and Digital City; these two topics will be analyzed together because they are the most used and representative terminologies in the literature to indicate the smartness of the city; but they are quite different to require a distinct analysis and further comparison.

2.3 Literature Search

This phase "involves database, keyword, backward and forward search, as well as an ongoing evaluation of sources" [4]. To conduct this literature search process, the author evaluated the following search strategy steps: (a) to choose the database source; (b) to choose keywords and search criteria; (c) to choose if to apply backward and forward search; (d) to evaluate the literature subset suitability.

a. First, it is needed to choose the *database source* among the available ones. The selected on-line database has been Google Scholar, because it includes a broad field of publications (especially such as papers and journal articles) which focus on the chosen topic.
b. Second, it is needed to choose the most suitable *keywords* and *search criteria* in order to extract a representative subset from the selected database. In the present case, the search was conducted between February and May 2013. The system was request to search the words "*Smart City*" *OR* "*Digital City*" *OR* "*Smart Cities*" *OR* "*Digital Cities*" only in the title of paper and excluding all citations and patents. In this way, the search results included 987 papers. Then, the Google Scholar database was request to sort all the results by year of publication within 1993–2012 range. The author chooses this twenty years range in order to have a reasonable representative subset which does not include the work in progress (such as it could happen including 2013). After the filtering, the search results reduced to 843 papers which have been stored in an ad-hoc database. This database has been called "Literature Review Storage DataBase"

(LRS-DB) where each record corresponds to a paper. It is characterized by the following attributes:

– publication year;
– authors' name;
– title of work;
– source which identifies the typology of scientific publication;
– affiliation of authors, country included;
– abstract;
– keywords used by authors to index their work;
– citations only when superior to twenty;
– tag "smart" or "digital" in order to classify papers into Smart/Digital City label on the base of adjective used in the title;
– type of study identifies if the contribution is a theoretical study, a case study or a report;
– if case study, the object of it (that is, a smart or digital project or a smart or digital city);
– the name of the city in case of empirical study;
– the continent of city in case of empirical study;
– abstract available to delete the papers which are not abstract available.

c. Third, it is needed to choose to apply *backward and forward search*. In the present case, the amount of papers was considered an appropriate pool to investigate how and when Smart City and Digital City concepts were born, how they have been developing and if there are some shared features between these terminologies. Thus, the author decided not to apply any backward search nor forward search.
d. Fourth, *evaluation* in "all phases means limiting the amount of literature identified by keyword search to only those articles relevant to the topic at hand" [4]. In this phase, the LRS-DB was used as a source input platform and some criteria were applied to it to restrict the search. Indeed, the author removed: duplicates, thesis, power point presentations, white papers, book's introductions, competition announcements, all works which are not in English language and/or have not the full abstract available. The application of these criteria resulted in the exclusion of 115 papers, leading to a total 705 ones relevant to the present study.

Figure 1 shows in a sketch the steps of these described systematic review process.

The LRS-DB is an important tool for data-mining aiming to fulfill the following objectives around the Smart City and Digital City concepts:

- to filter the literature;
- to identify how Smart City and Digital City have been evolving during time;
- to identify research trends during the last two decades;
- to pinpoint the most studied research themes;
- to pinpoint the less studied research themes which can perhaps be expanded in future.

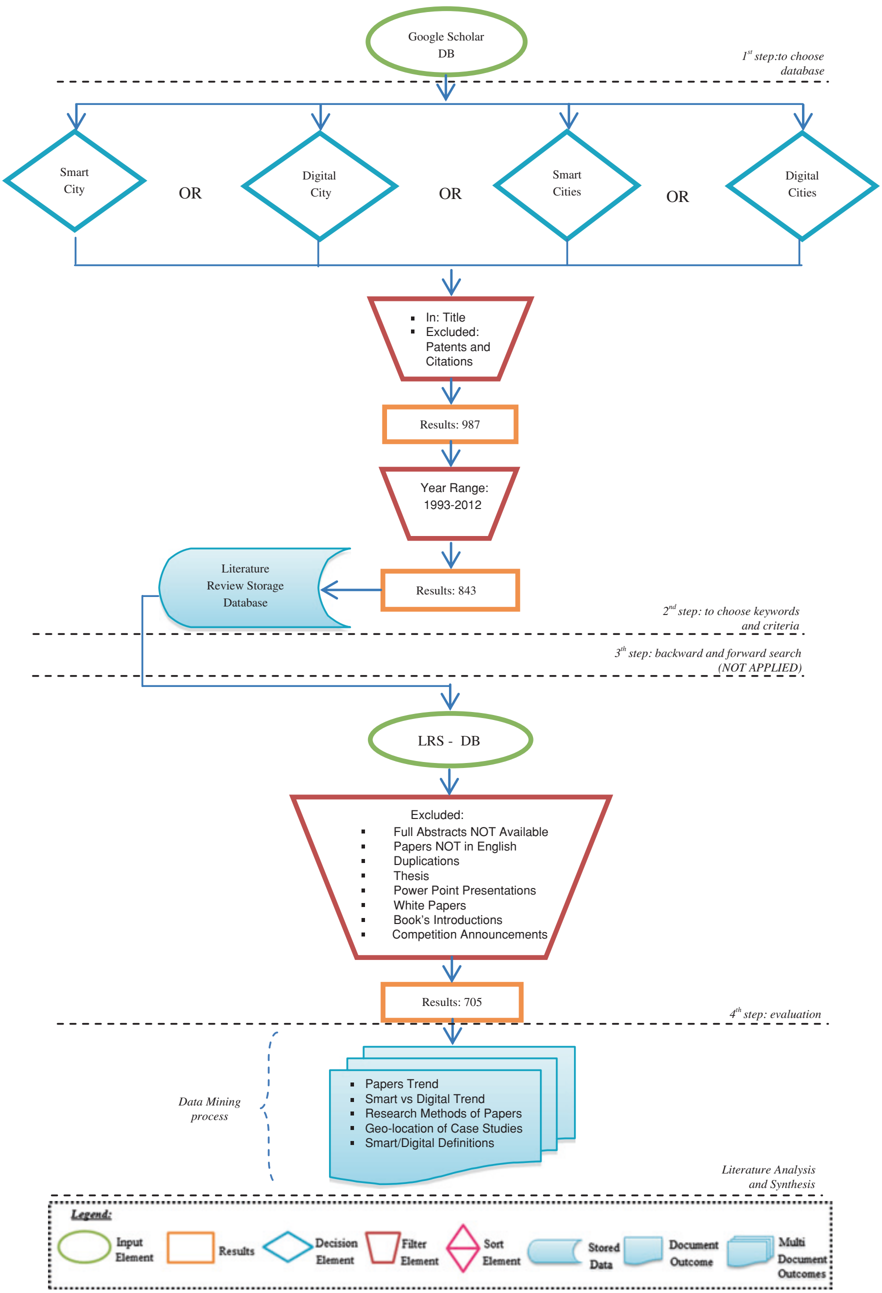


Fig. 1 Search strategy for systematic review

A part of these goals will be reached in this work,[1] while others are going to be accomplished in the future research studies.

2.4 Literature Analysis and Synthesis

"After collecting sufficient literature on a topic it has to be analyzed and synthesized" [4]. Therefore, the aim of this phase is to organize the papers stored in the LRS-DB to analyze systematically the collected literature. To accomplish with this goal, the 705 papers were organized to investigate about:

a. *time analysis*, it explores the evolution of researches about Smart City and Digital City during the latest twenty years. To achieve this purpose, the stored papers were organized by years of publication to count them per each year. The output of this analysis is to show in a graphic the trend of papers about Smart City and Digital City idea in the time frame 1993–2012;
b. *terminology analysis*, it explores how and when Smart City and Digital City concepts have being conceived and the relationships between the two topics. To achieve this goal, the stored papers were organized by years of publication and by "smart" or "digital" label, according to the adjective used in the title of paper. The output of this analysis shows in a graphic the time distribution of papers regarding Smart City or Digital City during the latest twenty years;
c. *definitions analysis*, it explores the most cited definitions of Smart City and Digital City, to compare their meanings and contents. To accomplish with this goal, the stored papers were organized by the most recurrent and validated definitions, according to the citation number and to the paper focus;
d. *typology analysis*, it explores if Smart City and Digital City are two initiatives which follow a specific urban strategy defined by governments (they have in this case a top-down approach) or if they solve specific and stand-alone urban issues without a comprehensive strategic vision (therefore they have a bottom-up approach). To achieve this aim, the stored papers were organized by years of publication and by "empirical study" or "theoretical study" label, according to the research method highlighted in the abstract of paper. The output of this analysis is to show in a graphic the distribution of papers labeled as "empirical study" or "theoretical study" regarding smart/digital cities/initiatives during

[1] Thanks to the use of LRS-DB, in this chapter will be investigated about the evolution of Smart City and Digital City concepts during the latest twenty years, in order to understand: how and where these two concepts were born, what causes mainly influenced their evolution, if Smart City and Digital City follow a bottom-up approach, where are the most large concentrations of Smart cities and Digital cities in the world, which are the empirical cases more frequently studied by researchers, how much these two topic are overlapping strategies and how much they are different. Therefore, this study is the first step to deep explore other research dimensions aiming to clearly design the contents and the boundaries of Smart City and Digital City idea.

the time frame 1993–2012; it helps to understand if the empirical studies come first, or after, the theoretical study of these topics, that is, if the bottom-up approach prevails on the top-down one, or vice versa;

e. *geographic analysis*, it explores where Smart cities and Digital cities are more concentrated in the world. To achieve this purpose, the stored papers were organized by "empirical study" label and by the "city of empirical study", according to the paper abstract. The output of this analysis shows in a graphic the distribution of empirical studies regarding Smart City or Digital City implementation all over the world.

2.5 Research Agenda

"The literature search process never comes to a definitive end" [15]. The final purpose of this literature review is not only to clarify the similarities and differences between Smart City and Digital City, or to find a good definition to identify both of them; but also to result in a new research agenda, which should be more insightful than the research question posed at the beginning. This new research agenda will aim to deep the characteristics of Smart City and Digital City, investigating about the contents of the papers included into the LRS-DB and also collecting several empirical case studies, to verify if the theoretical definitions designed in the present works are suitable to embrace the real implementation of Smart City or Digital City experiences all over the world.

3 Results

This section describes and explains the results obtained by the analysis of the LRS-DB, answering to the Research Questions #1, 2, 3, 4, 5 exposed in the previous paragraph.

3.1 Time Analysis

The purpose of time analysis is twofold; it aims both to analyze the time trend and distribution of researches regarding Smart City and Digital City and to understand which are the main determinants of this time trend.

To accomplish these objectives, the 705 papers stored in the LRS-DB were organized by chronological order, classified depending on publishing year to count them.

Figure 2 shows the number of papers about Smart City and Digital City during the latest twenty years. As trend line highlights, the first study concerning this topic is dated 1994. Between this start point and 1997, no more publications were found. After that, the total number has been gradually increasing until 2005. From

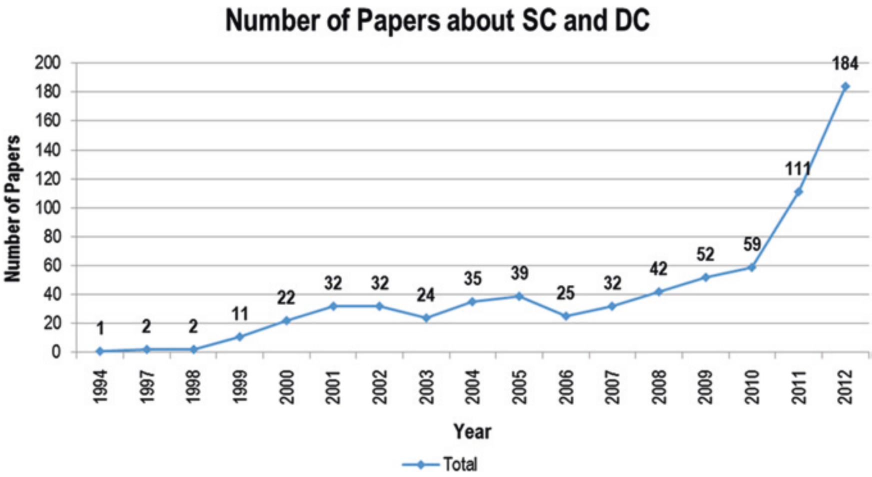


Fig. 2 Time analysis: number of papers about smart city and digital city

2006 to 2009, the trend line shows a steady increase (plus 10 units per year), while from 2010 its growth was doubled year by year up to 184 units at the end of 2012. Therefore, the interest about Smart City and Digital City is quite stable from 1993 to 2010 and it increases exponentially from 2010 to now.

Examining time analysis results, five dates have been identified as possible causes which could have influenced the development of Smart City and Digital City concept. These dates are: 1997, 2000, 2005, 2008, 2010.

1. *1997*. This year was characterized by *Kyoto Protocol*. Its main purpose is to limit CO_2 emissions and consequently to safeguard the environment all over the world. The Kyoto Protocol was signed by 192 Parties, including European Union and 191 States (such as, all United Nations members with the exception of the United States, Andorra, Canada, South Sudan). Nevertheless, it was entered in force in 2005 after Russia ratified it in October 2004. All parties were required to prepare policies and measures to decrease CO_2 emissions in their respective countries. There are two commitments periods in which developed countries have to achieve binding limitations or reductions emissions of greenhouse gases: the time frame between 2008 and 2012 and the time frame between 2013 and 2020 [16]. The Kyoto Protocol has certainly influenced the way to think the city, especially modern and industrialized cities characterized by a strong urbanization. In this context, during the latest twenty years, all State Parties have begun to foster several initiatives about CO_2 emissions reduction to apply them within their own boundaries with consequent studies increase about these scenarios. This role of Kyoto Protocol in driving countries and cities to design and apply environmental policies is also one of the main drivers of interest about the Smart City topic; less relationships are between Kyoto Protocol and Digital City.
2. *2000*. Two thousands were characterized by widespread of *Internet* all over the world, not only in business or academic context but especially in everyday life

[17]. In these years the *ICT* infrastructure, such as broadband infrastructures, wireless sensor networks, Internet-based networked applications, open platforms, were spread more and more, in order "to work together to form the backbone of a large intelligent infrastructure" [18]. Thanks to the use of Internet-based infrastructures, the e-services supply regarding healthcare, energy, education, environmental management, transportation, mobility and public safety, has begun to spread among citizens. At the same time, mobile phones have become more accessible for everybody (not only for businessmen but also for each citizen) evolving in technologically sophisticated products able to use the Internet access-point and to supply intelligent services to the users. The accessibility to the Internet in urban life has become easier and more popular [17, 19]. The newness it is that the city increases its cooperation with the surrounding territory in physic and virtual terms, in order "to build an arena where people in communities can share knowledge, experience and mutual interests" [20]. The author observes that this scenario supports more and more the concept of Digital City as a wired-city based on Internet, in which it is possible to provide public and private services to create socio-economic value for customers, citizens and the civil society [21]. Therefore, the Internet diffusion is one of the main driver of interest regarding the Digital City concept; less relationships are between the Internet and Smart City;

3. *2005*. During this year the *Kyoto Protocol entered in force* on the 16th February. After this moment, the international initiatives about the safeguard of environment have spread to achieve the Kyoto Protocol aims. Therefore, this scenario has fostered the development of smart strategies all over the world, focused on the environment safeguard.
4. *2008*. In 2008 two important events could have been influenced smart/digital researches: *the IBM Smart Planet concept* and *the Covenant of Mayors*.

   – IBM is the first company paying attention to the concept of "*Smart Planet*". For IBM, Smart Planet is as an instrumented, interconnected and intelligent planet in which leaders in business, government and civil society around the world could use Big Data to "transform enterprises and institutions through analytics, mobile technology, social business and the cloud" [6]. For IBM, this is the way to compete in the "smart" era, to have a good quality of life and to improve the city. Therefore, IBM has started a new business in this sector supplying to governments smart solutions focused on communications, energy and utilities, healthcare, insurance, retail, transportation, and so on. After that, many companies worldwide (such as Cisco, ABB, HP, Siemens, Ericsson, etc.) followed the IBM idea studying new smart projects for urban city issues. Therefore, putting together the event of the entered in force of Kyoto Protocol and the diffusion of Smart Planet concept, the author observes that the adjective "smart" gather with the word "city" has begun to widespread in every research field. However, the Smart City referred by IBM is not only smart, but also digital, because the role of ICT in pursuing the Smart City goals is crucial This is one of the most important example of confusion between smart and digital.
   – *Covenant of Mayors* is a self-started initiatives of European Cities. This initiative is finalized to spread the Smart City concept and to reduce CO_2

emissions by more than 20 % by 2020 through increased energy efficiency and fostering renewable energies. The agreement is fostered by European Commission in the frame of fulfilling the objectives of Strategy 2020 [22]. Its actions mainly focuses on: clean mobility, private and public buildings redevelopment, citizen awareness on the energy consumption theme. The signatory cities agreed to issue their own Action Plan for Sustainable Energy (PAES), which consists in a roadmap for fulfilling the agreement objectives. The Covenant of Mayors initiative is not isolated, it interacts with a number of projects, policies and initiatives. The main synergy in place is with the Strategic Plan for Energy Technologies (SET Plan). Indeed, SET Plan outlines the logic frame where the actions to fulfill Agenda 2020 objectives have to be developed [23]. In this context, the Smart City concept develops more than Digital City and it mainly regards the sustainability in terms of pollution reduction and environmental quality improvement.

5. *2010*. In 2010 the EU launched the *Europe 2020 Strategy* about delivering [22]: smart growth investing in education, research and innovation areas; sustainable growth investing in technologies and resources low-carbon economy; inclusive growth giving a strong emphasis on job creation and poverty reduction. The Europe 2020 strategy is focused on five goals in different areas, which should be achieved by European Union within the end of 2020 year. These goals concern: employment, research and developments, climate change and energy sustainability, education, poverty and social inclusion. Aiming to achieve these objectives, each European country commits to carry out smart or digital initiatives in its own major cities. In this way, the Europe 2020 Strategy has increased the widespread of both Smart City and Digital City concepts and, of consequence, the research studies about them.

Linking the papers trend with the most important events, the author identifies the links between technological and political situations and smart/digital researches. It emerges from the literature analysis that the time increasing of papers has been influenced by the Internet development, that justifies investments in Digital City initiatives, and environmental global policies, such as Kyoto protocol and EU 2020 Strategy, explicitly focused on sustainable growth and CO_2 emissions reduction, more influencing the Smart City investments. Therefore, both Smart City and Digital City strategies, and consequently also researches about these topics, are the effect of technology advancements and environmental sensibility. These two causes explain the most of papers published about Smart and Digital City and the exponential increase of papers after 2009.

3.2 Terminology Analysis: Smart Versus Digital

The terminology analysis aims to separate papers regarding Smart City from papers regarding Digital City and to order them chronologically, to distinguish the different time trends characterizing these two research topics. To accomplish with

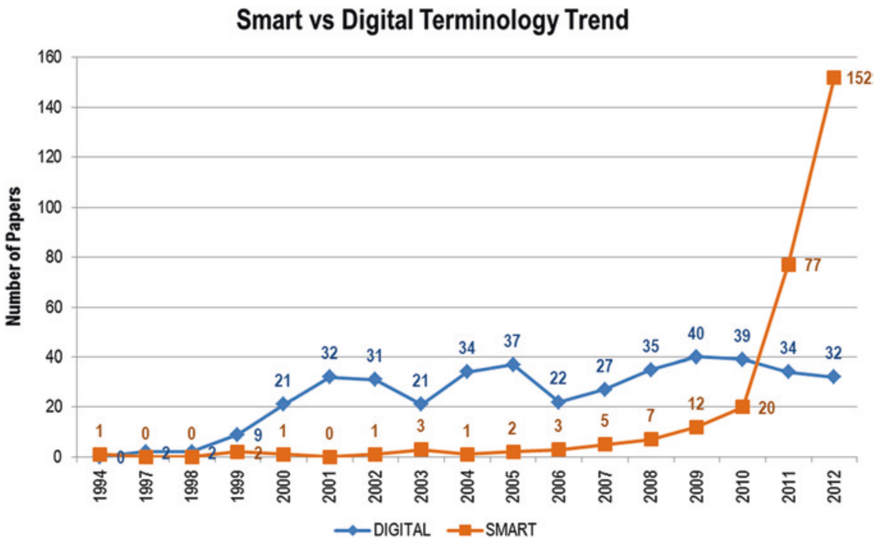


Fig. 3 Terminology analysis: smart versus digital terminology trend

these objectives, the 705 papers stored in the LRS-DB were organized and counted by chronological order of publication and by the label "smart" or "digital" according to the title of paper. The papers terminology trend is represented in Fig. 3.

Figure 3 shows the time distribution of Smart City papers and Digital City papers year by year. The graph underlines that these two topics have a very different time trend and it clearly appears from the figure that the Digital City concept was born before the Smart City one. Indeed, Digital City was conceived and developed in the nineties, in the context of Internet adoption in everyday urban life [20]. Smart City was born in 1994, but papers regarding this topic are few or zero until 2010, when the European Union started to use "smart" to qualify sustainability projects and actions in the urban space [24].

About papers labeled "Digital City", they have been rapidly increasing from 1997 until 2009. In this time frame, "Digital City" is always more used respect to "Smart City". Instead, after 2009, papers labeled Smart City have begun to exceed respect to Digital City papers. In this context, the author identifies two main events influencing the high interest in Digital City topic, in year 1994 and 2000.

1. *1994*, in this year Digital City Amsterdam was born. Amsterdam is the first Digital City in the Netherlands and in Europe. Nowadays, "it is usually taken as example of a successful project in that field" [25]. A major part of its success depends on the use of a virtual *metaphor of city*, because "the use of appropriate navigation metaphors can help to make the structure of modern information systems easier to understand and therefore easier to use" [26]. From this success, other cities tried to repeat the Amsterdam experiment contributing to spread the metaphor of "Digital City".

2. *2000*, this year was characterized by a large widespread of the *Internet* in everyday life and by *ICT* diffusion among citizens [17, 18]. In this context, the author believes that the newness of topic, the accessibility and affordability of the Internet and digital devices fostered the increase of papers labeled "Digital City". In these years, there were several studies about Digital City definition: some researchers affirmed that a Digital City is a wired-city [3]; while others affirmed that it is a virtual reconstruction of city [13]; but the most famous Digital City definition is by Ishida in his study about Kyoto Digital City, in which he defines Digital City as "an arena in which people can interact and share knowledge, experiences, and mutual interests" [20]. Ishida's studies have been very important for the development of Digital City topic, because they have paid attention to how a city could summarize different aspects (such as data and information, e-services, etc.) of urban everyday life on the Internet in order to facilitate people in their decisions-making process. Moreover, the Digital City idea is strictly linked with the use of ICT in public administrations and with the e-Government practices, regarding both central governments and also local governments such as municipalities and city councils and administrations. Adopting an e-Government policy a city starts a transformation path towards a digital city.

About papers labeled "Smart City", they had a flat growth until 2010. The author identifies three dates which characterized the most important increase of Smart City papers: 2005, 2007, 2010.

1. *2005*, after 2005 Smart City papers increased little by little year by year. The author identifies the reason of this growth starting point in the *entered in force of Kyoto Protocol*, which is already explained in the previous paragraph.
2. *2007*, Apple Ltd. launched the i-phone, the first *smart phone* and, from this moment, the use of smart devices has been spreading more and more in everyday life. The adjective "smart" identifies devices that combine telephony and computing: smart phone have high-speed data access by Wi-Fi and mobile broadband in order to supply in real-time digital services to their users and, at the same time, to improve their quality of life [27]. So, the success of word "smart" in mobile context could have influenced the adjective "smart" in urban city context; in this case, the smart label identifies a digital device and more generally the building of a digital urban arena, rather than the definition of smart strategies, and it contributes to overlap smart and digital meanings of innovative urban policies;
3. *2010*, papers labeled "Smart City" shows a huge hike till 2012. This strong excess of Smart City papers respect to Digital City ones could be caused by the *Europe 2020 Strategy* approved by European Commission (this issue was analyzed in the previous paragraph). Indeed, Europe 2020 Strategy have widespread the Smart City label in terms of urban space sustainability to the detriment of Digital City label, because the Europe 2020 Strategy focuses its attention on environment safeguard, sustainability and social issues [22].

Therefore, this terminology analysis regarding Smart City papers and Digital City ones highlights the evolution of these two topics:

- both Smart City and Digital City research fields start to develop in the Nineties, however Digital City has been gaining a steady interest for twenty years, while Smart City has a very low number of papers till 2009 and an exponential increasing from 2010 till now;
- the time trends of researches about both these topics are strongly influenced by external drivers, such as technological drivers like the Internet diffusion or the smart devices use, or political drivers such as the Kyoto protocol and the EU 2020 strategy;
- the different time trends regarding these two topics and the different drivers they are influenced by, shows to us that even if Smart City and Digital City are often used like synonymous, they are quite different. Their main differences regards:
  - their contents: the Digital City regards the use of ICT in urban areas, the Smart City regards the attention to be paid to the environmental quality in cities;
  - their nature and relationship with the government: Digital City is a free trend emerging from the daily use of smart and digital devices by citizens, and it incites the local governments to supply e-services, that is, to gradually transform the city into a Digital City; Smart City is a political trend, driven by international institutions, to implement adequate initiatives to improve the environmental quality in cities.

3.3 Definition Analysis

The purpose of the definition analysis is to compare the most cited definitions of Smart City and Digital City, to understand which are the main similarities and the differences between these two concepts, often overlapped or confused.

To accomplish with this goal, the 705 papers stored in the LRS-DB have been organized by the citation number and by the paper focus. Afterwards, the author analyzes and compares the most recurrent and validated definitions of Smart City and Digital City respectively in Tables 3 and 4. Each table discloses the definition and the reference, putting in evidence some words to extract the meaning of these concepts: the bold character is used to outline the human component of Smart/Digital City; while the italic character is used to outline the applied technologies.

The comparison of these definitions helps us to create a sound relationship between these two topics and to understand if and which are the links between these two different urban strategies.

If we consider the human aspect, both the topics refer to people or citizens. 7 out of 9 Smart City definitions regards citizens or people; several definitions explicitly refer to their quality of life in city. Some definitions recall the role of public

Table 3 Most cited definitions of smart city

Definition	Reference
"A Smart City is a city well performing built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens"	Giffinger [37]
"A smart community is a community that has made a conscious effort to use *information technology* to transform life and work within its region in significant and fundamental rather than incremental ways"	California Institute [42]
"A city to be smart when investments in human and social capital and traditional (transport) and modern (*ICT*) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance"	Caragliu et al. [1]
"Smart city is defined by IBM as the use of *information and communication technology* to sense, analyze and integrate the key information of core systems in running cities"	IBM [6]
"Smart City is the product of *Digital City* combined with the *Internet of Things*"	Su et al. [8]
"Concept of a Smart City where citizens, objects, utilities, etc., connect in a seamless manner using *ubiquitous technologies*, so as to significantly enhance the living experience in 21st century urban environments"	Northstream [47]
"A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, *communications*, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens"	Hall [36]
"Smart City is a city in which it can combine *technologies* as diverse as water recycling, advanced energy grids and mobile communications in order to reduce environmental impact and to offer its citizens better lives"	Setis-Eu [48]
"A smart city is a well-defined geographical area, in which high technologies such as *ICT*, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development"	Dameri [7]

and private services in improving the quality of life; only 4 out of 9 definitions explicitly recall the importance of the environmental impact of urban activities, the concept of better natural resources management or sustainable economic growth. Therefore, in the academic milieu, the idea of Smart City is not so focused on environmental goals, like it happens applying the EU definition; however, in empirical implementations, cities are ever more applying the EU definition, driven by the aim to obtain public funding to realize their own projects for better cities. Instead, in the academic definitions the quality of life is linked with the quality of people and community, depending on the cultural level, the data information and knowledge sharing, but also some other aspects of community life, for example awareness or consciousness, human capital, communication between people and so on.

Table 4 Most cited definitions of digital city

Definition	Reference
"A digital city is substantively an open, complex and adaptive system based on computer network and urban information resources, which forms a *virtual digital space* for a city. It creates an information service marketplace and information resource deployment center"	Qi et al. [49]
"A Digital City has at least two plausible meanings: (1) a city that is being transformed or re-oriented through *digital technology* and (2) a *digital representation* or reflection of some aspects of an actual or imagined city"	Schuler [11]
"The concept of Digital City is to build an arena in which people in regional communities can interact and share knowledge, experiences, and mutual interests. Digital City integrates urban information (both achievable and real time) and create public spaces in the *Internet* for people living/visiting the city"	Ishida [20]
"Digital city denotes an area that combines broadband communication infrastructure with flexible, service-oriented computing systems. These new *digital infrastructures* seek to ensure better services for citizens, consumers and business in a specific area"	Komninos [50]
"The term Digital City (a.k.a., digital community, information city and e-city) refers to: a connected community that combines 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. The goal of a Digital City is to create an environment for information sharing, collaboration, interoperability & seamless experience for all its inhabitants anywhere in the city"	Yovanof et al. [51]
"Digital City does not refer to a specific urban entity or formal communications mechanism, but it refers to a functional approach which describes four interdependent action types: Digital City supports data and information related to a city in digital format; Digital City supports a *communication infrastructure* (physical or virtual means for enabling information flows); Digital City delivers value added information and innovative services (these are likely to synthesize data from a range of sources, be location based and may include analytical interfaces); Digital City uses *virtual environments* in planning, decision-making and analysis (when data collected by citizens are used in the process of modeling or digitally recorded citizen behavior is influenced by formal planning an analysis a feedback loop is completed)"	Schiewe et al. [13], Dykes [52]

In Digital City definitions, people or citizens are cited, but their role is less proactive. Also the idea of improving the citizens' quality of life is not explicitly enounced in Digital City definitions. Instead, it appears crucial the virtualization process, that is, the transformation of a material city into a virtual city, able to create a new intangible urban dimension where people, relationships and services are virtually joined and shared to build a smarter community.

This different approach probably derives from the different role of the ICT in these two city ideas. The Digital City is obviously based on ICT: the ICT is the core component of a Digital City and all the other aspects—citizens, services, communities, relationships, communications, information and knowledge, human and social capital—are joined through the technology. Also the Smart City has the ICT like an important element: 7 out of 9 definitions explicitly or not recall the ICT, or the Internet, or similar concepts. Reading the Smart City definitions, it emerges that the ICT is ever an important element characterizing the Smart City, but not the only one, instead together with other aspects.

Examining the time distribution of the Smart City and Digital City definitions, it emerges also that the Smart City definitions are more recent respect to the Digital City ones: 6 out of 9 are after 2010, whereas only 3 out of 6 Digital City definitions are after 2010. We can argue that the Smart City concept somewhat includes the Digital City idea, that is, the present concept of Smart City actually is a merge of both the environmental requirements of a smart city with the digital requirements and attitudes.

This latest evidence contradicts the idea of two different contents in Smart City and Digital City; indeed, the Smart City has born from three different sources: the EU source, focusing on the environmental requirements; the digital source, based on the previous experiences of Digital Cities; and the cultural source, that is, the human and social capital able to build the smart community.

For these reasons, the Smart City definition analysis discloses a wide range of meanings associated with a smart city, including environmental, social and digital components.

3.4 Typology Analysis: Theoretical Versus Empirical

The purpose of the typology analysis is to separate theoretical papers respect to empirical papers and to count them during the time frame regarding the latest twenty years (1993–2012). The reason of this type of examination is to understand if Smart City and Digital City are mainly academic ideas, built on theoretical basis, or if they emerges from concrete implementations in cities, and which is the relationship between theoretical studies and empirical implementations. This analysis, moreover, aims also to investigate if Smart City and Digital City are top-down phenomena or bottom-up ones. For example, analyzing the Amsterdam Digital City case, one of the most successful in Europe and recognized like a pilot case, it emerges that it has been a bottom-up phenomenon, grown from the free use of the Internet by citizens to share their opinion before the local elections. On the contrary, the further experience of Amsterdam Smart City appears like a top-down project, where the Municipality of Amsterdam assumes the leading role to implement several smart initiatives in the urban area. To investigate about the distribution in time of both theoretical and empirical papers helps us to better understand the Smart/Digital City phenomenon and its origin.

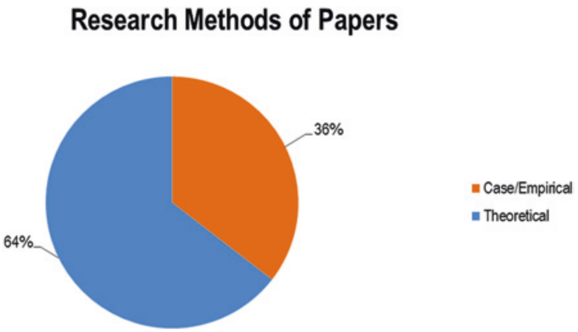


Fig. 4 Typology analysis: research methods of papers

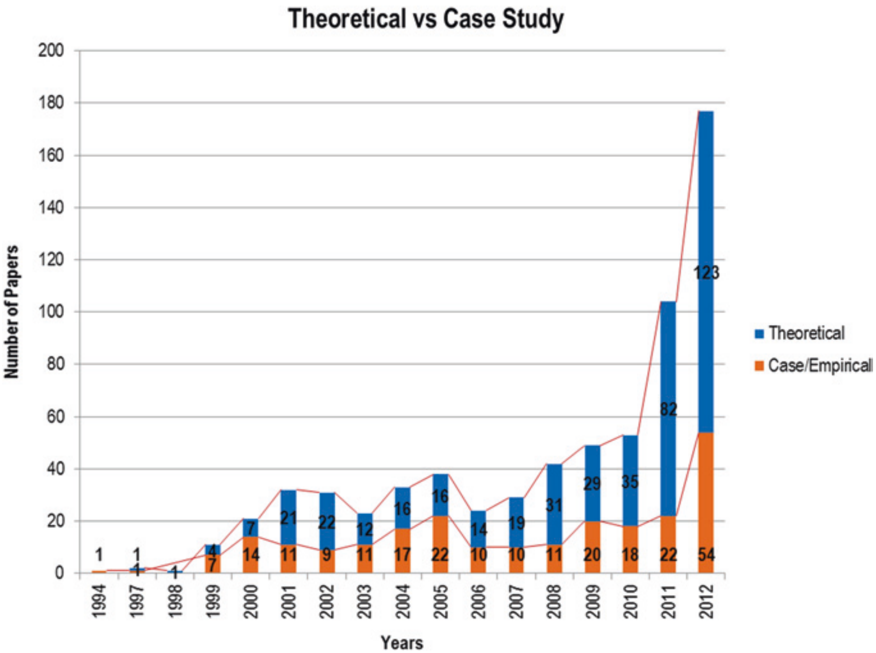


Fig. 5 Typology analysis: theoretical versus case study papers

To accomplish with these objectives, the 705 papers stored in the LRS-DB have been organized and counted by chronological order of publication and by the label “theoretical study” or “empirical study” according to the research method highlighted in the abstract. The share of each research method used in stored papers is shown in Fig. 4; while the theoretical/empirical study time trend is represented in Fig. 5.

As the pie chart shows:

1. *theoretical studies* are 64 % of the reviewed papers. As defined by Wacker [28] in his study about theory research, this category includes papers regarding the following research methods: "conceptual definitions, domain limitations, relationship-building, and predictions". This kind of study is therefore the most adopted among researchers to conduct the study about Smart City and Digital City;
2. *case studies* (also known as empirical studies) are 36 % of the reviewed papers. This type of papers includes researches where "the methodology must use data from external organizations or businesses to test if relationships hold in the external world" [28]. This kind of study includes all papers which investigate on the Smart/Digital City phenomena within its real-life context, in order to verify the empirical applications of theoretical concepts [29]. In this literature review, the object of empirical studies are especially case studies regarding cities implementations and projects defined as smart or digital.

Figure 5 shows the use of different research methods during the time frame 1993–2012: in the first decade, empirical studies are almost always more than theoretical studies. Depending on this evidence, it is possible to argue that the first steps regarding Smart City and Digital City are empirical and therefore the diffusion process probably has been mainly bottom-up; cities or other agents started to implement smart or digital initiatives, without a comprehensive strategy or a leader driving the implementation of a common and shared strategy [30].

Analyzing only the empirical papers, we can note that the smart or digital label is chosen depending on some smart or digital characteristics of one or a group of empirical implementations or projects, without referring to a smart or digital strategic vision regarding the whole city. If we consider a comprehensive smart or a digital vision of the city applied to the empirical papers, we can observe three different contexts:

1. Smart City, when the city follows sustainable strategies through the innovative and sustainable use of its own natural resources;
2. Digital City, when the city follows digital policies aiming to supply e-services to the citizens through the use of technologies such as Web 2.0, Cloud Computing, Internet of Things, and so on [31];
3. Smart City based on Digital City, when the city follows sustainable strategies using technologies applied in Digital City. In this case, the Digital City represents the ICT component on which the Smart City strategy is based.

From the empirical case studies survey it emerges also the central role of technological, innovative solutions for the Smart/Digital City implementations. We can say that the Smart or Digital City development is largely based on the application of innovative technologies to urban projects. It can also explain why at the beginning a shared definition of Smart City has not been conceived: the smart or digital projects have been influenced from the technological innovation and its application to urban areas and themes. It means that the idea of a Smart or a Digital

City has been mainly technology driven, instead of policy driven. However, after several different technological applications have been implemented in cities, and each of them has been qualified as smart, to express a unique, universal Smart City definition has become very difficult. The origin of smart implementations explains therefore why a shared definition of Smart City still lacks.

3.5 Geographic Analysis

The aims of geographic analysis is to discover where all over the world Smart City and Digital City strategies and projects have been more implemented, evidencing geographical areas more interested in smart themes and cities that are considered pilot cases worldwide.

To accomplish with these objectives, each of the 705 papers stored in the LRS-DB has been labeled by the city it refers to, according to the abstract of paper, and each city has been assigned to a continent. In this way, the subset of 705 papers has been analyzed only considering the empirical studies of Smart/Digital City, for a total of 162 case studies. Table 5 shows the relationship between cities and continents. Then the papers have been organized and counted by "empirical study" label and by the "continent". The geographical distribution of Smart/Digital Cities all over the world is shown in Figs. 6 and 7: the first graphic shows a pie chart counting the number of Smart/Digital Cities for each continent; the second one shows a bubble chart about the Smart/Digital Cities geo-location in the world.

Moreover, to better understand Fig. 7, we can see Table 5 depicting the list of Smart/Digital Cities per Continent and per Country.

The geographic analysis of Fig. 6 highlights that:

1. *Asia* is the continent where there is the highest number of Smart/Digital Cities with 49 % of reviewed papers;
2. *Europe,* after Asia, is the continent where there is a relevant number of Smart/Digital Cities with 36 % of reviewed papers;
3. *North America*, is the third continent in terms of Smart/Digital Cities with 9 % of reviewed papers;
4. *Oceania*, *Africa* and *Middle/South America,* are the continents in which there are the lowest number of Smart/Digital Cities, with respectively 3, 2 and 1 % of reviewed papers.

Figure 7 shows the Smart/Digital Cities position in the world, in order to detect if and where they form some clusters. From the exam of the above bubble chart, different aspects emerge:

- there are macro-clusters of Smart/Digital Cities both in *Asia* and in *Europe*. If we compare this two clusters depending on their extension, we can say that Asia presents a greater cities dispersion than Europe; while Europe highlights a greater cities concentration. In Asia we observe the greatest Smart or Digital

Table 5 List of smart/digital cities geo-location in the world on the basis of 162 case studies analyzed

Continent	Cities
Asia	Amman (Giordania), Bangladesh Region (Bangladesh), Beijing (China), Caofeidian island area (China), Changzhu (China), Chengdu (China), Cheongna (Korea), Dongying (China), Dubai (Emirates), Guangdong (China), Guangzhou (China), Guiyang (China), Hangzhou (China), Harbin (China), Heilongjiang (China), Hong Kong (China), Huizhou China), Jiangan (China), Kochi (India), Kuwait Region (Kuwait), Kyoto (Japan), Lianyuangang (China), Lijiang City (China), Linyi (China), Macao (China), Masdar City (Emirates), Panzhihua (China), Pudong (China), Qianjiang City (China), Seoul (Korea), Shanghai (China), Shenzhen (China), Singapore (China), Subang Jaya (Malaysia), Taipei (Taiwan), Tang Chang'An City (China), Tokyio (Japan), Wuhan (China), Xiamen City (China), Zhengzhou (China)
Europa	Amsterdam (Netherlands), Anpwerp (Belgium), Aveiro (Portugal), Barcelona (Spain), Beaufort (France), Berlin (Germany), Bilbao (Spain), Bologna (Italy), Bolzano (Italy), Bragança (Portugal), Bristol (UK), Como (Italy), Copenhagen (Denmark), Dubiln (Ireland), Fredrikstad (Norway), Genova (Italy), Ghent (Belgium), Helsinki (Finland), London (UK), Luxembourg (Luxembourg), Malta (UK), Manchester (UK), Marseilles (France), Milano (Italy), Nottingham (UK), Oulu (Finland), Parthenay (France), Trikala (Greece), Turin (Italy), Venice (Italy), Vienna (Austria), Vilnius (Lithuania)
North America	Charlotte (USA), Cleveland (USA), Edmonton (Canada), Iowa (USA), Montreal (Canada), New York (USA), Portland (USA), Quebec City (Canada), Saskatoon (Canada), Seattle (USA), Sudbury (Canada)
Oceania	Adelaide (Australia), Brisbane (Australia), Melbourne (Australia), Parramatta (Australia)
Middle/South America	Curitiba, Paranà (Brazil), Juarez (Mexico), Mexico City (Mexico), Nassau (Bahamas), Rio de Jainero (Brazil)

Cities concentration only in correspondence to the Chinese east coast; while European Smart/Digital Cities appear to be more concentrated in the North Sea Region (that is the Netherlands, Belgium, United Kingdom, Scandinavia) and in the Mediterranean Region (that is Spain, France, Italy);

- there is a little Smart/Digital Cities cluster also near the Great Lakes Region between United States and Canada (*North America*);
- in *Oceania* and in *Africa*, there are the smallest clusters observed and in both cases they are located along the most populated and developed areas: Australian east coast and South African coast.

The same results have been reached by the Ericsson Report about Networked Society City Index. This report shows that "cities located in Northern Europe, North America and parts of East Asia have a longer tradition of producing and using ICT equipment, and have therefore been able to benefit from their

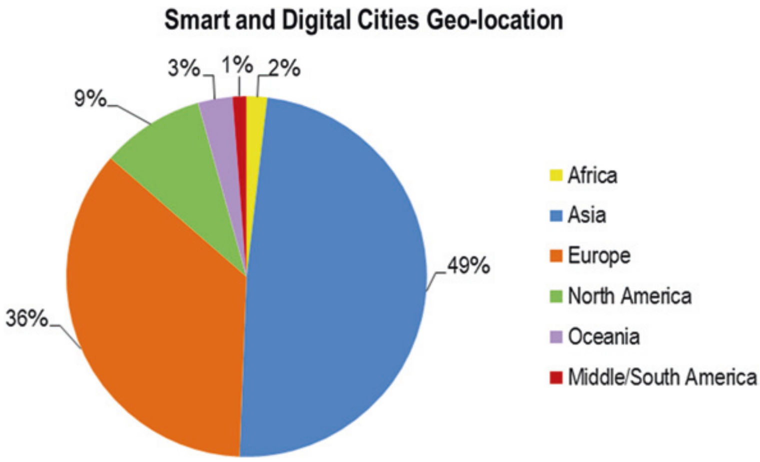


Fig. 6 Geography analysis: smart/digital cities geo-location (per continent) on the basis of 162 case studies analyzed

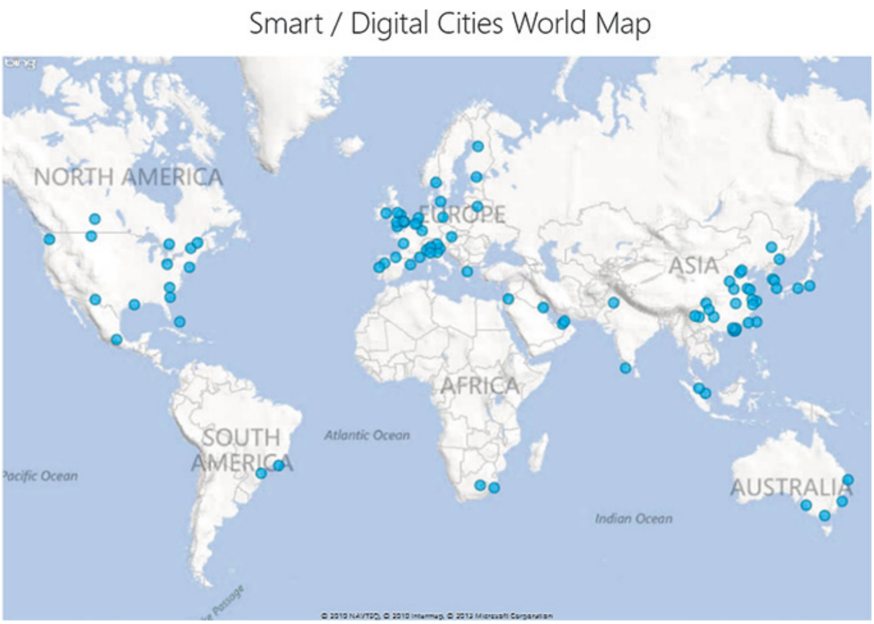


Fig. 7 Geography analysis: smart/digital cities geo-location in the world on the basis of 162 case studies analyzed

investments over longer periods of time" [32]. Indeed, from the literature review about city case studies, we can observe that the spread of Smart/Digital Cities in Asia, Europe and North America have some shared features:

1. the widespread and development of ICT infrastructures, considered like:
   - Internet diffusion among citizens in everyday life [17];
   - Internet more accessible and affordable for many people to reduce digital divide [33];
   - data sharing and open data;
   - increase the adoption of Community Network to supply e-government services (this aspect is more relevant especially among Smart/Digital Cities in Europe);
   - focuses on the use of ICTs for public administration;
   - to provide better public services and e-services also using Web 2.0 technology;
   - increase urban wealth [1];
   - increase innovation and entrepreneurship [32];
   - increase social cohesion;
2. the adoption of green policies for a smart growth, in order to:
   - reduce issues about urban crowding in terms of pollution reduction, improvement of urban planning, safety and sanitary conditions, power demand sustainable, and so on (these aspects is more relevant especially among Chinese Smart/Digital Cities);
   - reduce CO_2 emissions and greenhouse gases;
   - improve mobility services to reduce traffic congestion and then pollution;
   - achieve sustainable urban development and a better urban landscape [1].

Instead, Smart/Digital Cities in Middle/South America and Africa have in common the widespread and development of ICT infrastructures, but for other reasons in respect to Asia, Europe and North America. For example:

- to attract foreign investment promoting local advantage and to improve cultural, economic and social development [34];
- to enable service delivery and economic development;
- to enable the transition to a knowledge economy;
- to focus on ICT access in rural and periphery urban areas [35].

4 Conclusions

The large literature survey described in this work aims to clarify several aspects regarding the new, still immature strategies of Smart City and Digital City. Several goals have been reached thanks to this deep survey. We can summarize them respect to three large themes:

- Smart/Digital City definition;
- birth of Smart/Digital City ideas;
- diffusion of Smart/Digital City implementations.

Regarding the definition of both Smart City and Digital City, we can observe that a shared and acknowledged definition of both Smart City and Digital City still lacks. However, there are several most cited definitions and they are establishing themselves like standards (see for example Hall [36], Caragliu [1], Giffinger [37]). Digital City definitions show a higher uniformity, because all of them are focused on the key role of ICT in improving the quality of services and information supplied to citizens. Smart City definitions are more different each others, mainly because the purpose of a Smart City is often too large, that is, to improve the quality of urban life; depending on this goal, everything could be considered smart! However, deepening our analysis, we discover some shared features characterizing Smart Cities, that is, the role of innovation and technology, the environmental requirements, the economic and social development. Sometimes, especially during the latest years, also the use of ICT has been included into the Smart City perimeter; it means that the Digital City is becoming a subset of the Smart City.

Regarding the birth of Smart City and Digital City, both of them date back to twenty years ago environ. However, the Digital City has a development synchronized with the Internet diffusion, especially in everyday life and in e-government. This development has been quite stable during the latest twenty years, with some peaks around 2000. Smart City, on the contrary, had a very slow development till 2010, when the UE assumed the Smart City like one of its key development paths. From this year, papers and researches about this topic have a strong outburst.

It is interesting to note that the birth of both Smart City and Digital City has been mainly empirical, and only after sometime a theoretical research activity about these topics started to increase. Moreover, this empirical birth is also bottom-up, that is, it derives from the independent, free application of ICT or other innovative technologies to smart and digital aims, to improve the quality of life in cities. For this reason, Smart City and Digital City are often the result of a sum or collection of single initiatives, instead of the outcome of a well conceived strategy. Only the latest Smart City implementations show a new trend, towards a top-down path, where municipalities are assuming a leading role in defining and driving a comprehensive vision about the Smart or Digital City programs. Both Smart City and Digital City empirical implementations are strongly driven by the technology. ICT or engineering technologies are the real engine of the Smart/Digital projects, even if different are their application fields: information sharing, communication and citizens involvement for Digital City projects, environmental safeguard, pollution reduction and infrastructure quality for Smart City projects.

Also the diffusion of SmartCity and Digital City is largely driver from the technological progress. Indeed, the presence of Smart Cities or Digital Cities among the continents is higher where higher is the economic and scientific development of a country. Obviously, a strong driver for a Smart/Digital City implementation is the city dimension: indeed, the larger is the city, the worse is its environmental impact, to be reduced thanks to Smart City programs; the larger is the city, the better are the benefits deriving from data and knowledge sharing and e-services supply, to be taken thanks to Digital City programs [38].

Finally, we can say that the Smart City and Digital City phenomena are strongly spreading both in theoretical researches and in empirical implementations. Sometimes it is the result of a support from national or international governments, institutions or political bodies, such as the EU, that also finances Smart City projects in Europe; but more frequently it is the result of a new, innovative idea about city and urban life: more pleasant, more inclusive, greener and cleaner. The Smart City is nowadays seen like a key strategy to improve the quality of life of billions of people living in cities all over the world.

References

1. Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82.
2. Pardo, T., & Taewoo, N. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. *Proceedings of the 12th Annual International Conference on Digital Government Research* (pp. 282–291). New York: ACM.
3. Hollands, R. G. (2008). Will the real smart city please stand up? *City: Analysis of Urban Trend, Culture, Theory, Policy, Action, 12*(3), 303–320.
4. vom Brocke, J., Simons, A., Niehaves, B., Plattfaut, R., & Cleven, A. (2009). Reconstructing the giant: on the importance of rigour in documenting the literature search process. *ECIS 17th European Conference on Information Systems* (pp. 2–13).
5. Cooper, H. M. (1988). Organizing knowledge syntheses: a taxonomy of literature review. *Knowledge Society*, *1*, 104–126.
6. IBM (2010). *Smarter thinking for a smarter planet*.
7. Dameri, R. P. (2013). Searching for smart city definition: a comprehensive proposal. *International Journal of Computers & Technology*, *11*(5), 2544–2551(Council for Innovative Research).
8. Su, K., Li, J., & Fu, H. (2011). Smart city and the applications. *IEEE International Conference on Electronics, Communications and Control* (*ICECC*), pp. 1028–1031(IEEE Xplore).
9. Pardo, T. A., & Nam, T. (2011). Smart city as urban innovation: focusing on management, policy and context. *Proceeding of the 5th International Conference on theory and Practice of Electronic Governance* (pp. 185–194). New York: ACM.
10. Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Pardo, T. A., & Scholl, H. J. (2012). Understanding smart cities: an integrative framework. *45th Hawaii International Conference on System Sciences* (pp. 2289–2297). IEEE Xplore.
11. Schuler, D. (2002). Digital cities and digital citizens. In: M. Tanabe, P. van den Besselaar, T. Ishida (Eds.), *Digital cities II: computational and sociological approaches*. LNCS, vol. 2362, (pp. 71–85). Berlin: Springer.
12. Schuurman, D., Baccarne, B., De Marez, L., & Mechant, P. (2012). Smart ideas for smart cities: investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. *Journal of Theoretical and Applied Electronic Commerce Research, 7*(3), 49–62. (Universidad de Talca, Chile).
13. Schiewe, J., Krek, A., Peters, I., Sternberg, H., & Traub, K. P. (2008) HCU research group "Digital City": developing and evaluating tools for urban research. In: Ehlers et al. (Eds.) *Digital earth summit on geoinformatics*.
14. Moutinho, J. L. (2008). Building the information society in Portugal: lessons from the digital cities programm 1998–2000. In van Geenhuizen (Eds.), *Value-added partnering and innovation in a changing world*.
15. Ricciardi, F. (2010). ICTs in an ageing society: an overview of emerging research streams. In A. D'Atri, M. De Marco, A. M. Braccini, F. Cabiddu (Eds.), *Management of the interconnected world*. ITAIS, vol. 1, (pp. 37–44). Berlin: Springer.

16. Cosgrove, S. (2009). The United Nations framework convention on climate change. *15th Conference of the Parties—The Copenhagen Protocol*. Background Paper, AMUNC.
17. Ishida, T. (2000). Understanding digital cities. In: T. Ishida, K. Isbister (Eds.), *Digital cities*. LNCS, vol. 1765, (pp. 7–17). Berlin: Springer.
18. Schaffers, H., Ratti, C., & Komninos N. (2012). Special issue on smart applications for smart cities—new approaches to innovation: guest editors' introduction. *Journal of Theoretical and Applied Electronic Commerce Research*, *7*(3). (Universidad de Talca, Chile).
19. Ishida, T., & Hiramotsu K. (2001). An augmented web space for digital cities. *Proceedings of Symposium on Applications and the Internet* (pp. 105–112).
20. Sorrentino, M., & Simonetta, M. (2013). Incentivising inter-municipal collaboration: the Lombard experience. *Journal of Management and Governance, 17*(4), 887–906.
21. Dameri, R. P. (2012). Defining an evaluation framework for digital cities implementation. *IEEE International Conference on Information Society* (i-Society), (pp. 466-470). IEEE Xplore.
22. Europe 2020 Strategy. from ec.europa.eu/regional_policy/what/europe2020/index_en.cfm.
23. ABB Report (2012). Smart cities in Italia: un'opportunità nello spirito del Rinascimento per una nuova qualità della vita. Technical Report, ABB.
24. Al-Hader, M., & Rodzi A. (2009). The smart city infrastructure development and monitoring. *Theoretical and Empirical Researchers in Urban Management*, *2*(11).
25. van Bastelaer, B., & Lobet-Maris C. (1998). Social learning regarding multimedia developments at a local level. The case of digital cities. In B. van Bastelaer, C. Lobet-Maris (Eds.), *SLIM research—DG XII—TSER program. Final integrated study—Social learning in the public sector*, University of Namur.
26. Dieberger, A., & Frank, A. U. (1998). A city metaphor to support navigation in complex information spaces. *Journal of Visual Languages & Computing, 9*(6), 597–622. (Elsevier).
27. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). *Smart cities. Ranking of European medium-sized cities*. Vienna: University of Technology.
28. Wacker, J. G. (1998). A definition of theory: research guidelines for different theory-building research methods in operations management. *Journal of Operations Management, 16*, 361–385. (Elsevier).
29. Yin, R. K. (2003). *Case study research. Design and methods*. California: SAGE Publications.
30. Casalino, N., Buonocuore, F., Rossignoli, C., & Ricciardi F. (2013). Transparency, openness and knowledge sharing for rebuilding and strengthening government institutions. *IASTED Multiconferences—Proceedings of the IASTED International Conference on Web-Based Education*, (pp. 866–871). WBE.
31. Anthopoulos, L., & Tougountzoglou T. E. (2012). A viability model for digital cities: economic and acceptability factors. In: C. Reddick, S. Aikins (Eds.), *Web 2.0 technologies and democratic governance*. PAIT, vol. 1, (pp. 79–96). Berlin: Springer.
32. Ericcson Report (2012). Networked society city index—Part III: triple bottom line benefits for city business. Technical report, Ericsson.
33. Partridge, H., Hall, H., McAllister, L., & Hallam G. (2005). Effecting social change in the "Smart City": the west end connect community project. *Conference on the Social Change in the 21st Century. Centre for Social Change Research*, Queensland University of Technology.
34. Anci Cittalia (2011). Smart Cities nel Mondo. Technical report, Fondazione Anci Ricerche.
35. Odendaal, N. (2007). Towards the digital city in South Africa: issues and constraints. *Journal of Urban Technology*, *13*(3), 29–48. (Routledge).
36. Hall, P. (2000). Creative cities and economic development. *Urban Studies, 37*(4), 633–649.
37. OECD (2011). M-Government. Mobile technologies for responsive government and connected societies. Technical report, OECD Publishing.
38. ZArdini, A., Mola, L., Vom Brocke, J., & Rossignoli, C. (2010). The role of ECM and its contribution in decision-making processes. *Journal of Decision Systems*, *19*(4), 389–406.
39. Anthopoulos, L., & Fitsilis, P. (2010). From digital to ubiquitous cities: defining a common architecture for urban development. *IEEE 6th International conference on Intelligent Environments*, (pp. 301–306). IEEE Xplore.

40. Komninos, N. (2006). The architecture of intelligent cities: integrating human, collective and artificial intelligence to enhance knowledge and innovation. *IEEE 2nd IET International Conference on Intelligent Environments* (pp. 13–20). IEEE Xplore.
41. Couclelis, H. (2004). The construction of the digital city. *Planning and Design, 31*(1), 5–19 (Environment and Planning).
42. California Institute (2001), http://smartcommunities.org/concept.php.
43. Ergazakis, M., Metaxiotis, M., & Psarras, J. (2004). Towards knowledge cities: conceptual analysis and success stories. *Journal of Knowledge Management*, *8*(5), 5–15 (Emerald Group Publishing Limited).
44. OECD Observed (1999). Learning cities: the new recipe in regional development.
45. Batagan, L. (2011). Smart cities and sustainability models. *Revista de Informatica Economica, 15*(3), 80–87.
46. OECD: Green Cities Programme (2010). http://www.oecd.org/gov/regional-policy/49318965.pdf.
47. Northstream (2010). White paper on revenue opportunities, from http://northstream.se/white-paper/archive.
48. Setis-Eu (2012). setis.ec.europa.eu/implementation/technology-roadmap/European-initiative-on-smart-cities.
49. Qi, L., & Shaofu, L. (2001). Research on digital city framework architecture. *IEEE International Conferences on Info-Tech and Info-Net*, vol. 1, (pp. 30–36). Proceedings ICII.
50. Komninos, N. (2008). *Intelligent cities and globalization of innovation networks*. Lomdon: Routledge.
51. Yovanof, G. S., & Hazapis G. N. (2009). An architectural framework and enabling wireless technologies for digital cities and intelligent urban environments. *Wireless Personal Communications*, *49*(3), 445–463. (Springer).
52. Dykes, J. (2010). GeoVisualization and the digital city. *Computers, Environment and Urban Systems*, *34*, 443–451. (Elsevier).

Comparing Smart and Digital City: Initiatives and Strategies in Amsterdam and Genoa. Are They Digital and/or Smart?

Renata Paola Dameri

Abstract The objective of this research is to investigate the relations between Smart city and Digital city concepts and strategies. The author examines the international literature about these topics, comparing smart city and digital city definitions, components and goals. This survey shows that a clear definition of both smart city and digital city still lacks and that these two topics are often overlapped or confused. The same thing happens in empirical implementation of smart and/or digital strategies in cities. The research methodology includes the study and comparison of two important empirical implementations of Smart/Digital strategies in Europe: Amsterdam and Genoa. The results show that smart city and digital city are not the same, even if they are strictly linked each other and sometimes merged in common initiatives. Moreover, this empirical research highlights the key role of players, programs and governance in realizing smart/digital cities really effective for a best quality of life in the urban space.

Keywords Smart city • Digital city • Digital agenda • Case study

1 Introduction

The concepts of smart city and digital city are in the mood, however they are not clearly defined till now and several aspects of these two concepts are overlapping each other [1–3].

At present, several cities all around the world define themselves like smart city, but this definition is far from to be well stated. Indeed, these cities use the word smart to name a wide strategy, including a large spectrum of heterogeneous

R. P. Dameri (✉)
Department of Economics, University of Genoa, Genoa, Italy
e-mail: dameri@economia.unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_3,

initiatives involving several different technologies. A comprehensive vision of the smart city strategy lacks, so as a roadmap to implement it or a set of performance indicators to evaluate the success or failure of smart initiatives.

In the meantime, cities are also committed to create an ICT infrastructure to support big data collection and processing, communications between citizens and institutions, digital private and public services, and so on. EU, several national governments and cities themselves have their own digital agenda to be implemented and are becoming therefore digital cities [4, 5].

This panorama is quite confused and it impacts on the quality and effectiveness of public and private programs, to reach measurable and useful results by smart and digital city initiatives. To better drive city strategies, choices, investments, a clear definition of smart city and digital city is necessary, able both to understand these important phenomena and to support strategic decisions [6, 7].

This chapter aims to reach a definition of both smart city and digital city by comparing two smart city case studies: Amsterdam and Genoa. Amsterdam is the first European city launching a smart program. Genoa is the city leader in winning funding at the latest EU call for smart initiatives proposal. What are they doing? Which are they goals? Who are the main actors and stakeholders involved in the smart and/or digital city programs? The empirical study of the projects portfolio in Amsterdam and in Genoa is the instrument to understand their strategy and the meaning of the words smart and digital. Contents, goals and actors are examined, compared and evaluated, towards a theoretical definition of smart city and digital city supported by the empirical evidence of two case studies leader in Europe.

2 Smart City and Digital City

2.1 Why?

During the latest years, population in cities has been growing faster and faster. At present, 53 % of world population lives in cities, that occupy environ 2 % of the global space on the earth [8]. By 2050, 70 % of population will live in cities. This phenomenon is continuously increasing, and it is spread all over the five continents, even if some countries in particular could have a dramatic augment in urban population during the next 20 years: China, South Korea, Mexico, Brazil and several African countries [9]. Today's urban population is 3.3 billion and by UN calculations it is expected to double by 2050. It means that two out of every three people will live in city in 2050. In Fig. 1, we can see the world situation of urban density and population. There are 24 cities over 10 million inhabitants; several countries—have more that 75 % of population in cities, and many others are predominantly urban too, with more that 50 % of people living in the metropolitan areas.

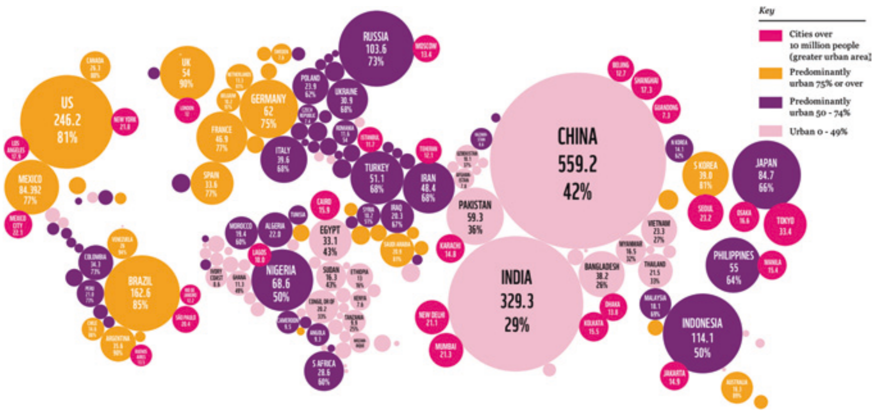


Fig. 1 The number of people living in cities in each country of the world in 2010, together with the percentage of the population in countries with large urban populations

This phenomenon regards not only large cities, but also the medium ones and all the countries in the world. Seeing as megacities such as New York, London, Beijing, Mumbai, and Mexico City can only grow so much, most of the urban growth will take place in smaller cities. The WWF predicts that the highest growth rate of 4.19 % will occur in cities with fewer than one million residents. Cities with more than one million residents will grow at rates less than 2 %.

Whenever in the history, the city has been the crucial space where economic and cultural development has happened, and nowadays the post-industrial development is more and more concentrated in the urban space [10]. However, the larger and larger dimension of cities all over the world poses the dramatic problem of their management. Pollution, overpopulation, scarcity of natural resources and food, difficulties in supplying public and private services are only some of the urgent challenges to face.

These two aspects—the good and the bad one—of the urban life are at present the most interesting drivers for the development of a smart city strategy [11]. Indeed, we could consider that if the metropolitan dimension of a city is a problem to solve, on the other hand it is also able to produce attractiveness and humus for a better development. A smart city strategy can aim in the meantime both to face the negative aspects—the threats—and to empower the positive ones—the opportunities of the greater dimensions of a city (see Table 1).

Opportunities in city are given by universities where to study, companies and public bodies and organizations where to work, theatres, cinemas, libraries, concert halls and all the public spaces where to catch cultural opportunities and spend his own free time in leisure and sport; the city is obviously a place where to live and a formidable milieu where to meet people. In city ideas born, circulate, create initiatives and business; in city things happen… How many initiatives could be exploited and supported thanks to smart and/or digital strategies?

Table 1 City threats and opportunities

Opportunities	Threats
Living	Traffic
Studying	Pollution
Working	Poverty
Cultural opportunities	Energy consumption
Leasure	Resources scarcity
Meeting people	Social tension
…	…

However, the presence of people, organizations, business in the urban space is a threat for the daily life: inefficient local public transports, traffic, the high cost of houses and loans are some of the more diffused negative impacts of the population high density in cities. Pollution is a main characteristic of several large and medium cities, with low rate of green spaces; the buildings use a high quantity of energy, the environmental impact is strongly negative and the social differences, especially in large cities, create poverty and social tensions [12]. Could a smart/digital strategy make something against these problems?

It is time to try to develop an answer to face the situation, before it becomes too difficult to face. Somehow, somewhere, the idea to use the technology to support a better way of life in cities, especially in large metropolitan areas, begins to emerge [13]. The use of high technology to shape the urban skyline is driven by the potential of the technology to enforce new strategies, initiatives, projects and infrastructures aiming at improving the quality of life in urban space along different axes: a smart development trend, able to create much economic value thanks to the use of better informed and linked people and business [14]; a sustainable development trend, using technology to implement low carbon economy, resource efficiency, sustainable transport [15]; and an inclusive development trend, using especially information and communication technology (ICT) to create social inclusion, civil participation at the political debate, higher education and information quality [16].

The smart city idea therefore follows a bottom-up path, growing from single initiatives of business, non profit organizations, public bodies, local governments, universities, … aiming at using the technology to struggle against the menaces in large cities like pollution, energy shortage, water and air bad quality, poverty and social exclusion and to create opportunities for sustainable growth, green cities, shared information, social communication and a higher quality of life in the urban space [17].

The smart city concept often overlaps with the digital city idea [18, 19]. These two urban strategies are not the same, but in the meantime they are not so different each other. Both of them use the technology—especially the ICT—to improve the life quality in city, to create economic development, to save the environment. But they are different both in their history and in their present implementation, in goals and aims to be reached, in strategies and projects to be implemented [20]. However, no one of key subjects—governments, businesses, universities and the citizens their own—is aware about the real differences between smart and digital; a clear and sound definition of smart and digital city also lacks in the academic debate. But a well-conceived definition is necessary to drive choices and to increase the probabilities of success in a so difficult context. Therefore, on the next paragraph the author will introduce some different aspects characterizing smart and digital city concepts. Further in the chapter, the differences in smart and digital urban strategies will be searched in two success case histories, Amsterdam and Genoa, two of the smarter cities in Europe.

Finally, both the theoretical and the empirical investigation will support the conclusions, lessons learned and further work aims.

2.2 What Smart City and Digital City Are?

The smart city idea was born from the application of hi-tech solutions to urban problems, but especially from the use of ICT in connecting people, political institutions and business. This use of ICT is also at the basis of the digital city idea. For this reason, these two concepts are quite confused. Moreover, each city implementing a smart or a digital strategy defines itself like smart or digital, using this word in relation with its own initiatives and projects, without referring to a shared and recognized standard.

The literature survey shows that the topic is not so recent, because researchers started to study the ICT application to urban life several years ago, twenty environ. However, especially the Internet wave and the Web 2.0 technology have been the main drivers for the development of the digital city research topic.

One of the most interesting aspects regarding smart city and digital city is the use of heterogeneous terminology to define them. People often uses the same word to define different things, and in the same way different words are used to define the same thing.

Analyzing the international literature about this aspect, the following keyword definitions have been found, to be compared with the smart city definition explained above [21].

- Intelligent city. It is a city that has several competences, able to produce knowledge and to translate it into unique and distinctive abilities; it is also able to produce synergies from knowledge and competences mixed in an original way, difficult to imitate; this city is smart because it is able to create intellectual capital and to ground development and well-being on this intellectual capital [22].
- Digital city. It is a wired, digitalized city, using ICT both for data processing and for information sharing, but also to support communication and Web 2.0 democracy [23, 24].
- Sustainable city. It is a city that uses the technology to reduce CO_2 emissions, to produce clean energy, to improve the buildings efficiency; it aims to become a green city [25].

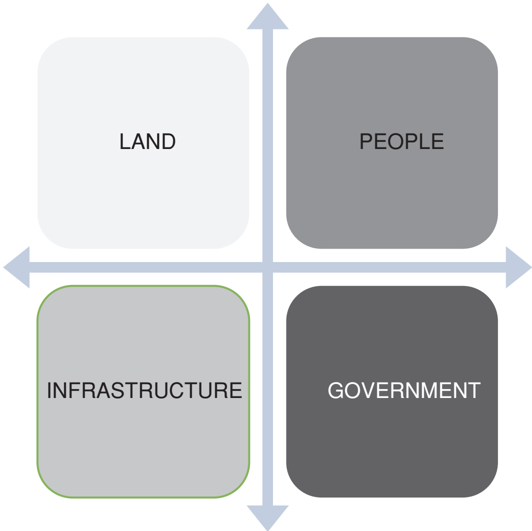


Fig. 2 The basic components of a city

- Technocity. It is a city that uses the technology to improve the efficiency and effectiveness of its infrastructures and services: it focuses its smart projects on urban space quality, mobility, public transports, logistic [26].
- Well-being city. It aims to produce the best quality of life for citizens, but also to create regional attractiveness both for people and for business. The technology is only a part of the instruments used to obtain these goals, but also culture, climate, history and monuments are considered important success factors [27].

Obviously, all these concepts are not in contradiction each other, as they share some aspects and are partially overlapping. But to consider all these aspects enlarges at maximum the concept of smart city, and it is misleading both to understand this concept and to compare it with the digital city concept. Too many definitions mean a lack of focus on the really important factors.

To face this complexity, it could be useful to start from the analysis of the concept of a city, especially identifying such components functional to support a smart or digital city implementation. As showed in Fig. 2, we will consider four basic elements to compose a city:

- **land**, that is, the territory on which the city is built, the geographical area on which the city has its own boundaries;
- **infrastructures**, that is, all the material or technological facilities supporting the urban life, such as public and private buildings, streets, transports, production sites, and so on;
- **people**, that is, the citizens living in the city, but also who works or studies in the city, or comes to visit the city or to enjoy there some cultural or leisure facilities;
- **government**, that is, the public powers to govern the city and the public administrative agencies to manage and supply public services.

Also in the city tout court, all these components are not so well-defined.

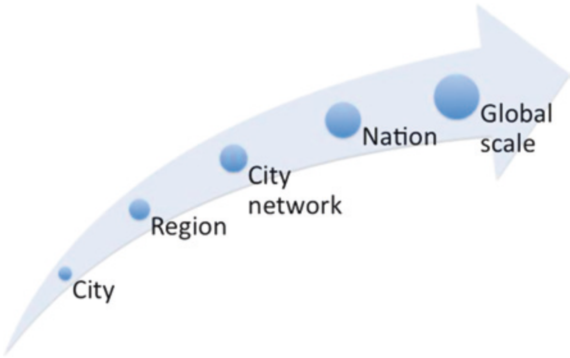


Fig. 3 The territorial dimension of city and urban policies [28]

Regarding the **land**, the territorial dimension not ever corresponds to the administrative boundaries of a city. Sometimes, a city extends its role of economic and social attractiveness well beyond its administrative boundaries. OECD is developing a new way to define metropolitan areas, using a methodology based on the economic function of the city, rather than its administrative boundaries [29]. Also the political aspect is important; in Italy a deep reform of administrative metropolitan areas is underway, extending the administrative boundaries of large cities to the metropolitan area interested by common public services and characterized by high population density and working fluxes from the neighborhoods to the city centre [30]. Sometimes cities link together to create city networks, to share best practices and face together deep urban problems; and not ever these cities are contiguous, but perhaps they are similar in their own characteristics.

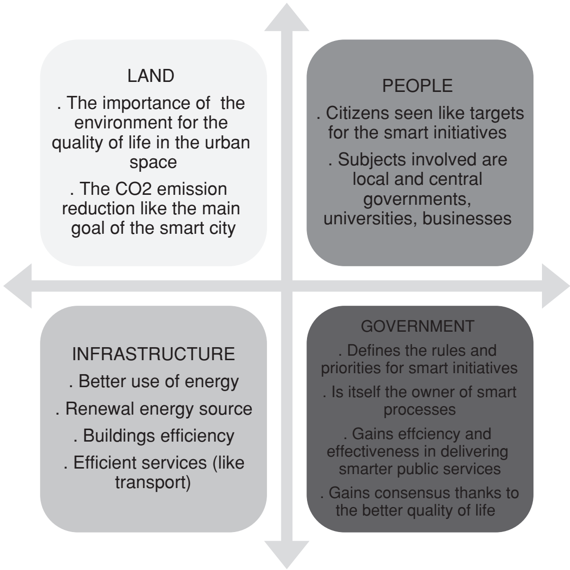
Infrastructures are one of the most important aspects of the quality in urban space. Private and public buildings, and their quality, create the urban skyline and define the city character. Streets, traffic and public transports heavily impact on the quality of urban life, but infrastructures also have an important role in the quality of urban environment. Buildings and transports consume energy and produce pollution; they play a double role, both positive and negative, on the quality of their city.

Regarding **people**, it is too simple to include in the city perimeter only who resides in the city. Cities are daily interested by fluxes of workers and students living in the neighborhoods and reaching their own work place or school or university. Moreover, cities are visited by travelers for work or tourism.

About **government**, urban policies are defined not only at urban level, but also at the regional, or national or global level; therefore the urban area and its form are fuzzy and they change depending on the topic, the action, the project, … In Fig. 3 the different levels of urban policies and government are showed. They go from the local dimension, to regional, network, national and finally the global dimension.

Therefore, all the basic components of a city could be seen both from the positive and from the negative side, considering their impact on the urban quality of life; the city dimensions could be the main driver of both a city success and its problems. How smart city and digital city strategies could help to face and solve these problems, but also to highlight the good resources of a city? In the following

Fig. 4 The basic components of the smart city



paragraphs the basic components of a city are examined considering smart city and digital city strategies, to explore the achievable goals to improve the quality of life in the urban space.

2.3 Smart City

The smart city idea has born in the nineties, but only recently it has become a current topic. Two are the main reasons: the use of the word smart to indicate the so-called smart devices like smart phones, tablets, and so on; and the impulse of the EU to implement smart cities, conceived like low emissions cities, with the main aim to reduce CO_2 emissions.

Therefore, the idea of smart city is mainly focused on the use of high technologies to improve the quality of urban infrastructures and to reduce their environmental impact in the metropolitan area. Indeed, the EU impulse is so strong to overcome all the previous academic visions, based more on knowledge and human capital in city, than on the environmental aspects. Depending on the EU vision, the basic components of the smart city are introduced in Fig. 4.

The **land** component is mainly considered looking at its environmental dimension. Pollution, traffic, waste and energy consumption are important aspects of the daily urban life, they have a high cost for both the citizens and the public administration, they are able to differentiate nice, clean, livable cities from dirty and unlivable ones. The CO_2 emissions in the urban areas are under the main attention of governments at the global level (see the Kyoto protocol) and the EU strategy for

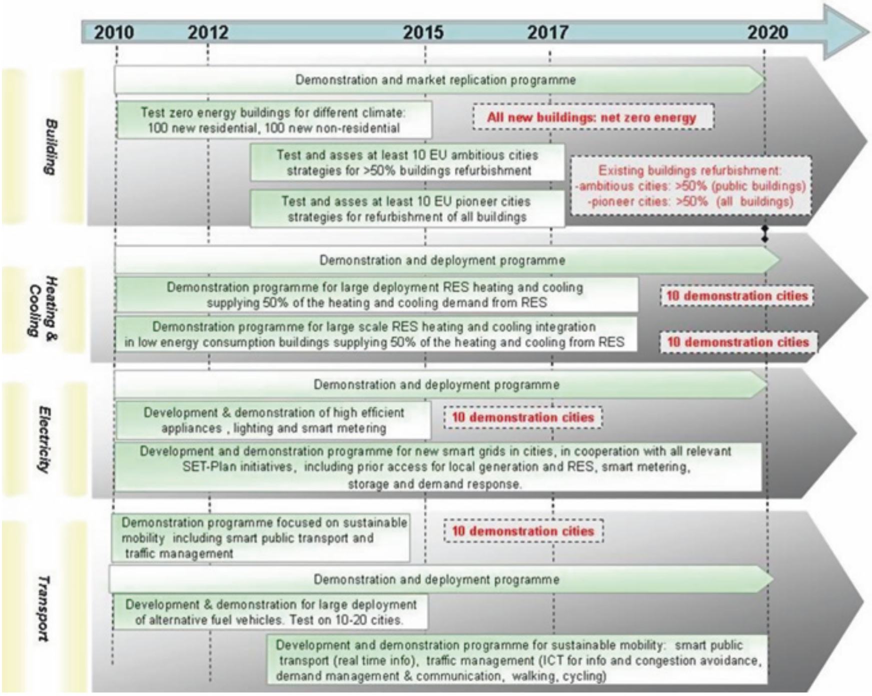


Fig. 5 The EU-SETIS plan implementation

better quality of life in metropolitan areas especially focuses on this goal, easy to define and to measure. Therefore, the land dimension in the smart city is to be considered in the material, environmental sense.

Also the **infrastructure** dimension has a material meaning; streets, buildings, public transport facilities are the instruments to both supply services to the citizens, and to reduce the CO_2 emissions by their quality improvement. A summary of smart city EU strategies could be found in the EU-SETIS program; it is focused on four pillars: clean energy production, low energy consumption, buildings efficiency, sustainable transport (Fig. 5). Each of these pillars has several subsets of goals, strategies, actions and projects [30]. Several targets regard the technological research, the development of prototypes, the implementation of new solutions to support energy, transport and buildings characterized by the near-zero impact goal and the concurrent better quality of public services [31].

Regarding **people** in the EU smart city vision, the role of citizens is not very proactive, as they are mainly seen like the address of this strategy. The subjects involved in the smart city strategy are the triple helix subjects, that is: public administration, universities and research centers, businesses. They play their own role (to govern, to discover, to produce), but are involved to cooperate to design better answers to reach several different goals in the same time: to improve the quality of the technical solutions, thanks to the research outcomes; to deliver better public services and public value to the citizens, thanks to the capacity of local and central government to drive the technological solutions towards the real needs of the people; to create economic value and development, thank to the capacity of companies to produce the desired products and services.

Regarding **government**, local government is generally the main actor involved in supporting smart city projects. Municipalities have been everywhere the first mover in implementing city wide programs regarding smart and/or digital plans for city. Central government plays a key role especially in supporting the city choice to implement a smart city program. However, an important role for European cities is played by the EU; indeed, the scarcity of financial resources available for the municipalities drives the local government to try to obtain funding from the EU programs about smart city. For this reason, smart city strategies are mainly driven by the SETIS program and the EU addresses to implement low carbon programs and projects in urban areas. Only recently, defining the Horizon 2020 goals, the EU changed a little its vision about the smart city idea, conceived now like a larger plan focused not only on the energy pillar, but on three main aspects: economic development, sustainability and inclusion. This new trend in smart city strategy for European cities enlarges its perimeter from the material aspect to the socio-economic aspects, putting inclusion and the social impact of better city at the top of the 2020 agenda.

However, till now the smart city is still considered like a set of strategies and programs regarding the reduction of CO_2; therefore, the smart city perimeter is defined through its goal, and not by the technologies used to reach it. For this reason, smart city is a heterogeneous idea, using several technologies, applied to several and different topics, with the common aim to reduce the environmental impact of city life. In this sense, it is quite easy to define the smart city boundaries, its goals and also to measure the reached results. But both in the academic literature and in the empirical applications, smart city is defined differently and with a larger scope and it is the main reason for its open-endedness.

2.4 Digital City

The idea of a digital city also has born in the nineties, and it has become to spread especially in the so-called Internet era, at the beginning of the millennium. The use of the web both in the private and in the public sector, the social networks and other communication means, the e-services delivery and the availability of rich and up-to-dated online information are the main drivers to implement a digital city, able to exploit all the ICT instruments and devices to create a virtual urban space.

Respect to the smart city, based on several technologies, the digital city is based on the ICT. It means that the main digital city aspects regard:

- the diffusion of rich and updated information online;
- the use of social media or other communication media, to both connect people each others and to create a dialogue between the citizens and the public administration;

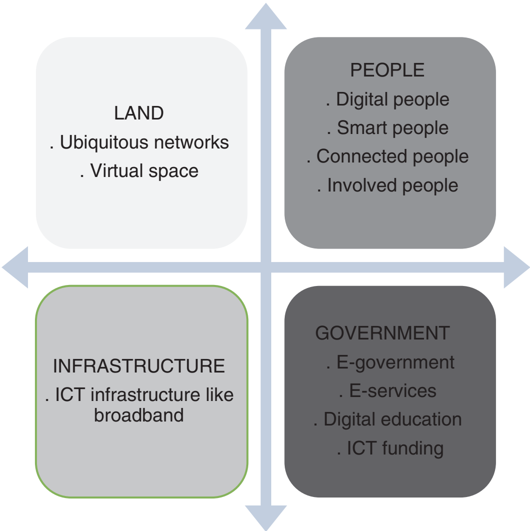


Fig. 6 The basic components of the digital city

- the e-service delivery, by both public agencies and private entities and companies;
- the ubiquity of information, communication and services, thanks to the mobile technology.

Also the digital city could be described adapting the basic components of the city to its characteristics, as shown in Fig. 6.

The **land** dimension is not very important, actually the ICT is used to overcome the material boundaries of cities to create relationships between citizens, among citizens and the public administration, between citizens in the same city or in different geographical areas, all over the world. Indeed the digital city, when fully implemented, is able to support ubiquitous networks and to create a virtual space.

The main component in a digital city is the **ICT infrastructure**, especially the Internet connection based on the broadband. This is the main driver of the digital city implementation. However, also other aspects are important, for example:

- the diffusion and use of smart devices among citizens;
- the high speed connection;
- cloud computing;
- open data;
- system security and resilience;
- and so on.

Some of these components are realized thanks to the cooperation between public administration and enterprises; a wired city needs a comprehensive project, able to support long-term strategy and investments.

Another crucial digital city component is **people**. Indeed, the ICT infrastructure itself is not enough to support the digital city implementation: also the involvement of citizens is necessary. Indeed, otherwise respect to the smart city, the role of people in implementing a digital city should be highly proactive, because they should take part in communication, data processing, information use and e-service enjoyment. For this reason, a digital city should include digital, smart, connected, involved people, able to enjoy the benefits deriving from this urban strategy. One of the main obstacles in digital city implementation is not the broadband diffusion or the lack of high-speed connection, but the overcoming of the digital divide and the increase of people access to digital knowledge and services.

The **government** component is summarized by the word e-Government; the digital city is the main instrument to deliver e-services from the public administration to citizens, aiming both at reducing the service cost and at improving the service quality and effectiveness. However, the complete implementation of the e-government strategy meets several strong obstacles like the digital divide, the lacks of public funding, the lack of digital culture in the public administration. The government should increase the digital readiness of public bodies and workers to success in the digital city strategy [32].

The previous dimensions of the digital city are at first glance deeply different respect to the smart city dimensions. However, smart city and digital city often are two faces of the same coin, as explained in the further paragraph.

2.5 Smart city and Digital City: Two Faces of the Same Coin

The analysis of the literature and of the empirical implementation of some smart or digital city prototypes shows us that smart city and digital city are different in their components, enabling technologies and goals. However, they are often linked together in the urban strategies for better quality of life. They have been also confused in several academic papers and public policies. There are two main reasons.

The first depends on the use of some words like smart, digital, green, to define innovative urban policies, without a clear reference to a sound definition or standard. This is therefore a terminological confusion, but it has few impacts on the concrete implementation of smart or digital city programs.

The latter derives from the interlaced role of technologies and goals, that needs of both smart and digital projects and actions to realize a better city for people.

In Fig. 7 the main components and actions of smart city and digital city are summarized. It is evident that infrastructures and solutions regarding the digital city are useful—or necessary—also for the smart city. Several plants and devices used for smart transport or energy efficiency are based on ICT and wired houses, buildings and cities. Data availability and processing are crucial to support planning and delivering smart products and services and e-government, e-commerce, e-business are the instruments to exploit the smart initiatives.

Digital city	***Digital infrastructure*** - new ICT infrastructure - high speed broadband - fibre optic cables - wireless technology - networked information systems	***Data*** - Data collection, storage and analysis at city level, potentially through the cloud, which can enhance a city's ability to predict and plan for the future ***Information*** - Processing of information to service programmes ***Service development*** - Development of service application	
Smart city	***Smart transport and Mobility*** - Bike schemes - Real time bus timetable information - Electric Vehicle car pools - Congestion charging	***Rebewable energy & energy efficiency*** - Combined Heat and Power - Renewables - Electric Vehicle Charging Poimnts - Sensor to monitor traffic, pollution, emissions - Street lighting - Waste collection systems - Smart grids	***Smart and sustainable buildings*** - Smart meters - Energy efficiency measures: insulation, low energy lighting, efficient boilers - Building Integrated Renewables - Electric Vehicle Charging Point - Smart appliances - Motion detectors - Automatic weather forecasting

Fig. 7 Comparing smart city and digital city

The comparison between smart city and digital city and the analytical individuation of their components aim not to separate, but to create a sound basis for the strategy definition of quality of life in urban areas. The role of technologies, environmental quality, energy safety, information and communication access should work together, but with the awareness of their differences, and not putting all of them on the same footing.

The separation between smart city and digital city could be functional to better investigate about what and how to plan smart and digital strategies, and especially how much results and returns are awaited and finally reached. However, it is important not to be wrong, considering smart city and digital city two different, separate urban strategies. They should be linked together and harmonized to individuate priorities and better investments to create the maximum outcome and public value for citizens.

To support this vision of smart city and digital city, defining them like two different but integrated innovation paths for urban areas, the empirical analysis is necessary. Two important cases have been examined: Amsterdam, The Nederland and Genova, Italy. The analysis is deep and it permits to understand how the smart or digital city idea has born, how it has been developing during time and which are the main aspects of urban strategy in these two cities. For a complete empirical research, two aspects are examined: the key partners involved in the project and the initiative portfolio. Actors and partners define how the project is thought, that is, if top down—drove by the local government, or bottom up—gathering the private and public initiatives by enterprises, associations, citizens and so on. They define also the work method, centralized or federal or some other topological choice. Initiative portfolio permits to understand which are the contents prioritized by the city, and to outline if they have a smart or a digital profile, or both. It is helpful to define the characteristics of a smart/digital city strategy.

The aim of this investigation is to understand if these two cities, defining themselves smart city, are pursuing a smart city strategy, a digital city strategy or a blend of them.

3 Case Study: Amsterdam

3.1 Introduction

Amsterdam Smart City is universally recognized like the first smart city not only in Europe, but in the world. However, the development of Amsterdam Smart City has crossed several different phases, starting just from the digital city strategy. The literature analysis helps us to discover how the Amsterdam case has been becoming the most important in the smart city panorama.

Looking at papers regarding Amsterdam Smart City, Google Scholar shows that the first writings regarding this topic date 2009, whereas papers regarding Amsterdam Digital City date from 1995. Indeed, the Digital City concept has born just in Amsterdam in 1994, when ICT was used to create an online connection and community to enforce Amsterdam citizens in facing political election. Amsterdam Digital City is therefore in its first phase a political and social instrument, arranged by people to communicate and exchange political opinions. Environ 170 papers focus on the Amsterdam pioneer case in digitalizing a city from 1995 till today.

The high success obtained by this project—140.000 subscribers in few months in 1994, well before the Internet boom—was the motor to transform an occasional initiative in a permanent instrument to connect people in the city. However, as the Digital City platform was not a public initiative, but a private project, public funding were not enough to support the infrastructure and its daily functioning, therefore the Amsterdam Digital City became a company and started to test some new business models to use e-commerce for financing the social side of this initiative.

Unfortunately, these economic returns were not enough to support Amsterdam Digital City and this project had a certain decline, especially at the beginning of the new millennium. At the end, we should say that this interesting and pioneering experiment failed to become a sustainable local information and communication infrastructure, but opening new paths of urban development.

In the meantime, the awareness of the city environmental footprint begun to grow; Amsterdam was one of the first cities to think about a strategy to face pollution and energy consumption in urban areas. In 2009, three subjects: Liander, a grid energy operator, Accenture, and Amsterdamse Innovatie Motor, a public agency founded to support innovation in the city of Amsterdam, joined their forces to create the Amsterdam Smart City program; its aim was mainly to create collaborative pilot projects to support a better use of energy and a reduction of pollution and CO_2 emissions in Amsterdam. From this date, we have found 84 papers speaking about Amsterdam Smart City.

Amsterdam assumes the following definition regarding smart city: "A city is smart when investments in capital and communication infrastructure fuel sustainable economic growth and a high quality of life, in combination with an efficient use of natural resources". Applying this definition, the Amsterdam Smart City partnership defines its own strategies to build a smart city in Amsterdam urban area.

However, Amsterdam was no more the first mover, as it was for the digital city experience: [33] show that a lot of large and medium cities in Europe begun to go through the smart city path, even if most of them are not aware of this strategy or are pursuing smart goals without using a clear or explicit smart city framework.

Nevertheless, Amsterdam is an interesting case study, mainly because during its digital phase it developed a virtual community and the people involvement is at the basis of both its digital and its smart strategy. Moreover, the capability of Amsterdam Municipality to involve also private actors and to design a comprehensive smart city plan, able to include near every aspect of the urban life, qualifies this experience at the top level in Europe. In the further pages, we will examine the Amsterdam case to understand the relationships between digital and smart aspects and if these two paths are alternative or complementary.

3.2 Key Players

As already explained, the Amsterdam Smart City initially started like a Digital City initiative in 1994. Only in 2009 the municipality, with some key partners, moved towards a clear smart city project. One of the most interesting aspects of the Dutch experience is the involvement of several players, belonging to different but complementary categories.

To examine the key players both in Amsterdam Digital City and in Amsterdam Smart City, we should organize our analysis in two streams:

1. who are the "shareholders", that is, who decides about the planning of a smart or a digital urban strategy;
2. who are the "stakeholders", that is, who benefits from the smart/digital urban strategy implementation.

We clear also which are the subjects participating to the different implementation processes.

In the Amsterdam Digital City experience, first mover were the citizens, organized in associations; precisely, the political-cultural center The Balie and the computer activists group Hacktic launched the DDS (in Dutch: De Digitale Stad, abbreviated as DDS) as a ten weeks experiment to provide an electronic democratic forum to the citizens of Amsterdam. The pilot project had a great success and it continued well over ten weeks, till 2001.

DDS has been conceived like an information platform, designed like a virtual city, hosting several private and public institutions sites, and also citizens' ones, to deliver data and information to the registered users. Institutions cover several categories, such as health, education, ICT, leisure, media, politics, and business bodies. These subjects are the shareholders, that is, the key actors aiming at using DDS to diffuse their own information and to publicize their activities among citizens, both for commercial and for social aims. DDS has born and ever remains a flat initiative, with nor governance nor formal leadership. Perhaps this lack is also one of the reasons of the failure—or better the extinction—of this pilot project; nobody had enough interest to invest important sums of money in the maintenance and innovation of this platform, and it was just for financial reasons that the initiative expired. Moreover, DDS was not able to renewal its offer and to face competition from followers in the use of the Internet to provide information to the citizens.

DDS was a first experiment of social platform to share information about the life in the urban area. For this reason, its stakeholders were for the first the citizens, even if DDS attracted visitors and users from elsewhere, more interested to the innovative communication medium than to the contents. However, during its life, DDS involved more and more business players, offering free information but with the aim to publicize their products and services and to attract customers. Therefore, DDS lost its social profile to acquire a public–private nature; stakeholders are therefore also the business system and the economic players in the city of Amsterdam.

A few important role has been played by the public institutions; some of them—schools, hospitals, and so on—participated to the initiative with their own web site, but they hadn't a leader role in the DDS. Therefore, we can conclude that the DDS was a bottom-up, flat program to share information among citizens in the Amsterdam urban area, without a formal organization or governance structure.

Very different is the experience of Amsterdam Smart City initiative. In 2009, the Municipality of Amsterdam begun to think about some instruments and projects to face the problem of pollution, energy consumption and environmental quality in city. The "Am*smart*erdam city" project has been founded on this basis. The first mover is therefore a public body and the initiative is top down, as it is driven by a pool of four founding partners, involving in the following several other actors. They are the shareholders of the initiative.

To implement the Amsmarterdam program, the founders settled an association to gather all the players working for the smart goals. Therefore, the governance platform is a closed one, including all the associated partners, and a hierarchical body, because the main actors are the founding subjects, that is: Amsterdam Economic Board, Gemmente Amsterdam, KPN and Liander. If in the DDS the first mover had been a private subject, in the Amsmarterdam initiative it is a public subject and the shareholders are both public and private. Finally, in the DDS project each partner was working alone and there were no interactions between all the

Table 2 Key characteristics in Amsterdam digital city and in Amsterdam smart city

	Amsterdam digital city	Amsterdam smart city
Starting process	Bottom-up	Top-down
Participation	Open	Closed
Structure	Flat	Hierarchical
First mover	Private body	Public body
Actors	Mainly private ones	Public–private partnership
Governance	No interactions between the actors (self organizing platform)	Formal organization (Quadruple helix model)

participants to the DDS platform. In Amsmarterdam, there is a strong connection and cooperation between all the shareholders of the initiative; the aim of the platform is to keep together different categories of players, such as public bodies, universities and research centers, companies and social bodies, to build a quadruple helix able to create also a regional knowledge network to enforce the smart city development in the future.

The Amsmarterdam initiative involves these actors, including also social bodies and therefore the citizens, also if their active role is few represented. Indeed, the citizens are the final stakeholders of the Amsmarterdam project, but they obtain benefits in a mediate manner, that is, thanks to the improvement of environment and life quality in city. Therefore, even if the citizens are the final stakeholders of this urban strategy, they are often not really aware of this.

This analysis shows that DDS and Amsmarterdam—digital and smart strategies in Amsterdam—are very different respect to the role of key players. Their differences are summarized in Table 2.

The quadruple helix model describing the governance and cooperation model in the Amsterdam Smart City initiative is not a declared choice, but the result of the urban vision pursued by the key players and the cooperation model they are trying to implement. The most known triple helix model is a theoretical framework explained by [34]. This model refers to a spiral involving different categories of actors playing in different stages of knowledge capitalization: public sector, industry, and academy. Thanks to their relationships, they are able to support a faster, deeper and higher value innovation process.

However, in the triple helix model the civil society is not included and it is not considered like a key actor in innovation process. The smart city idea is quite different, because it considers the involvement of citizens like a winning weapon to build successful smart strategies. This idea includes citizens and the civil society not only like stakeholders of the smart initiatives, but like active actors, playing a crucial role in supporting innovation in the culture, knowledge and mentality of people, changing their behavior towards a smart awareness.

Amsmarterdam is an initiatives explicitly involving not only the civil society through the active participation of citizens and social bodies in defining the smart priorities and projects, but also declaring that active behavior of citizens and knowledge sharing permits the successful smart implementation in urban spaces.

The quadruple helix in Amsmarterdam is not an explicit strategy, but the result of strategic choices regarding the active role of the citizens' intellect, awareness and commitment. Citizens are therefore both the main shareholders and stakeholders of Amsterdam Smart City.

3.3 Initiatives

To realize its own goals the Amsterdam Smart City partnership defines an implementation strategy including a initiative portfolio; each initiative in some way contributes to create a smart city in Amsterdam.

At present, this portfolio is made by 43 projects, organized by 5 themes and regarding three geographical areas inside Amsterdam urban boundaries. These projects are very heterogeneous, on all points of view: involved actors, applied technologies, role of citizens, and so on. However, all of them are mainly focused on energy transition and open connectivity. These streams recall both smart city aims (energy transition) and digital city ones (open connectivity). Also the definition of a smart city used by Amsterdam to drive its activity recalls investments in communication infrastructure and the aim to pursue sustainability. It seems therefore that the present Amsterdam City strategy includes both smart and digital initiatives.

To better verify these hypothesis all the 43 projects have been deeply analyzed, examining both their content, their aim and the involved actors. To understand if a project is smart or digital, or both, and to classify it depending on its nature, goals and technological contents, a schema has been defined, explained in the following Fig. 8.

The main classification in smart or digital initiatives derives from the smart city definition suggested by Amsterdam Smart City and related in Sect. 3.1. In this definition, a smart city should both invest in ICT and obtain sustainability, that is, environmental footprint reduction and a better use of natural resources. In Fig. 8, we define smart initiatives the ones aiming at sustainability, and digital initiatives the ones based on ICT, web communication and data sharing. Moreover, we consider some other factors in classifying the smart/digital projects.

In smart projects, we consider also the use of ICT like functional technology (that is, ICT is not the aim of the project but the instrument to realize smart goals) and the high or low involvement of citizens: indeed, smart projects could be essentially technological, applied to buildings, transport facilities and other infrastructures without involving the proactive behavior of citizens, or on the contrary they could base their success on the concrete participation of people.

In digital projects, we consider also the eventual impact of digital initiative on smart goals: for example, an ICT system aiming at monitoring energy consumption in private houses has also a smart impact, as it drives people's behavior towards a better use of energy through their higher awareness about consumption.

The project portfolio analysis is showed in Table 3. In column 1 a progressive number is reported, column 2 contains the name of the project, column 3 a brief description; column 4 has the label SC for smart project, DC for digital project,

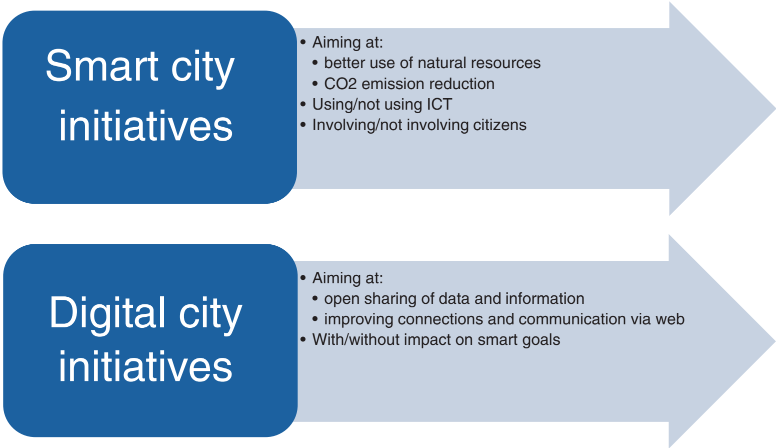
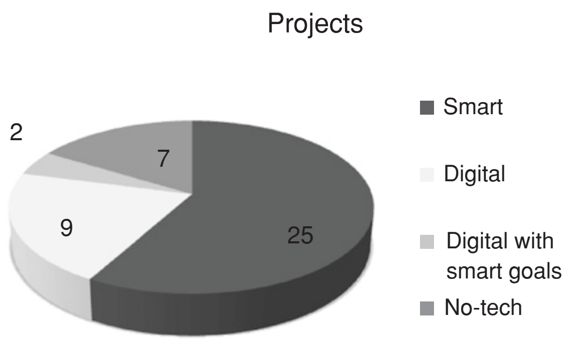


Fig. 8 Smart and/or digital projects classification

Fig. 9 Smart and/or digital project range in Amsterdam Smart City



NOTECH for project not based on technology, DC → SC when a digital initiative produces outputs also on smart goals; column 5 reports other specifications, as described in Fig. 8: EFF for smart projects aiming at energy saving and environmental impact, +ICT for smart projects with a strong ICT base, PEOPLE for smart projects involving active citizens participation, DATA for digital projects aiming at open data and information sharing, COMM for digital projects aiming at a better communication with citizens.

This analysis shows that 25 projects out of 43 are smart projects; 9 are digital projects; 2 are digital projects with a strong impact on smart goals; 7 projects are no-tech projects, that is, initiatives aiming at smart goals, but without using technology. For example, these projects regards to human behavior, legal instruments, and so on, to improve city sustainability. The range of projects is displayed in Fig. 9.

Table 3 Project portfolio in Amsterdam Smart City

	Project	Description	Type	Spec
1	Almere smart society	Almere Smart Society, is a vision of living and working in Almere, in all its facets supported by ICT and technology	DC	DATA COMM
2	Amsterdam free Wifi	Offering Free Wifi on Amsterdam IJburg harbour connected on KPN consumer fiber	DC	COMM
3	AmsterdamOpent.nl	AmsterdamOpent.nl is the platform where civil servants of the city of Amsterdam can propose questions and ask the Amsterdam people to share their ideas	DC	COMM
4	Apps for Amsterdam	Apps for Amsterdam 2 is the second open data contest of the municipality of Amsterdam in which developers are challenged to build apps based on municipality's data	DC	DATA
5	Climate street	Together with entrepreneurs, a typical Amsterdam street, the Utrechtsestraat, is transformed into a sustainable shopping street where innovative technologies are tested	SC	EFF PEOPLE
6	E-harbours —Innovative energy contract Zaanstad	The Municipality of Zaanstad has negotiated a new energy contract, that saves energy, stimulates the local production of renewables, and reduces energy costs substantially.	NOTECH	EFF
7	E-Harbours—ReloadIT	The core of Zaanstad's showcase 'REloadIT' is innovative technology for clean mobility	SC	EFF
8	Energy management Haarlem	250 customers in the Haarlem region tested an energy management system free of charge for four months	SC	EFF PEOPLE + ICT
9	Flexible street lighting	No description found	SC	EFF
10	Fuel cell technology	Using innovative local energy generation technology will enable the "Groene Bocht" building to provide in its own electricity and will reduce CO_2 emissions by 50 %	SC	EFF
11	Geuzenveld—Sustainable Neighborhood	More than 500 homes were provided with smart meters and some with an energy feedback display that can make residents more aware of their energy consumption	SC	EFF PEOPLE + ICT
12	Health-Lab	Health-Lab is a collaboration between companies, government, care and research institutes to stimulate ICT and Care developments	DC	DATA

(continued)

Table 3 (continued)

	Project	Description	Type	Spec
13	IJburg—Fiber-to-the-Home	A new fiber network has been unrolled by Reggefiber in cooperation with KPN to facilitate the inhabitants of Amsterdam with 3 play services	DC	COMM
14	IJburg—Smart Work@IJburg	Amsterdam Smart City offers IJburgers alternatives for the traffic jam: work at home or at a Smart Work center	DC	COMM
15	IJburg—Wijk TV	A local private TV channel via fast fiber internet	DC	COMM
16	IJburg: YOU decide!	In the EUDI (End User Driven Innovation) project, IJburgers are asked to describe their issues and ideas on energy and mobility in their neighborhood	NOTECH	
17	IRIS—Research into the legal frameworks of energy provisions	The goal of project IRIS is to establish legal frameworks that offer the best opportunities to develop local sustainable energy provisions	NOTECH	
18	ITO	By applying Smart Building technology, even a modern building like the ITO Tower can greatly reduce its energy use	SC	EFF + ICT
19	Moet je Watt—charging system	The Moet Je Watt (MJW) is a smart electrical battery charging system for electrical cars that communicates with a smart meter in the meter box to prevent power wastage and overcharging. The purpose of this project is to test the combination	SC	EFF
20	Monumental buildings	The purpose of the project was to find out which technologies and methodologies are practical when it comes to rendering monumental buildings. The shared office building, De Groene Bocht, was a part of this pilot	SC	EFF
21	Municipal buildings	Measuring energy consumption in municipal buildings via an online portal enhances awareness and shows that energy-saving measures do yield real results	SC	EFF + ICT PEOPLE
22	Nieuw-West—City-Zen	A total of €30 million will be invested in innovative projects in urban areas of the city in the years ahead, primarily in the District of Nieuw-West	SC	EFF
23	Nieuw-West—Energy storage for households	Technology development for energy in households which are linked to the smart grid	SC	EFF + ICT PEOPLE

(continued)

Table 3 (continued)

	Project	Description	Type	Spec
24	Nieuw-West—Serious Gaming	A serious Game designed to playfully enable and encourage bottom-up participation of residents in creating a Smarter City	NOTECH	
25	Nieuw-West—Sloten Windmill: smart meeting spot	The Sloten Windmill is a meeting place in the district of Nieuw-West. Together with local residents and our partners, we are working to develop and introduce smart initiatives throughout the district	NOTECH	
26	Nieuw-West—Smart Grid	In the Amsterdam New-West area the first intelligent self healing grid has been implemented with which the city of Amsterdam can realize its sustainability objectives	SC	EFF + ICT
27	PLAY DECIDE	A discussion card for young and old that aims to raise awareness of participants on the topic of smart cities and the city of Amsterdam, intrigue them to see the theme of smart cities in a critical and rounded way and enhance their debating skills	NOTECH	
28	Ring–Ring	Bicyclists are worth everything. By choosing to ride a bike over other transportation, the environment, public space and our own health benefits from this directly. That should be rewarded	NOTECH	
29	Ship to grid	Almost 200 shore power stations are installed allowing ships to connect to green energy instead of relying on polluting on-board diesel generators for their power supply	SC	EFF
30	Smart challenge	Eleven companies compete in the Smart Challenge where the Wattcher gives employees insight in energy consumption. The winner of the contest will be the company whose employees save the biggest amount of energy	SC	EFF + ICT PEOPLE
31	Smart schools contest	In the Smart Schools project 6 primary schools in 7 locations compete on energy efficiency program results, comparing performance through an online portal	SC	EFF + ICT PEOPLE
32	Smart sports parks	In this project sports associations, the local city council and several entrepreneurs work together to build and maintain sustainable and strong sports grounds. Main focus is on Energy Efficiency, Smart Lighting, Bio Diversity and Shared Resources	SC	EFF

(continued)

Table 3 (continued)

	Project	Description	Type	Spec
33	Smart traffic management	Amsterdam has it's own 'virtual traffic manager', a technical tour which enables traffic to be managed almost automatically. Unique in The Netherlands	DC → SC	COMM DATA
34	Swimming pools	Swimming pools are public buildings that consume a great deal of energy. Amsterdam Smart City wishes to work with partners in an effort to find sustainable, energy-efficient solutions to secure maximum cost-efficiency in swimming pool management	SC	EFF
35	The Green Canals of Amsterdam	"De Groene Grachten", an initiative of Wubbo Ockels, has as purpose to make the canal ring of Amsterdam sustainable	SC	EFF
36	The smart home	Benext-iHome demohouse, in which more than 60 domotics products control the house and minimize the energy consumption	SC	EFF + ICT
37	TPEX—Smart Airmiles	To operate TelePresence Conference Centers (meeting rooms, board-rooms or classrooms) in Amsterdam and environs, connected to a worldwide network of international conference centers	DC	COMM
38	Watt for Watt	Watt for Watt uses a neighbourhood-level approach to improve the energy efficiency of houses. The campaign is also dedicated to making residents aware of how they use energy with the aim of keeping energy costs at an affordable level	SC	EFF PEOPLE
39	WEGO Car sharing	WeGo is a new sustainable platform that allows neighbours and friends to safely rent their cars to each other	DC → SC	COMM
40	West Orange	400 households in Amsterdam tested a new energy management system. This system can make residents more aware of their energy consumption and will help them to save energy	SC	EFF + ICT PEOPLE
41	Zuid Oost—Laws and regulations	Free zone for sustainable energy	SC	EFF
42	Zuidoost—Energetic Zuidoost	Energiek Zuidoost wants to reduce the ecological footprint of roughly the area between Amsterdam Arena and the hospital AMC	SC	EFF
43	Zuidoost—Stakeholders in the drivers seat	Value case development in a area where several stakeholders work together to develop the area in a sustainable and integrated way	SC	EFF PEOPLE

Further considering Smart projects, 16 out of 25 are based on a strong participation of citizens in implementing home technologies to improve sustainability in private spaces, or in modifying their behavior to reduce Amsterdam environmental footprint. It means that Amsterdam Smart City is a strong-human-based strategy, were technologies and behaviors should work together to reach the expected results. It is confirmed also by the high rate of no-tech projects, 7 out of 43, demonstrating that a smart city is not only based on technologies, but also on best practices and awareness. Moreover, 10 out of 25 smart projects requires a strong role of ICT in implementing digital platforms, control systems, sensors or other digital devices integrated in other plants or buildings, transport facilities and so on. It means that digital and smart are two attributes difficult to separate in smart contexts.

Further examining digital projects, 7 out of 11 regards an improvement of web-based communication between citizens, or between citizens and public administration bodies. 2 out of 11 are based on open data and 2 out of 11 mixes data sharing and communication. Also these evidences show that the involvement of citizens is at the core of smart city strategy.

3.4 Analysis

The history, the actors and the projects portfolio of Amsterdam Smart City are at the basis of our empirical analysis to understand what a smart city is, if it is similar or different respect to a digital city, where and how much they overlap and mix each other and so on.

Originally, Amsterdam knew an important, pioneering experience of digital city, in 1994. This experience was born from the citizen, it was a bottom-up initiative and it was able to involve thousands of citizens, using the Internet and creating the first digital community in the world. However, the Amsterdam Digital City project failed, especially because it was not able to create the conditions for its economic survival.

In 2009, the Municipality of Amsterdam started a new experience, labeled smart this time. No surprise that, considering the reasons of the failure of the digital experience, nowadays the first actor is the Amsterdam Economic Board, a public body representing governmental agencies, research institutes and the business world. Therefore, the economic dimension plays a key role in implementing the smart plan.

The main goals of Amsterdam Smart City are two: economic development and quality of life. Quality of life is the instrument to attract young and educated people to live in Amsterdam, producing therefore the economic development. The quality of life is obtained mainly through three different paths: environmental quality, digitalization of public and private communication and services, and a more general supply of public services and facilities. These paths are the drivers for determining the goals of smart city initiatives, that is: a better use of natural resources; a strong attention towards energy consumption, clean energy production and reduced environmental blueprint, especially conceived as CO_2 emission reduction; a pivotal role of ICT, web communication and data sharing, continuing the tradition of Amsterdam Digital City, but with a top-down process this time; a special focus on people, their behavior, their inclusion, their democratic participation to the city planning.

All these aspects—environmental attention, digital maturity and high democratic sentiment—traditionally define the cultural profile of The Nederlands. Therefore an idea of smart city based on these drivers is easy to share with Dutch citizens but also to transmit to who wants to reside in Amsterdam. It outlines also the need to define smart strategies well rooted into the culture and the specific history and profile of each city; no standard smart strategy exists, but standard themes specified in each specific city.

Examining the project portfolio, we could also answer to the question, if smart city and digital city are the same thing or if they are different, and if Amsterdam is a smart city, a digital city, both of them or smart/digital at the same time, without distinction of these two urban strategies.

Our survey permits to say that smart city and digital city are indeed two different things. A close and delimited definition of smart city says that a smart city is a strategy aiming at improving the environment quality in the urban area. A close and delimited definition of digital city says that a digital city is a strategy aiming at wiring and digitalizing data, information and public and private services in the urban area. These close definitions permit to trace well-conceived boundaries between smart and digital. It could be very useful to both classify cities, strategies, projects, and to prioritize investments, assess policies, evaluate expected and obtained returns.

However, the reality is not so simple. As we have seen, in Amsterdam a lot of projects classified like smart use ICT, even if a smart project generally uses ICT to process data and not to share information or to connect people; but not ever. In Amsterdam Smart City it is the specific city vision that puts these two urban innovations out the same hat, called smart city program. Amsmarterdam applies a more comprehensive definition of smart city, including both ICT investments and sustainable development. It is therefore a specific, political choice of Amsterdam to join smart and digital initiatives in a unique, large program to improve the quality of life, to sustain economic and social development, to digitalize information and services.

But Amsmarterdam should take into consideration that smart and digital initiatives require different policies. For example, digital initiatives are strongly based on the digital literacy of almost all citizens, to prevent digital divide and to grant the larger participation. It is based on the daily use of web and mobile devices to enjoy digital information and services. It requires therefore a digital maturity of both infrastructure and people. Smart city on the contrary especially requires strong investments in facilities and plants and it is based on active participation of private companies in funding smart investments. Therefore, an effective economic plan should support the smart city implementation, to prevent it fails owing to the lack of financial resources.

Despite that, Amsmarterdam shows all the success drivers to succeed in implementing its smart plan, joining both smart and digital measures.

3.5 Conclusions

The analysis of the Amsmarterdam case has been very useful to better understand the contents of smart city and digital city strategies, to compare these two urban development paths and to verify if the empirical implementation of smart city programs reflects the theoretical definitions.

The Amsmarterdam projects portfolio reveals that a smart city is indeed a mix of smart and digital projects, but also of no-technological based activities. What links together smart, digital and no-tech projects is simply the aim to improve the quality of life in urban space. However, this perimeter would be too large and potentially includes all urban initiatives. We can find two common aspects in all the examined projects, composing the Amsmarterdam projects portfolio: the information and services digitalization and the environmental footprint reduction.

Starting from these empirical evidences, we could rewrite a comprehensive smart city definition able both to include all the smart activities, but also to exclude initiatives out of scope. The definition is: “Smart city is a wired urban space aiming at implementing digital data, services and communication and clean infrastructures, to improve the quality of life in the city through a large web connection and a reduced environmental footprint”.

Assuming this definition, a digital city is indeed a subset of a smart city, but a required part, because a city without wired connections and web communications is not conceivable like a smart city. Moreover, the role of ICT in supporting several smart infrastructures in reducing their environmental impact creates a strict relationship between digital and smart technologies.

Finally, the role of citizens has been often neglected in the past implementations of smart city initiatives, giving more importance to the technological aspects. However, Amsmarterdam is a good case to outline best practices in involving citizens in smart and digital projects, aiming at changing their behavior towards more digital relationships each other and with the public administration, and a more careful respect of the urban environment. A smart city becomes therefore also an instrument to increase the democratic participation of people in city government and therefore to create higher consensus and a better quality of life in a social sense. This aspect is not less important, but a core element in the smart city definition and implementation.

4 Case Study: Genova

4.1 Introduction

If Amsterdam is recognized like the first digital city in the world, Genova is the leader city in winning European calls for smart cities. Genova submitted three projects to all the three calls for smart cities launched in 2011, obtaining a funding of 5.5 ml/€, in the amount of 8 % of the total EU funding for these calls.

Moreover, Genova presents a best practice in smart city governance, as it has been the first city creating from the beginning a governance authority to drive smart public policies and smart private initiatives towards a unique goal.

Genova could be defined like a “big bang case” in the smart city strategy; indeed, the idea to participate at the EU calls for funding smart projects has been the first step to start the smart action in Genova. No other initiatives had been implemented before.

The Genova success derives especially from the strength of the team defining the projects and a comprehensive strategic vision for Genova Smart City. This team was initially composed by three big players, that is: the Municipality of Genova, the real mover of the strategy; a couple of large companies in the energy and building industries; and the University of Genova, especially the Polytechnic Faculty. This team includes from the beginning all the main actors able to activate the triple helix and to create a positive synergy in research, innovation and technological transfer from the smart projects to businesses, public bodies and citizens. In the following, Genova settled an association, Genova Smart City Association (GSCA) to drive all the further initiatives, projects and strategies in developing a smart urban area.

The main goal of GSCA was especially to innovate the obsolete public infrastructures, especially in transport, building and energy production, pursuing in the same time the goal to create a more sustainable city. Indeed, the GSCA definition of a smart city recalls the main goals of sustainable cities: “Genova Smart City aims to improve the quality of life through the sustainable development, based on research, innovation and technology, driven by local leadership and applying integrated strategic planning”.

To concretely implement Genova smart city, a large portfolio of actions has been developed, based on 9 big projects and 51 smart initiatives. Each of them is focused on one or more smart goals, but ever aiming at contributing to the shared goal included into the Genova smart city definition. To pursue a comprehensive result, the governance structure and processes are crucial; for this reason, Genova could be considered a best practice case, as it implemented a governance body and specific processes able to effectively drive the multi-purpose, multi-subject smart initiatives towards a unique objective.

4.2 Key Players

To drive and govern the smart strategy implementation, Genova settled a governance body, Genova Smart City Association. It was initially composed by the three main partners participating to the EU calls for smart projects funding, that is: Genova Municipality, Enel Spa (the Italian main electricity producer) and the University of Genova. The first aim of GSCA was to involve the smart city main stakeholders in joining the Association and participating to the smart strategy implementation, but also to the dissemination among companies and citizens of the smart culture.

GSCA is an open association, that is, each public or private body interested in smart actions and projects could join the association, paying a fee and participating to a democratic governance board; each member indeed has voting right to modify the statute, to elect the Directive Committee and to approve the main initiatives. This is the most important characteristic of this original idea, to formally join all the stakeholders in a body working for a shared goal. At present (October 2013) GSCA has more than 70 members and this number is continuously increasing. GSCA has the role to fix the smart agenda, especially aiming at applying the EU smart idea, and to concretely define actions, projects and initiatives to realize the Genova Smart City transformation process.

GSCA has a dual governance framework, composed by two main boards: the Directive Committee, with the role to define the strategic vision and main development paths, and the Executive Committee, to realize the strategies. GSCA President is the Mayor of Genova, to confirm and enforce the role of the Municipality in driving the smart process.

To support the innovation activity, GSCA has also a Scientific Committee, that has mainly a consulting role: it should examine and ratify—or reject—the proposal of actions, initiatives and projects submitted by the members, and it maintains the relationship between GSCA and the research institutions members.

A deeper analysis of the GSCA members reveals that the composition is very heterogeneous. Indeed, we can count several companies, but also a lot of not-for-profit bodies and public agencies; for example, the Port Authority, The Regional Energy Agency, Trade Unions and so on. We can find also trade associations like Industrial Trade, Commercial Trade, Building Trade; together with cooperative companies and Association of Citizens working in culture, welfare and education sectors. The dimension of company members is very heterogeneous, too: we can find several global, large companies like Toshiba, Siemens, Selex, Ericsson, Erg, Ansaldo; but also a large number of SMEs, mainly working in energy or ICT industry. Also research bodies are represented by several members like University of Genova, CNR (National Research Centre) and IIT (Italian Institute for Technology, settled in Genova).

In Fig. 10 the classification of GSCA members is graphically represented. All the members are classified in one of these categories: Public bodies, Research bodies, Large companies, SMEs, Trade associations and Trade unions, Not-for-profit associations.

This panorama suggests that GSCA is a real connector of different ideas and competences regarding the smart city definition, implementation ad dissemination. GSCA is an important example of quadruple helix and it is the main strength for Genova, to create a smart city being at the same time a smart community. Indeed, we already said that sometime smart projects, especially when focused only on technical implementations, tend to exclude the active role of citizens, considered like the final address of benefits deriving from these implementations, but without an active role in the process. On the contrary, GSCA wants to pursue an inclusive strategy, involving all the stakeholders not only in enjoying the benefits, but also in participating to the picture of their desired smart city.

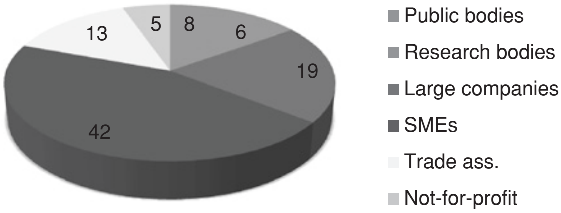


Fig. 10 GSCA members categories

Table 4 Key actors in Genova and Amsterdam smart city

	Genova smart city	Amsterdam smart city
Starting process	Top-down	Top-down
Participation	Open	Closed
Structure	Flat	Hierarchical
First mover	Public body	Public body
Actors	Public, Private and Not-for-profit	Public–private partnership
Governance	Formal organization (Quadruple helix model)	Formal organization (Quadruple helix model)

Moreover, it should be considered that Genova is one of the more aged cities in Europe; citizens over 65 are the 27 % of the inhabitants. It means a low awareness about the smart city idea and a low ICT education level. However, elder people are main stakeholders of smart city initiatives and services; for example, e-health systems, better public transport services, cheaper heating and cooling plants. Therefore, they should be educated and adequately informed and involved in the smart city projects and some not-for-profit members of GCSA are working just for this goal. Only with the higher active participation of all the citizens the smart city could produce and deliver the higher public, economic and social value for all.

In Table 4 we can compare the key players in Genova and in Amsterdam. There are some similiarities and some differences. Both the cities have a top-down process, driven by a public body, that is, the Municipality. It suggests that a smart city project is complex, requires important plans and funding and it is necessary to well define its development paths to obtain effective results. However, Amsmarterdam choose a hierarchical, closed governance model, Genova a flat and open one. Genova, even if strongly focused on smart initiatives interesting physical infrastructures and less involved in digital initiatives, considers the citizens and not-for-profit associations like key players for its success, and a formal, democratic organization of GSCA like a crucial instrument to drive the development of Genova smart city gaining the higher consensus. At present, it is early to assess which is the best solution; but perhaps all of them are the best solution for each city. Indeed, a smart city comprehensive project, involving completely a city and aiming at transforming its profile, needs to be city-specific and harmonized with the culture and the other characteristics of the urban area.

Both Genova and Amsterdam settled a formal body to govern the smart city strategy, in which the Municipality is a key actor, but juridically separated by the association. It is an important choice, in Italy only Genova made it; it shows the intention to give to the smart city an independent life respect to both the politic local Govern and all the private companies.

4.3 Initiatives

To realize the smart city plan, Genova built a portfolio, composed by three types of elements: large EU projects, other funded projects, smart initiatives.

Large EU projects are three and are the projects winning the EU calls for funding smart city projects. Other funded projects are six and they received funds from both international and national govern bodies, for example from MIUR (Minister for Education, University and Research), from different calls respect to smart city topic, but similar in their contents. Smart initiatives are other actions drove by the Municipality of Genova and regarding especially its own organization.

All the projects and initiatives have been analyzed and classified applying the schema already applied for Amsterdam, showed in Fig. 8 and explained in Sect. 3.3. The results of this analysis are showed in Table 5 regarding the 9 large projects and in Table 6 regarding the 51 initiatives.

Analysing Table 5, 8 out of 9 projects are smart and only one is digital. Among the smart projects, only one has a strong role of ICT to support smart actions. Three projects are no-tech: it is because a lot of calls regarding EU projects in smart city topic are focused on design the guidelines, policies, best practices, but also definitions and main contents of a new and immature research field. EU recognizes that to foster a rapid and efficient smart city implementation all over Europe, it is better to pursue a top-down strategy, defining processes and behaviors and spreading them collected in a sort of white book, explaining what and how to do and what not to do, to save time and money and to prevent mistakes.

Genova Smart City presents a lower rate of digital projects, because the main driver of the Genoese strategy has been to adhere to the EU smart city vision, to win the more EU calls, and this vision is mainly technological and focused on CO_2 emission reduction and building efficiency improvement, also through cooling, heating and lighting innovative systems.

For the same reason, Genova presents a lower rate of people involvement respect to Amsterdam. For the first, the strong technical focus of the majority of projects excludes the participation of citizens; moreover, the low rate of digital projects reveals that Genova considers less important in this phase to use ICT to create people networking. Probably it depends also on the lower literacy rate of Genoese citizens, their less daily use of smart devices and the Internet and the lower readiness of Public Administration in supplying digital services.

Generally, we could conclude that Genova choose to apply to EU calls, completely assuming the EU smart city vision, strongly committed in pursuing CO_2

Table 5 EU smart project in Genova

	Project	Description	Type
1	Illuminate	To realize smart illumination in large urban areas to reduce energy consumption	SC
2	ElihMed	Realising innovative existing building refurbishment to improve the energy efficiency; it regards public dwelling	SC
3	R2Cities	To define innovative strategies and solutions to improve energy efficiency in large buildings	SC
4	CELSIUS	Developing pilot project about district heating and cooling systems and energy networks	SC
5	ICITY	Open Platforms implementation to realize public e-services	DC
6	Peripheria	Developing an innovative approach to involve final users and citizens (especially in suburbs) in planning and implementing new products and services. This approach uses especially ICT and Living Lab	NOTECH
7	HARMONISE	To define EU standards and best practices to support security, resilience and sustainability in urban long-term planning	NOTECH
8	Transform	To define a methodology to transform cities in smart cities collecting both theoretical studies about strategic planning and best practices in six EU implementing cities	NOTECH
9	Very School	Realising a heating system in public schools aiming not only at reducing energy consumption and CO_2 emissions, but also at educating children and their parents to a smarter use of energy	SC

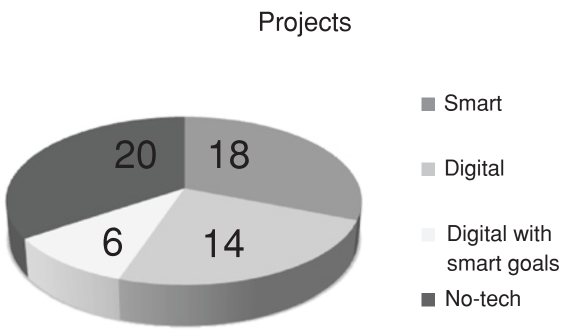


Fig. 11 Smart and/or digital project range in Genova Smart City

reduction in urban areas. However, a stronger focus on the digital side of smart city emerges from the analysis of smart initiatives, showed in Table 6. We can count 10 smart initiatives, 13 digital initiatives, 6 digital initiatives with a strong smart impact and 14 no-tech initiative. These latest mainly regard regulations about the behavior of the Municipality, introducing a smart trend in each act, for example introducing green criteria in procurement, or regard infrastructure initiatives like cycling routes, local public transport, and so on. The projects + initiatives range composition in Genova is showed in Fig. 11.

Table 6 Smart and/or digital project range in Genova smart city

	Title	Description	Type	Spec
1	E3SoHo	To develop an ICT platform to monitor the families' energy consumption in a popular dwelling area, with the aim to extend it all over the city and to educate people in more sustainable behaviors	DC → SC	DATA COMM
2	Diamond Social centre	To develop a social centre built with sustainable criteria and to extent best practices to further similar projects	SC	EFF PEOPLE
3	Molassana civic centre	To develop a civic centre built with sustainable criteria and to extent best practices to further similar projects	SC	EFF PEOPLE
4	Young people centre	To develop a young centre built with sustainable criteria and to extent best practices to further similar projects	SC	EFF PEOPLE
5	Renewable energy plants in civic buildings	To develop a pilot project to collect best practices to convert energy plants in municipal buildings in sustainable plants, based on renewable energy sources	NOTECH	
6	Energy efficiency in public markets	To develop a public market built with sustainable criteria and to extent best practices to further similar projects	SC	EFF
7	SEAP—Action Plan for sustainable energy	The SEAP (Sustainable Energy Action Plan) is the key document signed by the Covenant of Mayors, to guide the city actions to reach its CO_2 reduction target by 2020	NOTECH	
8	Smart Traffic Light	To convert traffic lights in sustainable traffic lights	SC	EFF
9	ELENA European Local Energy Assistance	An EU project to furnish technical support to innovative solutions in cities aiming at reducing the environmental footprint of urban areas	NOTECH	
10	Sun Procurement	To develop rules, administrative and legal instruments, type contracts to produce and distribute solar energy in large co-owner buildings	NOTECH	
11	Servizionline.comune.genova.it	To create a large platform to offer to the citizens e-services, aiming at administrative process efficiency, paper consumption reduction ad mobility reduction	DC	COMM
12	FreewifiGenova	Implementing a lot of public areas in Genova with free wi-fi service	DC	COMM
13	Genova Optical Fibre	To create a proprietary optic fibre to connect all the municipal branches in city	DC	COMM

(continued)

Table 6 (continued)

	Title	Description	Type	Spec
14	FTTH « Fiber to the home »	To offer to citizens broadband services	DC	COMM
15	Municipal Bulding Regulations	To develop a territorial regulation to support a larger use of buildings techniques, to improve building energy efficiency	NOTECH	
16	Smart Energy at Work	To write a handbook to drive best practices regarding energy consumption in workspace	NOTECH	
17	Smart City Management	Organizing a University Master Course for the management and governance of a complex smart city program	NOTECH	
18	Electric Mobility	To create a large urban infrastructure to support private use of electric cars	SC	EFF
19	Infomobility	To create an ICT platform to offer information about the traffic in the urban area in the real time and to reduce traffic and pollution	DC → SC	DATA
20	Mobility Supervisor	To develop an integrated ICT system to collect information about traffic and transport, merging data deriving from different data sources such as sensors, private and public databases, videosystems, and so on	DC	DATA
21	App AMT	To develop a mobile application to supply information about the local public transport systems in Genova and around	DC	DATA
22	Electra—Electric City Transport	To develop an innovative public transport system, based on electric scooter sharing	SC	EFF
23	Car Sharing	To develop an innovative public transport system, based on electric car sharing	SC	EFF
24	Bike Sharing	To develop an innovative public transport system, based on bike sharing	SC	EFF
25	Epistemetec	To realize a digital library to preserve the cultural heritage of some Italian regions	DC	DATA
26	Med-3R	To realize international cooperation between Mediterranean cities to share technical implementations regarding the waste treatment	NOTECH	

(continued)

Table 6 (continued)

	Title	Description	Type	Spec
27	CycleCities	To promote an educational campaign regarding policy-makers, citizens and institutions, about the importance of sustainable transport systems	NOTECH	
28	CATMED	To implement a sustainable district ICT platform, based on sustainability education and citizens involvement, to be gradually applied to all the districts in a smart city	DC	COMM
29	Web Sellers	To realize an ICT platform to sell abroad touristic services in Genova and surroundings	DC	DATA
30	Smart University Energy	To realize a set of sensors and an ICT platform to measure energy consumption and building inefficiency in the University of Genova; these measures will be used to support the smart energy system regarding all the Genoese university	CD → SC	DATA
31	Tecnoedile	To realize a prototype of "near zero energy building", using integrated systems to produce energy from renewable sources	SC	EFF
32	PEAP- Port Energy Plan	To define the energy plan of the Port of Genova, aiming at optimize the energy efficiency	NOTECH	
33	Climate Change! We Change!	This project regards and integrated approach at the problem of reducing the energy consumption in multi-owner building; it involves all the stakeholders: co-owner representatives, energy companies, municipality, etc.	NOTECH	
34	H@H (HEALTH @ HOME)	To offer to elder citizens an ICT application to support medical assistance online	DC	DATA COMM
35	SCOC (SmartCity Operation Security Center	To develop an Open Data platform to integrate heterogeneous information about territorial safety systems	DC → SC	DATA
36	Inset (INTEROPERABLE NATIONAL SYSTEM FOR ETICKETING	To realize an ICT platform to integrate e-ticketing service with municipal policy for tourism in Genova	DC	COMM

(continued)

Table 6 (continued)

	Title	Description	Type	Spec
37	Urbelog	An ICT system to support the efficiency of product delivery in the urban areas	DC → SC	DATA
38	Accessit	To develop an ICT platform to support the design of touristic itineraries in Genova and in the Mediterranean area	DC	DATA
39	Energy Building Business Protocol	To create a Protocol to integrate business with the Municipality of Genova in defining a long term plan about municipal building energy efficiency	NOTECH	
40	Public Transport Business Protocol	To create a Protocol to integrate business with the Municipality of Genova in defining a long term plan about public transport energy efficiency	NOTECH	
41	Genova Smart City Web Site	To create a web site for the Genova Smart City program, able to spread the culture of smarter city among the citizens	DC	COMM
42	Smart Revolution Award	A competition among citizens regarding smart proposal to be submitted to the Municipality	NOTECH	
43	Decision Theatre Partner	To realize an ICT platform to support the strategic planning and governance of long term, integrated smart projects	DC → SC	DATA

The graph shows that the highest number of projects is classified like no-tech. This outline the more comprehensive vision of Genova Smart City. Indeed, not only Genova settled from the beginning a formal association to govern the Smart City initiative, but it gives the highest importance to the context definition. Genova thinks that it is important to define a smart city framework, including governance, processes, best practices, before to implement single initiatives. In this sense, the projects and initiatives are not a sum of independent actions, but a subset of a larger vision including all the smart initiatives in the general framework.

4.4 Analysis

The deep analysis of Genova Smart City case shows to us that different paths could be walked through, to improve the smartness of a city. Genova is an interesting case especially because it demonstrates that each city, even with no experience in smart or digital projects, could become a leader smart city if pursuing a well defined strategy. It shows also that in smart city practices the followers could be better than the first movers, because they will be able to apply the best practices, policies and guidelines developed worldwide to drive the smart city implementation.

Our analysis is useful to outline both the strengths and the weaknesses evidenced in this large smart strategy.

The main strength for Genova Smart City is the key role of the Municipality, able both to start a large implementation of smart actions inside its own organization and to drive the smartness improvement of the whole city area. The settlement of AGSC and the quadruple helix model (even if unconsciously applied) are winning steps towards a comprehensive and shared vision of a smart city capable to sustain and renew its own development over time. The high cooperation between public administration, university and business is the main driver of the future dissemination of smart knowledge.

Another strength is the high international visibility and collaboration and the possibility to collect abroad and to develop smart practices, to be applied in Genova in further projects. Thanks to its nine international projects, Genova participates to a large network of European cities, both large or medium, at different stages in implementing their own smart strategies; this is an inestimable knowledge base.

Finally, Genova has developed a comprehensive vision about the city smartness, regarding not only the technological aspects, but also the regulatory aspects and it has well understood the key role of the Municipality in driving and disseminating smart awareness among companies and citizens.

On the other side, Genova presents also several weaknesses, to be faced not to induce the failure or the low returns of smart initiatives. The more critical weakness is the excessive reliance on the EU funding to implement smart actions; it derives also from the uncritical adhesion to the EU smart city definition, strongly focused on CO_2 emission reduction. This acceptance of the leading role of EU strategy could be a strong obstacle in the future, to develop in Genova its own smart city vision and to replicate best practices, guidelines and innovative technical solution in several smart projects, extending by this way the smartness from one site or areas to several sites and city areas. Surely, the worst obstacle to be overcame is the lack of funding from its own financial resources or the lack of EU funds financing not only pilot projects, but a smart initiative along with its full life cycle.

Another weakness is the low involvement of citizens. It is partially due to the low role of digitalization and smart community development, with a excessive focus on technological aspects. The low digital literacy in Genoese citizens is not a good reason to neglect their digitalization. On the contrary, a stronger effort should be done, to both reduce the digital divide in using digital services and smart devices, and improve digitalization and employees training in planning, using and delivery ICT applications and services.

4.5 Conclusions

The analysis of Genova Smart City projects and initiatives portfolio shows that the profile of these two cities—Amsterdam and Genova—is quite different.

The project portfolio of Genova Smart City contains 8 smart projects, all of them funded by international institutions and especially the EU. The EU vision of a smart city is also the vision assumed by Genova to participate to the EU calls for funding. We could say therefore that the Genova Smart City project portfolio is EU-driven and it reflects the EU smart city idea indeed. Depending on this point of view, Genova is very smart and few digital, very technological and especially based on hard technologies, and less IT based.

The situation is different if we examine the whole portfolio including both large smart projects—funded by EU—and initiatives driven by the Municipality of Genova. In this second case, the portfolio composition is different. Not only we can find several digital initiatives, but also a lot of no-tech small actions, aiming at defining the smart context in the city, regarding a large spectrum of topics. Depending on this point of view, Genova supports a more comprehensive idea of smart city, not only based on environmental urban footprint and sustainability, but more generally on the improvement of the quality of life in the urban area.

Another interesting aspect emerging from the Genova Smart City experience is the more integrated view of smart initiatives and projects. It emerges not only from the role of AGSC in governing the whole process of improving the smartness of Genova, coordinating public and private institutions, business and research bodies, not-for-profit organizations and citizens. It emerges also from the trial to put all the efforts into a unique framework able to measure also the obtained results from not a single project, but the project portfolio. For example, Genova links the smart project portfolio to the SEAP—Sustainaible Energy Action Plan signed by the Covenant of Mayors. Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. By signing the SEAP, the adherent mayors aim to meet and exceed the EU 20 % CO_2 reduction objective by 2020.

Linking smart city projects and SEAP means mainly two thinks:

1. to consider CO_2 one of the most important smart city goals;
2. to collect all the smart projects into a unique basket of actions intended to work together to reach a shared objective, that is, to view all the projects in a comprehensive manner.

However, it means also that it is easier to link smart projects to environmental goals such as energy consumption or pollution, as these goals are measurable; too difficult is to link smart projects to quality of life level, as this goal is fuzzy and often a direct causal impact of smart projects on the quality of life is not granted. Therefore, there is a gap between the ideal definition of smart city assumed by Genova in describing its own aims, as reported in Sect. 4.1; and the pursuing of more restricted goals, such as CO_2, more reflecting the EU definition of a smart city.

It impacts also on the smart portfolio composition; on one side the smart projects are too focused on few topics, especially energy consumption and pollution reduction; on the other, the initiatives portfolio is very broad, potentially including each public or private initiative aiming at an improvement in the quality of life in the urban space.

Therefore, Genova swings between three different smart city ideas:

1. The "close" idea, strictly focused on a smart city definition regarding only the environmental footprint of cities, and consequently it includes mainly the projects and initiatives aiming at reducing pollution and CO_2 emissions and reducing the energy consumption: it reflects the EU smart city idea;
2. The "medium" idea, including both smart city as conceived above and digital city, that is, it joins both the use of hard technologies and ICT, the first to reduce the infrastructure impact on the environment and the latter to connect people through open data, information sharing, broadband connections and digital e-service: it reflects the more accepted smart city idea, both in the academic world and by companies;
3. The "large" idea, including into the smart city definition all the initiatives aiming at improving the quality of life in the urban area, both technology-based or not; this broad definition is quite fuzzy and it makes difficult to really understand what a smart city is.

For these reason, the analysis of Genova Smart City interesting case, even if helps us to enlarge our understanding of the contents and scope of a smart city strategy, doesn't help us to define a smart city thanks to the empirical analysis.

In the further and last paragraph these two empirical cases—Amsterdam and Genova—will be compared each other to extract a smart city evidence from the overlapping of these two leader experiences in Europe.

5 Conclusion, Lessons Learned and Further Works

The analysis of these two case studies—Amsterdam and Genova—has been carried out with the aim to compare smart and digital city each other and to understand which are similarities and differences between these two urban strategies. From the beginning, the hypothesis under our survey has been that, even if they are often overlapped or confused, smart city and digital city are not the same thing and cities implementing smart city programs implement indeed a mix of smart and digital actions. Finally, after our study, we can say that our hypothesis have been confirmed; even if smart city and digital city have a lot of common aspects, they should not be confused as they need different strategies to be successfully implemented. The outcomes of our research are shown item by item below.

The historical analysis of both the literature and the business cases shows that digital city has born before smart city; like the Amsterdam case study demonstrates, digital city has been developing during several years—and till now—like an instrument to empower citizens respect to government, political issues and the public administration. It establishes itself along with the diffusion of the Internet among people, business and public administration.

Digital city is strongly based upon the ICT and especially the Internet, and therefore the communicational content is its more important aspect; other main aspects of a digital city implementation are data availability, information diffusion and e-services. It emerges from both Amsterdam and Genova that digital actions are mainly focused on improving the relationships with public bodies by delivering digital services or using the web site to spread information and create a more direct relationship with citizens. It means that a digital city strategy somewhat pursues the same goals of e-Government, but with a specific accent on the urban life. Thanks to this strict link with the ICT, the digital city perimeter and boundaries are well defined and its contents are easy to qualify. Also the required infrastructures are well identified, based on broadband connection, open data and web-based public services.

Citizens are actively involved not only in digital city implementation, but especially in the daily use of digital facilities; therefore the role of citizens is not only to receive or to enjoy the results and benefits of a digital city strategy, but to participate to its concrete functioning; without the active, daily use by citizens, a digital city cannot fully exploit its role and its success is limited by the insufficient returns obtained from the digital investments. It means that a digital urban strategy requires a high attention to the digital education of citizens and a strong contrast against digital divide like one of the most important barriers to a digital city full success. For this reason the educational level of citizens in using smart devices or ICT is one of the main drivers for the successful implementation of a digital city plan; as the digital culture has ever been better in The Nederland respect to Italy, no surprise that Amsterdam is a pioneer city in implementing such strategy, whereas Genova has been starting to implement a smart city strategy before.

Smart city has born several years after respect to digital city and had a boom in 2009 after the EU strongly committed to support and fund smart initiatives in European cities, aiming to reduce CO_2 emissions and to govern energy consumption, waste treatment and building efficiency. It appears clearly in Amsterdam but especially in Genova, where all the big smart projects are funded by the EU and the smart strategy has been planned just to catch the opportunity of EU calls. Smart city is nowadays a fuzzy idea, but its original core focus is on environmental impact of urban areas and activities. These topics emerge from the urbanization happened during the latest twenty years and the increasing problems it produces, like pollution, traffic congestion, high dwelling price, inequality and poverty. These goals are easily to individuate in both Amsterdam and Genova smart initiative portfolio.

Also the smart city considers technology like a core component, but in this case we haven't only one technology, like ICT in digital city, but a large set of innovative technologies like for example smart grid, renewable energy sources, new types of fuel for transports, new materials for building, and so on. Respect to digital city, we could say that smart city is based on hard technologies, a digital city on soft technologies.

The role of citizens in smart city is not necessarily active; for example, to reduce pollution by electric buses is a choice made by the local transport companies, and the citizens are the beneficiaries of this urban transport policy. They gain the benefits, but they are not actively involved. Obviously there are also smart actions requiring the citizens commitment, but it is not ever necessary in a smart city strategy, unlike in a digital city. Respect to this aspect, also a different orientation by a specific city can deeply modify the involvement of citizens in smart plan. For example, analysing Amsterdam and Genova smart initiative portfolio, we discover that in Amsterdam the involvement of citizens generally plays a more important role than in Genova, where the technical content of several smart projects prevails respect to the human side.

Despite these differences, smart city and digital city are not completely separable. As we have seen in examining Amsterdam and Genova, both these cities are developing their urban strategy mixing smart and digital actions. The main reason is that both smart and digital strategies have the same final goal, that is, to improve the quality of life and the citizens' satisfaction in their city. Smart and digital initiatives are joined in the strategic vision of local governments and these development paths are often defined in the same long term plan. As smart city is a more recent idea, it tends to absorb also digital city, combining both these strategies in a mixed, city-specific roadmap.

One of the negative effect to include digital into smart and to enlarge the smart city scope is that smart city has more fuzzy perimeter and boundaries respect to digital city. The main reason is that smart city tends to include all the initiatives aiming at improving the quality of life, that is, digital initiatives, but also green actions, inclusive actions, cultural programs and so on. For example, Genova defines its own urban city plan like a smart action, because it tries to incorporate also some trends like to reserve areas for parks or green areas and so on.

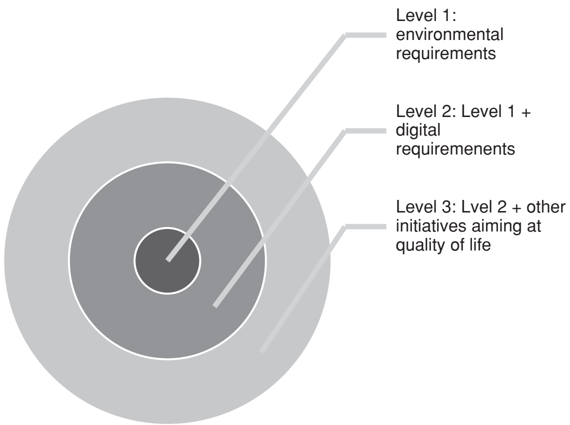


Fig. 12 A three level smart city definition

Moreover, digital city is based on only a technology, that is, ICT, whereas smart city is based on several innovative technologies, but sometimes it includes also initiatives without technological basis: for example, to educate parents to accompany their sons at school by foot instead that by car is a smart initiatives (in a large sense) because it aims at reducing pollution and CO_2 emissions, but using no technologies. In both Amsterdam and Genova initiative portfolio there is a certain percentage of no-tech projects indeed. Therefore, to define what a smart city is becomes more and more difficult.

The case studies show to us that the concept of smart city has indeed different contents, depending on the meaning a city attributes to it. Both Amsterdam and Genova merge in a large smart city strategy a large set of initiatives, contributing to the quality of life in their urban area through different aims. To summarize the evidences emerging from both the literature review and the case studies about the multi-level definition of a smart city, we can define a three-level smart city concept (Fig. 12):

- the smaller concept is represented by the actions, initiatives and strategies aiming at improving the quality of life in city, through the reduction of its environmental footprint, especially using innovative technologies applied to building efficiency, energy production and consumption, transport systems efficiency;
- the intermediate concept merges the smaller one—with environmental goals—with the digital city, that is, the digitalization of data, information and services, and the empowerment of citizens' communication with government and other public bodies;
- the larger concept adds to the intermediate one other initiatives, aiming at improving the quality of life in city, but not based on ICT or hard technologies; for example, green, inclusive, cultural initiatives, and so on; these latest actions are the more city-specific respect to the strictly smart and digital actions, that are more similar in several cities.

Table 7 Comparing smart city and digital city

	Digital city	Smart city
Year	Nineties	Boom in 2009
Technology	ICT	Hard technologies, especially applied at energy production, distribution and consumption
Focus	Information and communication by digital devices	Environmental impact of urban areas and activities
Process	Bottom-up	Top-down
Citizens	Active involvement	Active involvement not required, it depends on both the city vision and on the specific smart actions
Governance structure	No formal governance structure	Different governance structures, driven by public bodies and especially municipalities

A comprehensive comparison between smart city and digital city and their different characteristics are exposed in Table 7. Even if smart city is absorbing digital city, these two different urban strategies need different processes and practices to successfully be implemented and to gain the best results from them. For this reason, even if they are concretely merged into a unique city plan, they should be implemented taking into consideration their different nature.

One of the effects of fuzzier and larger boundaries is that the smart city output and impacts are more difficult to measure, the larger and heterogeneous its perimeter its. Indeed, it is quite easy to link and measure the effects of smart actions impacting on environmental aspects such as energy use and CO_2 emission reduction or cleaner energy production by renewable sources. But more difficult is to measure the impact of digital policies; indeed, it is necessary not to confuse the readiness of a policy with its impact. It is easy to measure the digital infrastructure or facilities realised by a city, measuring the broadband extensions or the number of citizens using smart devices or e-services. But more difficult is to evaluate the benefits or the public value produced by an integrated smart and digital strategy; these measures are only a proxy of the strategy effects. Both smart and digital city, in a large sense, present a high difficult to evaluate the returns they produce. It is an important barrier to smart and digital initiative implementation, because both of them often require a large amount of public investment and therefore also the need to justify the expenses and to demonstrate the reached results.

More generally, the large smart city scope negatively impacts on all the life cycle and governance framework of this urban strategy. Indeed, with very heterogeneous aims, technologies, stakeholders, it is difficult to support investment decisions, funding of projects, priorities demonstration and expenses justification, outputs measurement and performance evaluation. For this reason, to find a sound and shared smart city definition, with clear boundaries and delimited goals, it is necessary to better support the further smart city planning and implementation. As seen in our two case studies, at present all the cities, also the pioneer ones, are at an early stage in smart city development; nowadays all the projects have mainly the role to experiment initiatives and to collect best practices, but in the future these projects should become daily work to improve the quality of life in cities. Therefore, to be able to govern the smart city will be the most important weapon to reach substantial results. Further works will therefore use this study about the contents of smart and digital city to support the definition of a governance framework for their effective realization.

References

1. Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology, 18*(2), 65–82.
2. Anthopoulos, L., & Fitsilis, P. (2010). From digital to ubiquitous cities: Defining a common architecture for urban development. In *2010 Sixth International Conference on Intelligent Environments* (*IE*). IEEE.
3. Dameri, R. P. (2013). Searching for Smart City definition: a comprehensive proposal. *International Journal of Computers and Technology, 11*(5), 2544–2551.
4. Shin, Y., & Shin, D.-H. (2012). Community informatics and the new urbanism: incorporating information and communication technologies into planning integrated urban communities. *Journal of Urban Technology, 19*(1), 23–42.
5. Morganti, L., & Donders, K. (2013). A digital agenda in search of evidence. *info 16*(1), 1.
6. Kim, J., & Steenkamp A. L. (2013). Analysis of smart city models and the Four-Foci taxonomy for smart city design. *The Visibility of Research,*(2013), 637.
7. Dameri, R. P. (2012). Defining an evaluation framework for digital cities implementation. In *2012 International Conference on Information Society* (*i-Society*). IEEE.
8. Dameri, R. P., & Ricciardi, F. (2014). Using social networks in smart city: organizational challenges, synergies and benefits. In *Proceedings of European Conference on Social Media*, Brighton.
9. Dameri, R. P., D'Auria B., & Ricciardi F. (2014). Knowledge and intellectual capital in smart city. In *Proceedings of European Conference on Knowledge Management, Santarem Portugal*.
10. Bosker, M., Buringh, E., & van Zanden, J. L. (2013). From Baghdad to London: unraveling urban development in Europe, the Middle East, and North Africa, 800–1800. *Review of Economics and Statistics, 95*(4), 1418–1437.
11. Zhang, L. Y. (2013). City development strategies and the transition towards a green urban economy. In *The Economy of Green Cities* (pp. 231–240). Netherlands: Springer.
12. Stigt, R., Driessen, P. P. J., & Spit, T. J. M. (2013). Compact city development and the challenge of environmental policy integration: a multi-level governance perspective. *Environmental Policy and Governance, 23*(4), 221–233.
13. Bowerman, B., et al. (2000). The vision of a smart city. In *2nd International Life Extension Technology Workshop*, Paris.
14. Paskaleva, K. A. (2009). Enabling the smart city: the progress of city e-governance in Europe. *International Journal of Innovation and Regional Development, 1*(4), 405–422.
15. Ramaswami, A., et al. (2012). A social-ecological-infrastructural systems framework for interdisciplinary study of sustainable city systems. *Journal of Industrial Ecology, 16*(6), 801–813.
16. Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation: Focusing on management, policy, and context. *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance*. ACM.

17. Ricciardi, F., Rossignoli, C., & De Marco, M. (2013). Participatory networks for place safety and livability: organisational success factors. *International Journal of Networking and Virtual Organisations, 13*(1), 42–65.
18. Yuan, Y. M., et al. (2012). Architecture and data vitalization of smart city. *Advanced Materials Research, 403*, 2564–2568.
19. Lombardi, P., et al. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research, 25*(2), 137–149.
20. Cocchia, A. (2013). Smart and digital city: a systematic literature review. In: NOSTRO LIBRO.
21. Jenks, M., & Dempsey, N. (Eds.). (2005). *Future forms and design for sustainable cities*. London: Routledge.
22. Komninos, N. (2006). The architecture of intelligent clities: integrating human, collective and artificial intelligence to enhance knowledge and innovation. In *2nd IET International Conference on Intelligent Environments*, *IE 06*. (Vol. 1). IET.
23. Ishida, T. (2002). Digital city kyoto. *Communications of the ACM, 45*(7), 76–81.
24. Komninos, N. (2008). *Intelligent cities and globalisation of innovation networks*. London: Routledge.
25. Camagni, R., Capello, R., & Nijkamp, P. (1998). Towards sustainable city policy: an economy-environment technology nexus. *Ecological Economics, 24*(1), 103–118.
26. Sorrentino, M., Niehaves, B. (2010, January 5–8). Intermediaries in E-Inclusion: a literature review. *Paper presented at the 43rd Hawaii International Conference on System Sciences* (HICSS-43), Kauai, Hawaii. IEEE.
27. McCarthy, S. (2007). Planning for health and wellbeing: city of greater Dandenong wonders of Dandenong and the walking revolution. *Planning News, 33*(5), 14.
28. OECD. (2013). *Functional urban areas in OECD countries*. Paris.
29. *Il riordino delle province e delle città metropolitane, Camera dei deputati-XVI Legislatura—Dossier di documentazione.*
30. Guerrini, A., Romano, G., & Campedeli, B. (2013). Economies of scale, scope, and density in the Italian water sector: a two-stage data envelopment analysis approach. *Water Resource Management, 27*(1), 4559–4578.
31. Guerrini, A., Martini, M., & Campedelli, B. (2013). Measuring the efficiency of the Italian construction industry. *International Journal of Business Performance Management, 14*, 307–325.
32. Zardini, A., Rossignoli, C., Mola, L., & De Marco, M. (2014). Developing municipal e-Government in Italy: the city of Alfa case. In M. Snene & M. Leonard (Eds.), *Exploring Services Science* (Vol. 160, pp. 124–137)., Lecture Notes in Business Information Processing Berlin: Springer.
33. Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). Smart cities in Europe. 0048.
34. Etzkowitz, H., Loet, L. (1997). The dynamics of innovation: from National Systems and Mode 2 to a Triple Helix of university–industry–government relations. *Research policy*, *29.2*(2000), 109–123.

Smart, Smarter, Smartest: Redefining Our Cities

Claire Thorne and Catherine Griffiths

Abstract The UK Government, like many national governments, has the creation of Smart Cities high on its agenda. This interest is triggered by the promise that as a significant part of its national armoury, smart cities can drive economic leverage and possibly even deliver economic salvation. This aspiration has fuelled a growing global competition to attract entrepreneurs, talented people, and investment. The race to create smart cities is on. This chapter will describe the components that make a city smart, and examine the emerging 'need' to create a smart London. While only governments can create policy that enables scale to be achieved, policy so often only follows where the green shoots have already emerged. This is the situation in the UK, in London, and currently policy is not keeping pace with the vibrancy of the initiatives. The evidence of so many successful initiatives and national achievements shows (e.g. the transformation of Singapore to an Intelligent Island,[1] the successful delivery of the London Olympic Games,[2] the aim of President Kennedy to put a man on the moon[3]) that much is driven by vision as well as time, skills and funding. It is this lack of a clear vision that if addressed would help unlock new potential and reinvigorate many existing and older investments. Policy and initiatives could then work cohesively to help deliver what is currently so often only empty rhetoric. This chapter is a clarion call for a vision that focuses

[1] Beyond 2000: A Source Book for Major Projects. Major Projects Association, Templeton College Oxford.

[2] Research by Prof Andrew Davies.

[3] http://history.nasa.gov/moondec.html

C. Thorne
Digital City Exchange, Imperial College London, London, UK

C. Griffiths (✉)
Data Science Institute, Imperial College London, London, UK
e-mail: c.griffiths@imperial.ac.uk

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_4, © Springer International Publishing Switzerland 2014

on delivery of pervasive integration so that peak congestion is removed from urban systems and the enhanced quality of life in cities can bring benefits to all. Lastly, it suggests 'smartness' may not come purely from technological solutions after all, but from the mechanisms used to engage and deliver a new kind of city.

Keywords Smart city • Digital revolution • London smart city • Economic leverage • Data science

1 A Smart City Landscape: The Digital Revolution

The 21st Century is arguably producing a third industrial revolution.[4] The first was the mechanisation of textile manufacturing in the 18th Century, the second was Henry Ford and assembly line mass production in the 20th Century, and the third is the digitization of manufacturing currently in progress. As before, the third industrial revolution is opening up huge areas for innovation, producing seismic changes in the development time, associated costs, and the applications of new technologies. The new world of big and open data is being driven by and simultaneously driving this innovation. Technologies that create and collect data, that manage data, and that enable us to extract value from data, are all being developed and adopted at a rapid pace. Outputs include new platforms, products and processes such as the Internet of Things, next generation sensors, social media, (almost) ubiquitous mobile connectivity, the cloud, along with visualisation, personalisation and miniaturisation. With the advent of these tools, the possibilities for making better use of resources and increasing standards of living in cities are being tantalisingly glimpsed.

In parallel another factor driving the need for innovations in cities is the huge increase in urban population, which is predicted to continue rising. Globally, for the first time in history more people live in urban centres than live in the countryside and it is predicted that by 2040 two thirds of the global population will have moved to cities.[5] Where there are existing historic cities these added numbers are increasing the pressure on already constrained logistics, resources and infrastructures. Addressing these challenges of how to make old systems work effortlessly with new technologies, while designing cities that can offer enhanced quality of life for citizens, requires entirely new thinking and vision, capitalising on the outputs and opportunities offered by the digital revolution.

A 'bigger, faster, easier' city of the future may only be realised however through the integration of platforms, products and processes (i.e. the 'digital') with city infrastructure and the urban space, such as buildings, parks and roads (i.e. the 'physical'). In this scenario, real-time, personalised information could flow within and across cities, and the peaks increasingly seen in city systems—in consumption,

---

[4] The Economist. 21st April 2012.

[5] Forum for the Future: Report: Megacities on the Move, by Ivana Gazibara.

capacity, congestion, and inefficiency—could be diffused. Through access to, and an understanding of, real-time information flows, and through seamless data integration across networks, dynamic city peaks such as traffic jams, hospital waiting times,[6] surges in utility uses and power outages could all be better managed, in a coordinated 'systems of systems' way. As a result all citizens, whether residents, commuters or tourists, would stand to benefit.

2 A Smart City: Pervasive Integration

'Smart' is often used interchangeably and frequently naively, with 'connected' (i.e. to the Internet) and 'interconnected'. It is used to identify and badge something as meaning leading edge and with seamless communications. 'Smart' is already a global brand. It is routinely being misapplied, inflating the real level of technicality and complexity of a (sometimes digital) system: Examples such as deterrents used to protect security vans being labelled—'smart water'; Teachers delivering lessons to pupils with next-generation blackboards—'smart boards'; Miniature vehicles buzzing around the road network—'smart cars'. Governments are proud of providing 'smart villages' (e.g. in Egypt),[7] 'smart cities' (Rio),[8] and smart initiatives are pushed and promoted as though they are innovative and new. But are all these really smart? In reality, there is little difference between these and older, now mainstream, technologies facilitating communications such as the basic telephone network.

The words are familiar, and increasingly used by public officials and industry consultants to establish credibility and verify their status, but exactly what is smart, where is the vision, and what is the reality? Smartness must be justified by real-world need in order to avoid switching off potential adopters too early otherwise there is a risk that the full promise of this development will not be realised. In a smart city engagement is key, and language matters.

Sensors, applications and devices requiring connectivity should in fact be categorised within 'digital' because in isolation they do not constitute 'smart'. Technologies may be smaller, more sophisticated and more portable than ever before, but often many innovations are simply about revised presentation, rather than new content, application or service. What would really innovate and take these 'digital' tools beyond, into the world of 'smart', is not enhanced connectivity, it is: seamless interconnectivity and interactivity (to and with other devices or systems) and real-time responsiveness (to events and preferences). A new language is therefore required to accurately describe and fully capture what cities need. In summary, the meaning of smart has been hijacked, and its application is limited. Instead, pervasive integration of digital devices and platforms across

[6] http://www.theguardian.com/society/2013/aug/15/nhs-hospital-waiting-lists

[7] The Smart Village Company, Egypt http://www.smart-villages.com/en/page/page/147.

[8] How to Transform a City. IBM Smarter Cities White Paper, March 2012.

city infrastructures and resources with real-time data streams, which people can engage with, should be the smart and more comprehensive goal. This involves the use of data to better understand and inform, to change behaviours (at the micro and macro level), to manage and control more efficiently, and to respond in real-time. With such innovation, major shifts in the (individual and shared) roles and responsibilities of citizens, business and governments can be anticipated.

The Almere Smart Society[9] is an example of a wider pervasive integration initiative to build a smart city. Amsterdam is backing a project working with a consortium of Cisco, IBM, Liander, Living PlanIT and Philips to make smart a reality by focusing on pervasive integration. Their vision is to create a 'smart society', along with the Almere Economic Development Board, through the realisation of an ICT facility to promote smarter deployment of ICT, people and resources, and more efficient urban management and innovation. The ultimate aim is economic growth, strong social cohesion and sustainable development. They have focused the strategic plan around five thematic areas:

- Living
- Working
- Mobility
- Public Facilities
- Open Data

Each theme is being developed in close collaboration with all the others. Encouragingly, integration is an aim and part of the project plan from the outset. The advantage of Almere, a new suburb of East Amsterdam, is being a city closely associated with new development. The integration of old and new systems, services and infrastructure in retrofitting large, complex cities such as London is undoubtedly more challenging.

Establishing a planned structure for cities, that may also apply to older cities, has been studied and one proposal is to work along the following six identified (and ranked) main axes[10]:

- Smart economy
- Smart mobility
- Smart environment
- Smart living
- Smart governance
- Smart people

These six axes connect with traditional regional theories of urban growth and development. In particular, the axes are based respectively on theories of regional

9 http://amsterdamsmartcity.com/projects/detail/id/30/slug/almere-smart-society

10 Giffinger, Rudolf; Christian Fertner, Hans Kramar, Robert Kalasek, Nataša Pichler-Milanovic, Evert Meijers (2007). "Smart cities—Ranking of European medium-sized cities". http://www.smart-cities.eu/. Vienna: Centre of Regional Science. Retrieved.

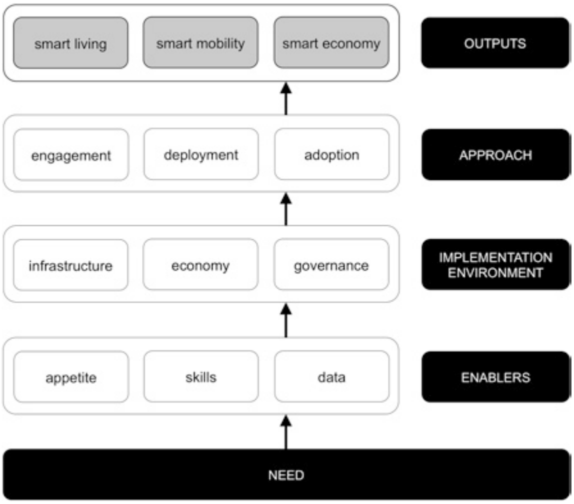


Fig. 1 A framework for defining and realising pervasive integration in cities

competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

The latter—'smart people'—is a crucial element and too easily played down by those operating in the smart cities space. Data scientists and engineers have an invaluable opportunity to learn from (and collaborate with) established disciplines that are traditionally focused on human factors, such as medicine, design, and architecture.

The six smart cities axes are easy to grasp and indeed acknowledge the core elements to build capacity for the 'what' and the 'who'. However, this framework does not venture to describe the 'how'.

3 Making a City Smart

Figure 1 presents a revised smart city framework—an attempt to map the constituents and provide the 'how'.

This revised framework is comprised of five descriptors, which offer a way of realising pervasive integration: Need; Enablers; Implementation Environment; Approach; and Outputs. It is important to note that all of the ingredients (i.e. skills, appetite, data) within each of these descriptors are required: Each component is integral, and the approach needs to be holistic.

- **Need**—Driven by growth in urban centres and technical innovation
- **Enablers**
  - *Skills*—Fostering a pool of specialist talent.
  - *Appetite*—Preparedness and willingness of citizens to adopt new technologies and smart interventions. This requires a digitally literate and engaged population.
  - *Data*—Tailored and personalised information streams, accessible to individuals, business and government, in real-time.

- **Implementation environment**
  - *Infrastructure*
  - *Economy*
  - *Governance*
- **Approach**
  - *Engagement*
  - *Implementation/deployment*
  - *Adoption*
- **Outputs**—The core principles are based around facilitating *quality of service*, *quality of life*, and *engagement*.
  - *Smart living*—Including smart health, e.g. How can a smart London enable me to access quality healthcare services locally and timely? How can a smart London enable me to foster (or belong to) a community?
  - *Smart mobility*—Encompassing issues of both transport and mobility, e.g. How can a smart London enable me to reduce my commuting time and/or cost?
  - *Smart economy*—At the least, this alone should be a motivating factor for a renewed and cohesive UK 'smart city' vision and implementation policy.

It is clear that some (but not all) of the smart city ingredients outlined in this framework are already coming together in smart initiatives around the world, albeit in a piecemeal way. In the UK currently there are sprinklings of so-called smart initiatives. However, it is possible that these will fizzle out; their contributions lost, and much well-intentioned investment will be wasted longer term. This is because although a cohesive vision and strategy at a regional or national level is expected to emerge, with a focus on translation, scalability and sustainability, it is yet to be clearly defined. There is as yet no clearly articulated common goal.

4 A Smart City Standard?

It is argued here that taking stock of what London has already achieved, and the expertise it is developing, can help define this much needed common goal and aspiration. Assuming a vision and strategy for London has been announced and a smart London is already emerging: then what? Figure 1 may assist but a discussion around how best to capture the value and the learning, and how to capitalise on the momentum, is also needed. In this case, there are key implementation questions to consider around translation, scalability and sustainability.

As London mostly requires 'retrofit' solutions to age-old infrastructure, transferring any unique 'smartness' to other UK cities and beyond is unlikely to be straightforward. With each city in the world varying in age, design and layout, regulations, existing or planned infrastructure and services, and geography, the smart solutions designed in response to any particular city are, by definition, unique. This means that translating or transferring any technologies or interventions mapped in a like-for-like fashion is unfeasible and most probably futile. In addition, each city should question whether standard solutions are the aspiration, however plausible. How appropriate is it to create a network of 'identic-cities' globally? Should we consider the preservation of other, non-technical attributes of a city, such as its distinct 'personality' and atmosphere, amid the ubiquity of universal devices, platforms and data?

While the specific solutions themselves, the new technologies and services, are not necessarily exportable and applicable to cities elsewhere, the knowledge economy created along the way may well be. This is the case, for example, of Aberdeen. Due to the challenging and unique environment of the North Sea, Aberdeen has amassed significant technical knowledge and industrial capability in deep-sea oil exploration.[11] This has made Aberdeen a world centre and the applications of, and demand for, complex innovative solutions and expertise now reach far beyond the UK.

5 London: The State of the (Sm)Art

How is London performing with respect to the two driving descriptors (enablers and implementation environment) of this new framework for pervasive integration (outlined in Fig. 1)? How is a smarter London realising its promise of better use of resources, more effective investment, increasing standards of living, and integrated services?

- **Enablers**
  - *Skills*—The UK Government, through its UK Trade and Investment arm, is helping to promote intelligent and green buildings, smart grids, the Internet of Things, sustainable urban transportation technology and networks, and telemedicine—it is focusing on the UK's ICT and smart technology and environmental expertise and how this can underpin the creation of low carbon future cities. This is promoting *national* capability—not just city capability.

    Higher Education Institutions are responding to the need with 'digital' and 'smart' educational and research offerings. For example, Imperial College London has launched an Executive Education[12] course on 'smart cities', in collaboration with Arup,[13] and hosts the Digital City Exchange[14] smart cities research project, the Digital Economy Lab,[15] and the Intel Collaborative

[11] http://www.bbc.co.uk/news/business-23490586

[12] www.imperial.ac.uk/business-school/executive-education

[13] http://www.arup.com

[14] www.imperial.ac.uk/dce

[15] http://www3.imperial.ac.uk/digital-economy-lab

Research Institute for Sustainable Connected Cities[16] (co-hosted with UCL). The LSE has established LSE Cities[17]—an international research and teaching centre, focusing on how the design of cities impacts on society, culture and the environment. In addition, London has recently seen the emergence of technology clusters, such as Tech City[18] in the East.

Collectively, this is encouraging, and builds on the existing skills base and experience within London, which has been developed through its historical large-scale technology and infrastructure projects (e.g. through Crossrail,[19] the mass deployment and adoption of the Oyster Card system, the delivery of the London 2012 Olympic Games, and the introduction of the congestion zone[20]). Through these, some of the *individual* issues common to smart cities—such as high demand on existing public services and networks, concerning CO_2 emission levels, and public engagement and community buy-in—have already been partially targeted. Now, there is an opportunity for London to take this learning and apply it to address similar challenges in a more holistic way, and on a larger scale across the country.

– *Appetite*—The adoption of connected devices (such as 'smart phones') has never been so high. Nevertheless there remains a real educational need and 'marketing' exercise to inform the public about pervasive integration and to highlight the benefits of London's smarter future. Most citizens may still view 'smart London' as—at best—irrelevant, or a waste of public funds because the real application has not been effectively conveyed.
– *Data*—In order to realise pervasive integration, access to real (not simulated) real-time (not historic) data is essential. Encouragingly, initiatives like the London DataStore,[21] the Open Data Institute,[22] and the European iCity Project[23] are making city data streams available for publication and discovery. The challenge now is in establishing a similar innovation ecosystem in the private sector domain. How can issues of ownership, regulation, IP, competition, legislation, security, privacy and value for privately generated/owned data sets be handled? And what happens when public and private data sets are combined?

- **Implementation environment**

  – *Infrastructure*—Current and planned investment in London's infrastructure is also encouraging. However, London needs to ensure future investment is

16 http://www.cities.io

17 www.lse.ac.uk/LSECities

18 http://techcity.io

19 http://www.crossrail.co.uk

20 http://www.tfl.gov.uk/roadusers/congestioncharging/

21 http://data.london.gov.uk

22 http://www.theodi.org

23 http://www.icityproject.com

really fit-for-purpose by meeting the growing projected demand. Meanwhile the predicted levels of adoption from past investments have not yet been fully realised. For instance, not all households and individuals in UK cities can afford to, or wish to be digitally connected and Internet access still remains out of reach for some socio-economic groups. Multiple blackspots are still to be addressed around the country and the government's rollout of broadband is 2 years behind schedule.[24]

- *Economy*—There is evidence that the UK is grasping some of the opportunities offered by the new digital revolution and supporting industrial activism to become more engaged and in some areas integrated. Over the financial year 2010–2011, the UK attracted one third of Foreign Direct Investments in Europe within the software sector, 129 of the 392 projects, and of these 70 were located in London. Private investment and venture capitalists invested £453 million in 60 technology companies in London during 2010 making it the most attractive region in the UK for private investment.[25]
- *Governance*—The Digital by Default government policy, the Government Digital Strategy[26] to transform the delivery of UK public digital services with a core principle of user centricity (via the Government Digital Service[27] team), the Race Online initiative (now led by Go ON UK[28] since April 2012[29]), and the formation of the Smart London Board and their published plan[30] are extremely encouraging. Initiatives like these have undoubtedly helped pave the way for future mass-scale adoption of other, smarter interventions. However, there are many issues still to be resolved, for example around the ownership and value of data.

With the diversity and momentum of current smart London initiatives, combined with this new framework for pervasive integration, there is a prime opportunity to speculate on what one/more 'end products' might look like. One version may be an accessible and truly inclusive London where physical and digital solutions enable wheelchair users to travel with unparalleled mobility; or where physical and digital provisions make walking a valid alternative to the traditional (bus, tube, tram and car) modes of transport.

---

24 http://www.bbc.co.uk/news/technology-23173157

25 London's Digital Economy, GLA Intelligence, by Margarethe Theseira.

26 http://publications.cabinetoffice.gov.uk/digital/strategy

27 http://digital.cabinetoffice.gov.uk/about

28 http://www.go-on.co.uk/about-us/our-mission

29 http://digital.cabinetoffice.gov.uk/2012/04/24/race-online-2012-hands-the-baton-to-go-on-uk/

30 http://www.london.gov.uk/media/mayor-press-releases/2013/03/mayor-announces-smart-london-board-to-realise-london-s-ambition

6 London Exemplar: Digital City Exchange—A Systems of Systems Approach

The Digital City Exchange[31] is an interdisciplinary research project funded by Research Councils UK. It focuses on integrating and repurposing real-time, cross-sectoral (transport, energy, water and waste) city data sets to enable business model innovation and to transform the planning, management and use of city services and resources.

The Digital City Exchange is a novel platform, aiming to allow individuals and organisations to combine, trade and exchange city data sets. Added value comes from the associated analytics; uniquely, the platform will facilitate the trade and exchange of real-time predictive models.

Through connecting citizens, business and government to real-time intelligence and enabling 'smart' decision-making, almost every aspect of our everyday lives could be revolutionised, leading to:

- Better monitoring and controlling of city services and networks to reduce emissions and waste;
- Improved health and well-being for the population;
- Increased public service productivity and quality;
- The creation of new business models, new data-centric industries, and jobs;
- Improved quality of life in cities.

Research commenced activity in September 2011 and by the end of the 5-year project, new technologies and services are expected to have been deployed and trialled in test-beds across London.

7 Summary

This chapter has argued for a larger vision to be articulated so that the existing sprinkling of initiatives and investments can be maximised by being part of a wider common aspiration. It has also stated that while smart is part of this, it is only part. What is needed is the aim of pervasive integration through the better collection, management and extraction of data.

It has emphasised the need for vision and focus. While London is being seen as a hub that might provide the flywheel for innovation in products, technologies and services, it does not yet have an overarching strategy.

This chapter suggests that there are two key areas to incorporate into this strategy:

- **A cross-disciplinary and cross-sectoral approach**

The real opportunity areas for smarter cities lie at the boundaries where the traditional research disciplines and industry sectors intersect. At these, there are opportunities to

---

[31] Digital City Exchange http://www.imperial.ac.uk/dce.

foster news types of collaborations, and devise new funding models. Hence, Higher Education Institutions, government departments, the London Boroughs and industry must all address the key question: Is London equipped for this new way of working?

Future cities must be places in which people want to live, work and play. Therefore, quality of life (and happiness) metrics should be seriously factored into any smarter strategy.

- **Avoiding the easy**, '**vanilla vision**'... **but still aiming for simplicity**

Any vision for a future London should be truly ambitious and revolutionary. Perhaps a 'grand challenge' should be set to capture the imagination of citizens, entrepreneurs and the private sector, and to galvanise the public sector. Technically, a vision is needed that goes far beyond app development as examples of a smart solution or an output of pervasive integration. Geographically, we should look far beyond the UK for examples of ambitious innovation (e.g. in Masdar City[32]). Once London has found something truly game-changing, it should avoid the temptation to imitate—it must trump it.

Finally, there is huge opportunity for environmental and sustainability issues to be more visible in smart city debates, and more integral to any smarter city master plan. There are many synergies between the challenges of realising pervasive, city-wide integration and the pressing energy, emissions and sustainability questions. These include: the specialist cross-disciplinary expertise to be fostered; the coordinated 'systems of systems' approach required; the necessary development of large-scale technological and infrastructural solutions; the citizen engagement central to any initiative's success; and the cohesive public-private cross-sectoral collaborations and responses demanded.

Shaping a future London with pervasive integration and people at its heart would be the smartest action to take.

[32] http://masdarcity.ae/en/

Recommendations to Improve the Smartness of a City

Elsa Negre and Camille Rosenthal-Sabroux

Abstract The concept of "smart city" has not yet been clearly defined. However, there are six characteristics/categories for classifying this kind of cities and compare them: smart economy, smart mobility, smart environment, smart people, smart living and smart governance. However, being "smart" is a challenge increasingly important for many cities or communities. This is of particular interest in the domain of Information and Communications Technology (ICT) and for such systems where there are economic, social, and other issues. To the best of our knowledge, there are no studies that attempt to help identifying the actions to be implemented to improve the smartness of a city. Recommending such actions is an emerging and promising field of investigation. Usually, recommender systems try to predict the rating that a user would give to an item (such as music, books, …) he has not yet considered, using a model built from the characteristics of an item (content-based approaches) or the user's social environment (collaborative filtering approaches). In this chapter, we present a framework for a recommender system for cities. The scope of this research work is to take advantage from recognized "smart cities" and to make same actions for city who wants to become "smart". The followed method is: having a list of characteristics of a "smart city", and having a city which wants to become "smart", which actions must be implemented to become "smart" regarding the characteristics of "smartness". This framework uses the actions already implemented in smart cities to enhance the smartness of a given city. The main idea is to recommend to the city the actions already implemented in those smart cities that are similar (the similarity between two cities is based on some indicators such as air quality, water consumption, etc.)

E. Negre (✉)
LAMSADE, Université Paris-Dauphine, Paris, France
e-mail: elsa.negre@dauphine.fr

C. Rosenthal-Sabroux
Université Paris IX Dauphine, Paris, France
e-mail: camille.rosenthal-sabroux@dauphine.fr

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_5,

as the actions to be implemented in the said city. This is done by (1) Pre-treating the indicators values of a given smart city category (only one among the six), (2) Matching the indicators corresponding to this category, (3) Returning to the city the actions to be implemented in a given order (according to the preferences of the city which needs help, for example). Thus, the city will be able to improve its smartness.

Keywords Information systems • Recommender systems • Smart cities

1 Introduction

Under the influence of globalization and the impact of Information and Communication Technologies (ICT) that modify radically our relationship with space and time, the city increasingly develops its activities in a planetary space with three dimensions:

- A global space covering the set of countries that are the geographic places of implantation,
- A local space corresponding to the subset of cities situated in a given geographic zone and,
- A space of influence that covers the field of interaction of the city with the other cities.

The hierarchical city locked up on its local borders is transformed into an Extended City, opened and adaptable. Furthermore, this Extended City is placed under the ascendancy of the unforeseeable environment that leads towards uncertainty and doubt. The Extended City meets fundamental problems of information exchange and knowledge sharing among, on the one hand, its formal entities distributed in the country (offices, core competencies, business units, projects) and on the other hand, the city's people (nomadic or sedentary), bearers of diversified values and cultures according to the places of implantation.

Two networks of information overlap:

- A formal information network between the internal or external entities, in which circulate data and explicit knowledge; this network is implemented under intranet and extranet technologies.
- An informal information network between nomadic or sedentary employees; this network favors information exchange and tacit knowledge sharing. It is implemented through converging Information and Communication Technologies (for example the new *Apple-ipod*© with Web 2.0).

The problems occur when nomadic employees placed in new, unknown or unexpected situations, needs to get "active information" that are information and knowledge they need immediately to understand the situation, solve a problem, take a decision, and act (Fig. 1).

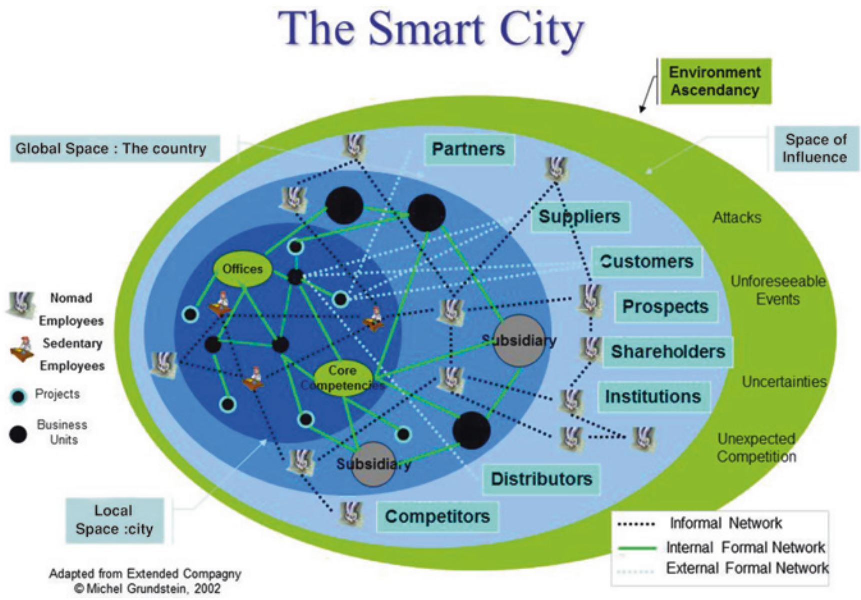


Fig. 1 The Extended city

The concept of "smart city" has not yet been clearly defined. From our point of view the concept of "smart city" is related to ICT and then to Extended City. However, according to [9], there are six characteristics/categories for classifying this kind of cities and comparing them: smart economy, smart mobility, smart environment, smart people, smart living and smart governance. They define for each of the six characteristics a number of factors (in total, 33 factors), each factor being described by a number of indicators (in total, 74 indicators). Each indicator is associated with actions that have been done to attain these indicators. However, being "smart" is a challenge increasingly important for many cities or communities. This is of particular interest in the domain of Information and Communications Technology (ICT); and for such systems where there are economic, social, and other issues. To the best of our knowledge, there are no studies that attempt to help identifying the actions to be implemented to improve the smartness of a city.

This chapter attempts to fill this gap. For our research, the starting point is [9]. Based on the fact that "One of the biggest surprises for the IBMers is how much cities have in common. Whether they're overgrown towns or giant metropolises, fast-growing or mature, the problems cities face are amazingly similar. And so are the potential solutions" [10]. Recommending actions is an emerging and promising field of investigation. Usually, recommender systems try to predict the rating that a user would give to an item (such as music, books, etc.) he has not yet considered, using a model built from the characteristics of the said item (content-based approaches) or the user's social environment (collaborative filtering approaches). In this chapter, we present a framework for a recommender system for cities. This framework uses the actions already implemented in smart cities to enhance the smartness of a given city. The main idea is to recommend to the city the actions already implemented in those smart cities that are similar (the similarity between two cities is based on some indicators such as air quality, water consumption, etc.) defined by [9], as the actions to be implemented in the said city. This is done by (1) Pre-treating the indicator values of a given smart city category (only one among the six), (2) Matching the indicators corresponding to this category, (3) Returning to the city the actions to be implemented in a given order (according to the preferences of the city which needs help, for example). Thus, the city will be able to improve its smartness. We based our work on the classification of [9], but the concept can be applied for other classifications as described in [7].

The chapter is organized as follow: Sect. 2 presents the related work about, smart cities, recommender systems and the link between smart cities and recommender systems, Sect. 3 presents the recommendation process with the presentation of the algorithm, finally we conclude with perspectives in order, for example, to take into account social and environmental aspects in the matching.

2 Related Work

2.1 Smart Cities

Based on [9], "A Smart City is a city well performing in a forward-looking way in these six characteristics, built on the "smart" combination of endowments and activities of self-decisive, independent and aware citizens. [. . .] Each characteristic is therefore defined by a number of factors. Furthermore, each factor is described by a number of indicators. [. . .] Finally 33 factors were chosen to describe the 6 characteristics": Smart economy (competitiveness, including innovation, entrepreneurship, trademarks, productivity, flexibility, international embeddedness and ability to transform), smart governance (participation, including participation in decision-making, public and social services, transparent governance, political strategies and perspectives), smart environment (natural resources, including attractivity of natural conditions, pollution, environmental protection and sustainable resource management), smart people (social and human capital, including level of qualification, affinity to life long learning, social and ethnic plurality, flexibility, creativity, cosmopolitanism/open mindedness and participation in public life), smart mobility (transport and ICT, including local accessibility, inter-national accessibility, availability of ICT-infrastructure, sustainable, innovative and safe transport systems), smart living (quality of life, including cultural facilities, health conditions, individual safety, housing quality, education facilities, touristic attractivity and social cohesion). These six characteristics and factors form the framework for the indicators and assessment a city's performance as smart city. The indicators that "describe the factors of a smart city are derived from public and freely available data" [9]. We consider that a city is "smart" for a given category if we have information for this category that means that the city is categorized "smart" in this category. If we do not have information for the given category that means that the city is not considered "smart" in this category. In a given category, we know that in reality all the cities do not have the same ranking; in this chapter, we consider that the cities are equivalent. That means that a city is not more "smart" that another in a given category. In the future we can introduce thresholds in a given category [9]. Focuses on medium-sized cities, and on the analysis of characteristics and factors decisive for a successful forward-looking city development, using data from official, public and freely available sources, on the basis of 74 indicators. On the basis of the indicators we mentioned the actions[1] that have been done in order to obtain a given indicator. For example: for *smart environment* and for the factor *sustainable resource management*, the smart city with a high level of indicator makes the actions: *after midnight shut down the public lights and fountains*.

2.2 Recommender Systems

Recommender systems are a particular form of information filtering designed to present information items (movies, music, books, images, web pages, …) that may interest the user.

Recommender systems have been studied in many fields, cognitive science, information retrieval [4, 11, 15], web [3, 20], e-commerce [16], web usage mining [2, 8, 14, 18], data warehouse [13] and many others. The problem of recommendation can be summarized by the problem of estimating scores for items that have not been seen by a user. Indeed, the number of items and the number of users of the system can be very important, it is, therefore, difficult for each user to see all items or that each item is evaluated by all users. It is therefore necessary to estimate the scores for items not yet evaluated.

Intuitively, this valuation is usually based on the scores given by a user to other items and other information that will be formally described below. When it is possible to estimate the scores for items not yet evaluated, then the items with the highest scores may be recommended to the user. More formally, [1] formulates the problem of recommendation in the field of e-commerce as follows.

Definition 1 (*Recommendation for e-commerce*) Given P the set of all users and M the set of all possible items that can be recommended (such as books, movies, restaurants, …). Given u a function measuring the utility of an item m for a user p, i.e., $u : P \times M \rightarrow \mathbb{R}$. Then, for each user $p \in P$, we want to choose the item $m' \in M$ that maximizes the utility for the user: $\forall p \in P, m'_p = argmax_{m \in M} u(p, m)$.

In recommender systems, the utility of an item is usually represented by a score that indicates how a particular user liked a particular item. For example, the user *Michel* gave the score 3 (the maximum score being 10) to the movie *Harry Potter*.

[1] An action is something done so as to accomplish a purpose [21], i.e., it is an operation which produces an effect on something and it is run/operated by a person or a group acting in a particular way [12].

Example 1 In this example, items are movies that the users Elsa, Camille, Michel and Nicolas have given a score. We obtain the matrix $P \times M$:

u(p, m)	Harry Potter	Ice age	Ice age 2	Hulk	Transformers
Elsa		8			7
Camille	9	8			6
Michel	3	5		5	5
Nicolas	5	3		3	3

Note that a cell (i, j) of this matrix corresponds to the utility score given to the movie j by the user i.

The central problem of recommender systems is that the utility u is not usually defined on the full $P \times M$ space, but only on a subset of it. This means that u must be extrapolated to the entire $P \times M$ space.

In recommendation systems, the utility is typically represented by the scores and is first defined over the items previously rated by users. Therefore, the recommendation engine should be able to estimate/predict the scores of item/user unevaluated combinations and to propose relevant recommendations based on these forecasts.

Adomavicius [1] propose that extrapolations from known to unknown ratings are usually done by (a) specifying heuristics that define the utility function and empirically validating its performance, and (b) estimating the utility function that optimizes certain performance criterion, such as the mean square error.

Once the unknown scores are estimated, actual recommendations of an item to an user are proposed by choosing the highest score among all the scores provided for the user, according to the formula given Definition 1.

A recommendation in e-commerce, as defined Definition 1, is the item $m \in M$ [set of all items (movies, books, …)] such as the utility for a user $p \in P$ (set of all users) is maximum.

2.3 Smart Cities and Recommender Systems

Due to the fact that the concept of "smart city" is still not clear and that this concept is emerging and has been developed in numerous publications [7, 9, 10, 17, 19], there are no studies that attempt to help identifying the actions to be implemented to improve the smartness of a city. Recommending such actions is an emerging and promising field of investigation.

To the best of our knowledge, this is the first work dealing with the problem of recommending actions in smart cities context and specially to improve the smartness of a city. Our contribution is to adapt the information retrieval techniques to our context.

By analogy, we can define a recommendation for smart cities as an action $a \in A$ (set of all possible actions) to implement such as its utility for a city $c \in C$ (set of all possible cities) is maximum.

Definition 2 (*Recommendation for smart cities*) Given A the set of all possible actions and C the set of all cities, given a log of cities and a city that wants to improve its smartness and given u a function measuring the utility[2] of an action a for a city c, i.e., $u : A \times C \rightarrow \mathbb{R}$. Then, for each city $c \in C$, the recommended action $a' \in A$ is the one that maximizes the utility for the city: $\forall c \in C, a'_c = argmax_{a \in A} u(c, a)$.

Example 2 In this example, we just illustrate the obtained matrix $C \times A$ where a score indicates that the action has been implemented and if the city has considered this action as efficient:

u(c, a)	Action 1	Action 2	Action 3	Action 4	Action 5
City 1	8	7			
City 2	9		3		
City 3	3	5		5	5
City 4	5	3		3	3

Note that a cell (i, j) of this matrix corresponds to the utility score given to the action j by the city i. Note also that an example of *Action*, as presented Sect. 2.1, can be *after midnight shut down the public lights*. Finally, note that the scores are obtained by giving an overall rating score but it could be obtained by combining the concepts of cost, time to implement, …

3 Recommendation Process

In this section we detail the framework for recommending actions.

First, we restrain our workspace by hypothesizing some assumptions:

- The city, which wants to improve its smartness, chooses, at the beginning, only one category of smart cities (among the six) it wants to join. Future work will automatically select the efficient category by searching into the log[3] similar cities to the one looking for recommendations.
- Indicator values are numerical. Future work will include semantic similarity between indicator values.
- Indicators are the same for a given category/factor for each city (only the values change and can be null). Future work will relax this constraint by including, for example, semantic similarity between indicators.

[2] Ratings/scores are given by a person authorized to make the decision of implementing different actions and through this score indicates whether the action is (or was) relevant.

[3] The log may be a database or other data structure. It will be powered by the recommender system as and when the use of the system by cities. However, for the initial data (the so-called cold start problem), we hope to use the data of the official, public and freely sources, possibly enriched with the participation of volunteers.

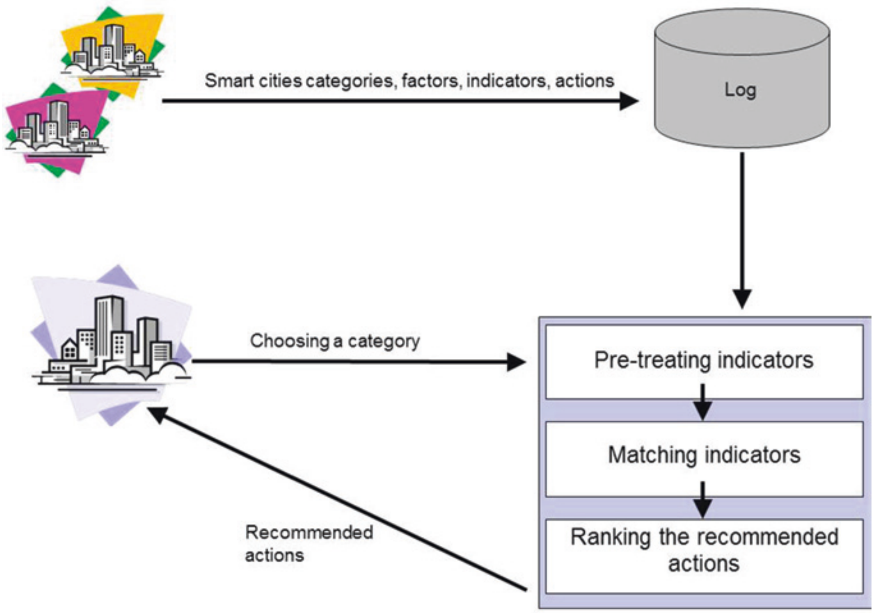


Fig. 2 Overview of the recommendation framework

The framework uses both the characteristics of the city which wants to improve its smartness, and the log containing for each smart city, its category, factors, indicators and implemented actions. It consists of the three following steps, as illustrated in Fig. 2:

1. The first step consists in pre-treating indicators of the smart cities into the log according to the category of smart cities chosen by the city which wants to improve its smartness (the current city),
2. The second step consists in comparing the indicators of the current city and the ones of the logged smart cities and extracting the corresponding actions,
3. The last step consists in ranking the candidate recommended actions.

Each step of this process is presented into more details below.

A city can be seen as a tuple containing the city description and the city information. The city information is a set of smart categories where each category is a set of factors and each factor is a 3-uple specifying the corresponding indicators and their values and for each indicator, the set of implemented actions. Note that the set of categories can be empty if the city is not "smart" for this category. Note also that the set of implemented actions can be empty if no action has been implemented.

So, we have, for each city C_i, $\forall i, j, k, n \in \mathbb{N}^{+*}$:

$$C_i = \langle Description_i, \{Category_{ij}, \{Factor_{ijk}, \{\langle Indicator_{ijk1}, Value_{ijk1}, \{Action^1_{ijk1}, \ldots, Action^{m_1}_{ijk1}\}\rangle, \ldots, \langle Indicator_{ijkn}, Value_{ijkn}, \{Action^1_{ijkn}, \ldots, Action^{m_n}_{ijkn}\}\rangle\}\}\}\rangle$$
$$\text{where } \forall l \in \mathbb{N}^{+*}, m_l \in \mathbb{N}^{+}.$$

The simplified algorithm 1 represents our process. Such an algorithm has a complexity of $O(mn^2)$ where m is the number of cities and n the max number of indicators and/or factors. Some choices of implementation have to be done in partnership with the stakeholders.

3.1 Pre-treating Indicators

Using the log L of smart cities (with their descriptions, categories, factors, indicators, indicator values and actions) and the category G of smart city chosen by the current city, this first step consists in pre-treating indicators of the cities of the log. In fact, we propose to compute intervals of indicator values. Note that our computation is limited to indicators corresponding to the given/chosen category G. In our algorithm, we use the *Pretreat* function. This function is used to compute a set of intervals of indicator values. In fact, this *Pretreat* function is used to search among the smart cities (of the log L) having factors and indicators corresponding to the given/chosen category G, for each indicator $I_{ijkl}, \forall i, j, k, l \in \mathbb{N}^{+*}$, the minimal recorded indicator value $V^{\min}_{ijkl}$ and the maximal recorded indicator value $V^{\max}_{ijkl}$. This function outputs a set of intervals (one per indicator I_{ijkl}) where $V^{\min}_{ijkl}$ and $V^{\max}_{ijkl}$ are the bounds of each interval $\left[V^{\min}_{ijkl}, V^{\max}_{ijkl}\right]$.

Note that, computing such intervals of indicator values is possible because of our hypotheses, i.e., indicator values are numerical and indicators are the same for a given category/factor.

3.2 Matching Indicators

The pretreat function of the previous step outputs a set of intervals of indicator values (one per indicator). The goal of this step is to verify if the indicator values of the current city match the indicator values of smart cities of the log. In fact, according to the previous step, the idea is to verify if the current indicator values belong to the intervals previously computed. Thus, one indicator by one, if the current indicator value $V_{current\,jkl}$ does not belong to the computed interval $\left[V^{\min}_{ijkl}, V^{\max}_{ijkl}\right]$, then the corresponding set of actions $\{A_{ijkl}\}$ (of the given indicator) is selected (without duplicates).

Algorithm 1 RecoSmart(L, C_c, G, Pretreat, Match, Extract, Rank, $\prec$)

Require:
L: The log of smart cities,
C_c: The current city which wants to improve its smartness,
G: The category of smart city chosen by the current city,
Pretreat: A function pretreating the cities of the log,
Match: A match function,
Extract: A function extracting actions,
Rank: A function ranking actions,
$\prec$: An action ranking.
Ensure: An ordered set of recommendations

```
CandCities ← ∅ // for the candidate cities
CandAct ← ∅ // for the candidate actions
Interval ← ∅
for each city c_i ∈ L do
    if c_i.category = G then
        CandCities ← CandCities ∪ c_i
    end if
end for
Interval ← Pretreat(CandCities)
for each factor f_j of G do
    for k ∈ [1..n] // n is the number of indicators of f_j do
        if Match(C_c.G.f_j.indicator(k), Interval_{G,f_j,k}) = False then
            for each city c_l ∈ CandCities do
                CandAct ← CandAct ∪ Extract(c_l.G.f_j.indicator(k))
            end for
        end if
    end for
end for
if CandAct ≠ ∅ then
    Rank(CandAct, ≺)
end if
return CandAct
```

The goal of the extract function is to extract a set of actions that will be the basis for the recommendation, i.e., the extracted actions can contribute to help the current city to enhance its smartness by joining the chosen category G. The obtained set of actions, *CandAct*, is the set of unordered recommendations which is returned.

Note that we are aware that such a set of actions can be voluminous.

Naturally, it would be interesting to take into account the environmental, economic and social aspects during our matching step, as pointed by [5, 6].

3.3 Ranking Actions

In the previous step, a set of recommendations is obtained. The purpose of this next step is to select, when the returned set *CandAct* is not empty, the most relevant one w.r.t. a satisfaction criterion expressed by the city which wants to improve its smartness. To this end, an action ranking is needed, that orders the candidate recommendations. There are many ways of ranking the candidates, from very basic to sophisticated ones. Because it is currently difficult to integrate knowledge in a computer system in order to automate decision making, this step is done by stakeholders. Our future work will try to automate this task.

3.4 Toy Example

In this section, we illustrate our proposition with a toy example (data are synthetic). Suppose there is a log containing some informations about two cities: *Smallville* and *Metropolis*. An extract of this log could be:

Smallville = ⟨small city of USA, {smart environment, {sustainable resource management, {⟨water consumption, 300 (liter per year), {after midnight shut down the public fountains, do not water plants during summer}⟩, ⟨electricity consumption, 3,000 (kW per year), {after midnight shut down the public lights, solar street lamps}⟩}, pollution, {⟨air quality, $\frac{10}{10}$, Ø⟩}}}⟩.

Metropolis = ⟨big city of USA, {smart environment, {sustainable resource management, {⟨water consumption, 100,000 (liter per year), {after midnight shut down the public fountains, do not wash cars during summer}⟩, ⟨electricity consumption, 200,000 (kW per year), {after midnight shut down the public lights}⟩}, pollution, {⟨air quality, $\frac{8}{10}$, {restrict vehicles access into town center, lower vehicle speed on big roads}⟩}}}⟩.

Now suppose that the city named *Gotham* (C_c in Algorithm 1) wants to improve its smartness for the category *smart environment* (G in Algorithm 1) where:

Gotham = ⟨city of Batman, {smart environment, {sustainable resource management, {⟨water consumption, 150,000 (liter per year), Ø⟩, ⟨electricity consumption, 100,000 (kW per year), {after midnight shut down the public lights}⟩}, pollution, {⟨air quality, $\frac{8}{10}$, Ø⟩}}}⟩.

Table 1 resumes informations for each city.

The corresponding utility matrix, as illustrated by Definition 2, could be:

u(c, a)	A_1	A_2	A_3	A_4	A_5	A_6	A_7
Smallville	9	7		8	8		
Metropolis	8		6	7		5	5
Gotham				8			

where the action A_1 is *after midnight shut down the public fountains*, A_2 is *do not water plants during summer*, A_3 is *do not wash cars during summer*, A_4 is *after midnight shut down the public lights*, A_5 is *solar street lamps*, A_6 is *restrict vehicles access into town center* and A_7 is *lower vehicles speed on big roads*.

Into the log, informations about the category *Smart environment* are known for cities *Smallville* and *Metropolis*. So, the candidate cities are *CandCities* = {*Smallville*, *Metropolis*}.

Table 1 Cities values

	Smart environment					
	Sustainable resource management				Pollution	
	Water consumption		Electricity consumption		Air quality	
	Value	Actions	Value	Actions	Value	Actions
Smallville	300	• After midnight shut down the public fountains, • Do not water plants during summer	3,000	• After midnight shut down the public lights, • Solar street lamps	$\frac{10}{10}$	Ø
Metropolis	100,000	• After midnight shut down the public fountains, • Do not wash cars during summer	200,000	• After midnight shut down the public lights	$\frac{8}{10}$	• Restrict vehicles access into town center, • Lower vehicles speed on big roads
Gotham	150,000	Ø	100,000	• After midnight shut down the public lights	$\frac{8}{10}$	Ø

Table 2 Intervals and Gotham values

	Smart environment		
	Sustainable resource management		Pollution
	Water consumption	Electricity consumption	Air quality
Intervals	[300; 100,000]	[3000; 200,000]	$\left[\frac{8}{10}; \frac{10}{10}\right]$
Gotham	150,000	100,000	$\frac{8}{10}$

The pretreat function outputs for the given category G, for each indicator of each factor, an interval of values. In our example, for the category *Smart environment*, we have two factors: *sustainable resource management* and *pollution*. For the factor *sustainable resource management*, we have two indicators: *water consumption* and *electricity consumption*. Values of *water consumption* are 100,000 for *Metropolis* and 300 for *Smallville*. So, the corresponding interval is [300; 100,000]. Values of *electricity consumption* are 200,000 for *Metropolis* and 3,000 for *Smallville*. So, the corresponding interval is [3000; 200,000]. For the factor *pollution*, we have here, only one factor: *air quality* and the values are $\frac{8}{10}$ for *Metropolis* and $\frac{10}{10}$ for *Smallville*. So, the corresponding interval is $\left[\frac{8}{10}, \frac{10}{10}\right]$. Table 2 resumes intervals and values of *Gotham*.

Then, the matching function returns the set of actions (implemented by the candidate cities) corresponding to indicators which Gotham's values are out of bounds defined by the pretreat function. In our example, see Table 2, Gotham's water consumption value is the only one being out of bounds. So, candidate actions that can be interesting (no redundancies) are the actions already implemented by *Smallville* and *Metropolis* for the indicator *water consumption* such as, *CandAct* = {do not wash cars during summer, do not water plants during summer, after midnight shut down the public fountains}.

Finally, these candidate actions have to be ordered. For example, they can be ordered according to the ease of implementation. It is easier and faster to decree that public fountains have to be shut down after midnight than to force people to not use water during summer. So, a possible ordered set of actions to be implemented in *Gotham* to improve its environmental smartness is: {after midnight shut down the public fountains, do not water plants during summer, do not wash cars during summer}.

The corresponding utility matrix could be:

u(c, a)	A_1	A_2	A_3	A_4	A_5	A_6	A_7
Smallville	9	7		8	8		
Metropolis	8		6	7		5	5
Gotham	9	7	6	8			

where the action A_1 is *after midnight shut down the public fountains*, A_2 is *do not water plants during summer*, A_3 is *do not wash cars during summer*, A_4 is *after midnight shut down the public lights*, A_5 is *solar street lamps*, A_6 is *restrict vehicles access into town center* and A_7 is *lower vehicles speed on big roads*.

4 Conclusion and Perspectives

We based our work on the classification of [9] focusing on medium-sized cities, and on the analysis of characteristics and factors decisive for a successful forward-looking city development, using data from official, public and freely available sources, on the basis of 74 indicators.

In this work, we restrain our workspace by hypothesizing some assumptions:

- The city which wants to improve its smartness, chooses: at the beginning, only one category of smart cities (among the six) it wants to join.
- Indicator values are numerical.
- Indicators are the same for a given category/factor for each city (only the values change and can be null).

Thus, we propose a kind of recommender system. Given some information on smart cities, our framework returns some actions to implement for a city which wants to improve its smartness.

This is a work in progress, it is a theoretical approach, and our future works include real cases with experts. We are aware that in some evaluations it is possible to expect a bias, because we are in human actions. Our main objective is to propose digital information system for decision aid. The final decision is done by decision makers and must be take with all the stakeholders, taking into account economical, social, financial aspects and all others stakes of this kind of project.

Our future work include (but are not limited to):

- Automatically selecting the efficient category by searching into the log similar cities to the one looking for recommendations.
- Including semantic similarity between indicator values.
- Relaxing some constraints by including, for example, semantic similarity between indicators.
- There are many ways of ranking the candidates, from very basic to sophisticated ones. Because it is currently difficult to integrate knowledge in a computer system in order to automate decision making, this step is done by stakeholders. Automating this task is also a challenge.

References

1. Adomavicius, G., & Tuzhilin, A. (2005). Toward the Next generation of recommender systems: A survey of the state-of-the-art and possible extensions. *IEEE Transactions on Knowledge and Data Engineering, 17*(6), 734–749.
2. Baeza-Yates, R., Hurtado, C., Mendoza, M., Dupret, G. (2005). Modeling user search behavior. *LA-WEB '05: Proceedings of the third Latin American Web Congress*, (p. 242). IEEE Computer Society, Washington, DC, USA.
3. Baeza-Yates, R.A., Hurtado, C.A., Mendoza M. (2004). Query recommendation using query logs in search engines. In W. Lindner, M. Mesiti, C. Türker, Y. Tzitzikas & A. Vakali (Eds), *EDBT Workshops, volume 3268 of Lecture Notes in Computer Science* (pp. 588–596). Springer.
4. Baeza-Yates, A. R., & Berthier, B. A. (1999). *Modern Information Retrieval*. New York: ACM Press.
5. Bettencourt, L., & West, G. (2010). A unified theory of urban living. *Nature, 467*(7318), 912–913.
6. Bettencourt, L. M. A., Lobo, J., Strumsky, D., & West, G. B. (2010). Urban scaling and its deviations: Revealing the structure of wealth, innovation and crime across cities. *PLoS ONE, 5*(11), e13541.
7. Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J., Mellouli, S., Nahon, K., Pardo,T.A.,& Scholl, H.J.(2012). Understanding smart cities: An integrative framework. In *Proceedings of the 2012 45th Hawaii International Conference on System Sciences, HICSS '12* (pp. 2289–2297). IEEE Computer Society, Washington, DC, USA.
8. Fu Y., & Shih, M-Y. (2002). A Framework for Personal Web Usage Mining. In *International Conference on Internet Computing*, pp. 595–600.
9. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic', N., & Meijers, E. (2007). *Smart cities: Ranking of European medium-sized cities*. Centre of Regional Science SRF: Vienna University of Technology.
10. IBM. Smarter cities. http://smartcitieschallenge.org, 2013.
11. Kent, A. (1971). Information analysis and retrieval. Wiley, Inc.
12. Larousse. Action. http://www.larousse.fr/dictionnaires/francais/action/924, 2013.
13. Marcel, P., Negre, E. (2011) A survey of query recommendation techniques for datawarehouse exploration. In EDA.

14. Pierrakos, D., Paliouras, G., Papatheodorou, C., & Spyropoulos, C. D. (2003). Web usage mining as a tool for personalization: A survey. *User Modeling and User-Adapted Interaction, 13*(4), 311–372.
15. Salton, G.(1983). Introduction to modern information retrieval (McGraw-Hill Computer Science Series). New York: McGraw.
16. Schafer, J. B., Joseph Konstan, A., & Riedl, John. (2001). e-Commerce recommendation applications. *Data Mining and Knowledge Discovery, 5*(1/2), 115–153.
17. Schaffers, H., Komninos, N., & Pallot, M. (2012). Smart cities as innovation ecosystems sustained by the future internet. Technical report.
18. Srivastava, J., Cooley, R., Deshpande, M., & Tan, Pang-Ning. (2000). Web usage mining: Discovery and applications of usage patterns from web data. *SIGKDD Explorations, 1*(2), 12–23.
19. The Committee of Digital and Knowledge-based Cities (CDC) of United Cities and Local Governments (UCLG). Smart cities study: International study on the situation of ict, innovation and knowledge in cities. Chaired by Inaki Azkuna, Major of the City of Bilabo, 2013.
20. White, R.W., Bilenko, M., & Cucerzan, S. (2007). Studying the use of popular destinations to enhance web search interaction. In SIGIR, (pp. 159–166).
21. Wiktionary. Action. http://en.wiktionary.org/wiki/action, 2013.

The Smart City and the Creation of Local Public Value

Federico Fontana

Abstract The creation of public value in a financially sustainable way, which is the distinctive function of local authorities, is becoming increasingly complex. This is due to many reasons, and most notably to the roles played by different stakeholders, such as citizens, businesses, other public authorities and not-for-profit organizations. To address this difficulty, many local authorities state that they wish to become 'smart'. A smart city is meant to be actively engaged in improving the quality of life of its citizens and in pursuing sustainable growth, thanks to the wide use of ICT. The aim of this chapter is two-fold. On a theoretical level, it aims at contributing to the definition of smart city and at critically analyzing its role in the creation of public value. On a practical level, it assesses the adoption of the smart city model by a significant number of large and medium-size Italian cities, in order to draw useful recommendations for the future.

Keywords Smart city • Urban strategic planning • Creation of local public value

1 Introduction

The distinctive function of local authorities is the creation of public value in a financially sustainable way. In other words, they are expected to effectively meet the public needs of their citizens, to generate a positive spread between social benefits and costs and thus to contribute to the prosperity of their constituencies. At the same time, they are expected to pursue financial stability by efficiently using the increasingly scarce and therefore precious public resources [12, 34].

F. Fontana (✉)
Department of Economics and Business Studies, University of Genoa, Genoa, Italy
e-mail: fontana@economia.unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_6,

The fulfillment of this function is very complex, due to both the growing proliferation of public needs and the progressive lack of available resources, but also because it is significantly affected by the roles played by many other actors, including citizens, businesses, other public authorities and not-for-profit organizations. These aspects are the main reasons for the wide and growing interest in urban strategic planning, which, in fact, may offer a useful contribution to local government, as long as it is set and carried out in an authentic and substantial way.

To face the difficulty of creating public value, the most innovative local authorities state in their urban strategic plans that they wish to become ‘smart’. A smart city identifies an urban environment that is actively engaged in improving the quality of life of its citizens while pursuing sustainable socio-economic development, thanks to the wide use of information and communication technologies (ICT).

Although widely used, so far the concept of smart city has not displayed a consistent meaning and therefore needs to be deepened and better defined. To address this problem, the chapter seeks to clarify the definition of smart city and to identify fields of action in which the city can be smart. It does so by analyzing the potential benefits that a smart city brings to the quality of life, environmental protection and economic development of its community, and at the same time by looking into the possible obstacles and solutions that characterize the relationship between the local authority and other actors in the social system.

Another problem is that even the application of the smart city model displays a large variation. In this regard, the chapter aims at describing the state of the art of Italian regional capitals, seen as a significant sample of large and medium-size cities in the country. Specifically, the chapter tests whether or not the smart orientation is taken into account in their urban strategic plans, analyzes their common and different features, strengths and weaknesses, and suggests some solutions to overcome weaknesses and exploit strengths.

To sum up, the aim of this chapter is two-fold. On a theoretical level, it aims at contributing to the definition of smart city and critically analyzing the relationship between this concept and the creation of local public value. On a practical level, it assesses the adoption of the smart city model by a significant sample of large and medium-size Italian cities, in order to draw useful recommendations for the future. In essence, the chapter aims at providing a critical and empirically informed analysis of the potential success as well as possible failure of various smart city projects.

2 The Creation of Public Value Through Urban Strategic Planning

The creation of public value in a financially sustainable way, which is the distinctive function of local authorities, is becoming increasingly complex, starting with the possibility of divergence between the community socio-economic development and the institution equilibrium [19].

Indeed, creating a positive difference between the benefits that are produced for and the sacrifices that are required from citizens is not in itself guarantee of financial sustainability for the local authority. This is because benefits and sacrifices are partly economic, but mostly non-economic in nature [45] and also because they often correspond to accounting records of opposite sign.

After all, financial sustainability does not necessarily imply the creation of public value, due to the multiple modes of remuneration of local authorities, which only partly require users to pay the nominal value of the services they are offered. Most often, local authorities are rewarded through political prices or taxation, either direct or transferred [38].

Nevertheless, the creation of public value and financial sustainability need to be pursued jointly: the non-transitory absence of either one or the other would in fact deprive local authorities of their own reason or even possibility to exist. Hence, the need to achieve appropriate levels of effectiveness and efficiency, favored by the new public management model and essential to the reasonable satisfaction of public needs, on the one hand, and the convenient use of scarce public resources, on the other [3, 18, 40].

To continue, the creation of public value is characterized by the degree of operational diversification of local authorities [4]: let's just think of the plurality of functions performed and of the services produced, which are very significant in terms of areas and groups to be targeted, of content and modalities of intervention and, finally, of the multi-disciplinary and multi-sectorial skills and of the composite nature of the problems to be tackled (which often involve aspects that are at the same time environmental, social, economic and technical).

Also the targeted geography is variable and often does not correspond to the administrative boundaries. One classical example is to be found in the field of transport but also in the public services of water distribution or tourism promotion.

Even more important, in terms of operational complexity, is the framework of relationships of opposite sign, sometimes co-operative sometimes competitive, that come into play. To begin with, the governing bodies of local authorities are the expression of the ideas, values and claims of only one section of the community. Secondly, in many cases there is no overlap between the citizens who use the services and products of a given local authority and those that contribute to their funding. Finally, even among the actors that use those services there are often divergent interests, which are functionally antagonistic (e.g. consumers and businesses, pedestrians and motorists) or compete in the allocation of scarce resources. The systemic process of bringing together different expectations is therefore a fundamental and critical condition for the creation of local public value.

Another element of complexity is the dynamism that significant changes in the socio-economic, scientific-technological, and political-cultural domains impress on public needs and public policies [2]. This means that the true identity of the city, of the territory and of the local community is often questioned, if not completely doubted, because of phenomena that give it uncertainty and discontinuity. At the same time, local authorities are assuming roles and features that are more and more composite: the productive role that pertains to them in their quality of service units, the directing role that belongs to them in their quality of public holdings, and the regulatory role that fits them in their quality of local governing bodies.

No less significant are the complementary institutional, political and business dimensions of local authorities [6]. The institutional dimension refers to the set of rules that constitute its statutory principles, defining both the areas of activity and the degree of autonomy [50]. The political dimension refers to the systematic search for consensus that characterizes all government entities, which has to be harmonized with the managerial function expressed by the administrative and technical structure [18, 35, 48]. Both affect the business dimension, influencing both the form of financial sustainability and the creation of local public value.

Last but not least, it should be noted that socio-economic development only partially depends on local authorities. The roles played by other actors in the system—citizens, businesses, other public authorities and not-for-profit organizations—are equally determinant, as well as the contributions they make in terms of resources, expertise, ideas and actions [28]. They constitute a rather fragmented framework, but their attitudes and behaviors nevertheless affect the output produced by local authorities and more generally the process of creation of public value. It is therefore critical that local authorities adopt a public governance approach, namely, a willingness and an ability to play the important role of attracting, involving, monitoring, and promoting the activities of other social actors. They need to facilitate and positively orient, in a collaborative and synergistic sense, the individual and collective development of these actors, thus contributing to generate and at the same time draw upon the social capital of the whole community [39, 42].

The above-mentioned aspects of specificity and complexity that characterize the distinctive function of local authorities are the main reasons for the wide and growing interest in urban strategic planning [33].

Urban strategic planning, in fact, may offer a useful contribution to local government, as long as it is set and carried out in an authentic and substantial way. It is necessary that the plan does not limit itself to only internal and external analyses—even if they are to a degree indispensable. It also needs to identify a fair model of development that is guided by a long-term and far-reaching vision and is able to make clear the meaning of its foundational choices and, on this basis, identify possible courses of action, projects to be given priority and related operational solutions.

More specifically, the effectiveness of the urban strategic plan requires some appropriate conditions for both the object and the subjects of planning.

With regards to the contents of the plan, it is necessary to have a selective and integrated approach, which is both far-reaching and perspective, sustainable and flexible [43, 46].

A selective approach, limited to a few themes, objectives and projects that are relevant to the socio-economic development of the territory and the community, is essential to focus attention and actions on crucial and decisive issues, those that are able to have a greater impact on future scenarios, and to avoid instead dispersion of energies and dissipation of resources.

At the same time, an integrated approach that is mindful of the interdependence and co-determination of the various policy interventions is essential to make them consistent and coordinated, to generate useful synergies and to create systemic value. From a space-time perspective, a far-reaching and long-term horizon is necessary to take account of complementarities (both as sources of constraints and opportunities) between different regions and various levels of government, to achieve important goals, to coagulate significant resources, and to enable innovative processes, overcoming the shortsightedness and constraints of each single administrative mandate.

Further key features to take into account are the sustainability and flexibility of the contents of the urban strategic plan. The former, which is the result of the beneficial correlation between goals and resources, makes the urban strategic plan rational and realistic, at once ambitious and feasible, avoiding idealistic temptations as well as the propensity to give up. The latter, which corresponds to the dynamism of the context, makes the plan adaptive and constantly updated (both in terms of geographical and operational contents).

In summary, all these characters of the urban strategic plan allows to identify (1) the areas in which the city, on the basis of its identity, vocation and resources can (and should) try to excel autonomously, (2) the areas in which, in order to be successful, the city must weave collaborative relationships with other entities (and on which it would be appropriate to invest), and, finally, (3) the areas where the city does not have or can acquire the conditions to play a significant role (and which it would be reasonable to give up).

As for the role of the actors involved in the planning process, the principles of openness, partnership and leadership are fundamental [14, 41].

The drafting and subsequent implementation of the urban strategic plan requires an open and transparent approach, which is at time relational and communicative, engaging and participatory. This would promote the fruitful interaction of the plurality of key public and private subjects and prevent both the self-referential attitude of the former and the opportunism, indifference or exclusion of the latter. In this way, it is possible to strengthen democratic participation as well as the accountability of local authorities, to balance all powers involved, to positively deal with conflicts of interest, and to promote mutual trust and a sense of belonging of all different actors, thus encouraging collaborative and proactive approaches.

Growing importance is also attributed to the development of partnership relationships between public and private actors. These alliances, which are the result of voluntary agreements governed by fair rules and by negotiation skills, allow for a clear distribution of responsibilities, tasks, risks and benefits among all relevant stakeholders.

What is essential, in any case, is the exercise of the function of leadership by local authorities, which presupposes their competence and legitimacy and results in the construction of truly shared and consensual scenarios.

Under these conditions, the plan can be a real and high-impact instrument for public governance and strategic management, able to dynamically integrate the needs for economic development and social and environmental protection with the management tools that are necessary to achieve the shared goals, on which it is then possible to gravitate interests, generate resources and promote the assumption of responsibilities [8, 21].

3 The Smart City Model for the Creation of Public Value

In the previous section we showed how the creation of local public value in a financially sustainable way is a very complex function, which can find a useful governance tool in the urban strategic plan.

To address this complexity, many local authorities state that they wish to become smart. A smart city is meant to be actively engaged in improving the quality of life of its citizens and in pursuing sustainable socio-economic development, thanks to the wide and innovative use of ICT.

However, so far the concept of smart city, although widely used, does not have a consistent meaning and therefore needs to be deepened and better defined.

The concept of smart city was first mentioned in the mid-90s [5], although its use became prominent at the beginning of the third millennium, due, on the one hand, to the interests of multinational companies operating in the ICT sector, such as IBM and Cisco, and, on the other hand, to the attention that international bodies such as the European Commission and the OECD devoted to the subject [23, 25].

It is no coincidence that, even in the scientific literature on the subject, different schools of thought have developed around the concept of smart city [11, 13, 36, 44].

Among the most prominent of these schools of thoughts, there is the one that focuses on ICT applied to the redesign of every aspect of urban life. In this sense, the smart city is considered an urban environment at the same time equipped, interconnected and intelligent [26]. An appropriate hardware, software, and network equipment composed of sensors, kiosks, personal devices, smartphones, tablet PCs, GPS devices, the web, social networks, etc. can detect massive amount of data on the life of the city in real-time [37]. Their interconnection, that is, their integration on a platform of enterprise computing, allows for the exchange of information between the various municipal services [31]. The intelligent use of such information allows to perform complex analyzes, to develop conceptual models, and to visualize and optimize critical processes, in order to take the most rational operational decisions [49].

This meaning of smart city can be seen as an extension and evolution of other concepts of the city, such as the ‘digital city’ and the ‘ubiquitous city’.

The digital city, the most dated among these concepts, was created to refer to any digital initiative undertaken by a city, starting with the provision of Internet access (in this case we also refer to the ‘wired city’) up to the 3D representation of the city (the so-called ‘cyber city’). In the most general sense, the digital city is identified as an information system that collects digital information on the real city and makes it available in a virtual public space, where citizens can consult it, but also interact with the system and with other users (hence the oftentimes used term of 'intelligent city') [16, 32].

The ubiquitous city (also referred to as 'U-city') further develops the idea of the digital city, creating a new generation of urban space, which results from the convergence between physical world and virtual reality. The U-city is defined as an innovative model designed to improve the management of the city, the quality of life and economic development by identifying the critical success factor in the attention given to the end user. Nonetheless, there are projects that focus only on certain categories of citizens (e.g. young people), which mitigates the user-centric nature of the ubiquitous city [10, 29].

In addition to the current of thought that focuses on ICT, another one worth mentioning defines smart cities as those cities that thoroughly innovate their governance and their own conditions of socio-economic development. This meaning, although it does not renounce the support that comes from a wide and innovative use of ICT, focuses on the proper fulfillment of the needs of citizens, businesses and other organizations. From this point of view, a smart city, by monitoring and integrating its critical infrastructure, whether it is the physical capital (roads, bridges, etc.), technological capital (hardware, software, network) or intellectual and social capital (resulting from the relationships between the members of the community), plans the activities of prevention, maintenance and management, makes an efficient use of its resources, and optimizes the effectiveness of its services. Under these conditions, a smart city is an urban context that is at the same time innovative, competitive, effective, efficient, as well as safe, livable, equitable, and sustainable [24, 47].

The main difference between this meaning of smart city and the previous one consists in the role attributed to ICT. In the first case, ICT is an indispensable element around which everything revolves; in the second case, it is only one of the pillars of the model, of which it represents an important enabling factor, but not necessarily the only one, and, sometimes, not even the most important one.

The non-ICT-centered meaning is characterized by a broader, more flexible and open vision. A vision that appears more consistent and convincing, certainly more coherent with the objective of creating local public value. Like for the ICT-centered approach, even this meaning can be related to other recently developed concepts of the city, and in particular to that of 'knowledge city' [1, 9].

In essence, a knowledge city is purposely designed to encourage and nurture the collective knowledge, that is, the intellectual capital of the community, seen as a determinant factor for the sustainable creation of local public value [15]. This city-model derives its social, environmental and economic success by a series of factors, notably [17]: the allocation of facilities, networks and tangible and intangible assets for the production of goods and services based on knowledge (in the broadest sense of the word and, thus, potentially in its scientific, technological, cultural, and artistic manifestation); the development of conditions able to promote talent, creativity, innovation and entrepreneurship; the availability of technologies, instruments and services for the systematic, effective and efficient dissemination of knowledge; the presence of actual and virtual places that can facilitate interpersonal relations, the exchange of information and the sharing of experiences; and, finally, the ability to generate, attract and retain citizens who are not only highly qualified from a professional point of view but also engaged with the political-institutional life and environmentally-conscious.

The similarities between the concept of knowledge city and that of smart city are very apparent, although the former is characterized by a greater focus on intellectual and social capital, and the latter by a broader, more open and flexible perspective. The concept of smart city, therefore, is more complete and more easily applicable to the majority of urban areas, since it is respectful of their identity, their distinctive characteristics and their evolutionary paths.

On this basis, it seems interesting to identify the areas of intervention in which the city can be smart, that is, able to contribute to the quality of life of its citizens, to the protection of the environment and to economic development. A systemic approach allows to identify six relevant dimensions [22]: smart economy (i.e. competitiveness), smart people (in terms of social and human capital), smart living (i.e. quality of life), smart environment (i.e. attention to the natural resources), smart mobility (which refers to both transport and telecommunication networks and services), and, of course, smart governance (with its features of openness, transparency, participation, and accountability).

These are the same dimensions that the European Commission takes into account when designing programs to give financial support to smart cities.

In this regard, it should be noted that the reference to such dimensions, each of which can be further articulated, has the advantage of making the model very encompassing, covering all the areas of intervention of the city. Yet it is unlikely that a single city can excel in all the above-mentioned areas. It is more likely that each urban reality can be smart in one or more areas of intervention (e.g. economic development, the protection of the environment), but not necessarily in all of them.

In other words, there is no single model of smart city, but rather as many variations as there are possible meanings and contexts of 'smartness', with all their possible nuances and combinations [27].

Despite its conceptual variety, the smart city, to be considered such and to become successful, must prove to be genuinely creative. This means that it must develop an original model of socio-economic development through a clear strategic direction, a model that makes the most of its identity, its vocation and its specificity, avoiding improvised or unrealistic approaches as well as to give into emulative practices—unfortunately fairly common.

Obviously, some contextual conditions are essential, notably the concentration, variety and variability of the community of reference [7, 30]. This concentration, which is defined as the presence of a significant number of people in a given geographical space, is an essential factor from both a qualitative and a quantitative perspective: it ensures the necessary population density, but especially the high intensity and frequency of interpersonal and inter-organizational relationships within which smart ideas can grow and spread.

Variety, in the broadest sense of the term, refers both to the community (i.e. diverse people, knowledge, activities and needs) and to the territory (a combination of different uses of the urban area, e.g. residential, touristic, administrative, manufacturing, commercial, recreational). Variety determines the wide array of opportunities for interaction and promotes the development of creativity, innovation and entrepreneurship.

Variability, in the double meaning of instability and dynamism, is also very significant, since it is from situations of uncertainty and struggle that important innovations might emerge (especially when the fear of a crisis overcomes the aversion to change). Likewise, it is from the opening and consequent evolution of the urban environment that the cognitive capital can be increased and new opportunities for development can materialize.

However, in order to accrue the benefits deriving from the creation of public value, a smart city not only must (try to) be such, it must also be able to communicate its objectives and be perceived as a smart city by all relevant stakeholders. The construction of an image that is at the same time recognizable and attractive, credible and distinctive plays a decisive role in determining the success of a smart city.

4 An Empirical Study About Smart City and Urban Strategic Planning

In view of the contribution that the smart city model gives to the creation of local public value, it may be interesting to assess if and how this model is included in urban strategic plans—and if consideration is given to its various meanings, fields of activity and contribution to the socio-economic development. Specifically, we intend to analyze whether or not the smart orientation is taken into account in the urban strategic plans of the Italian regional capitals, as reflected in the documents published on their institutional websites.

Focusing on the regional capitals allows us to analyze a relatively limited but significant sample of institutions that, although characterized by some common features, differ in several aspects, ranging from the size, geographical characteristics and territorial and socio-economic aspects. By covering substantially all of the significant areas of the country, they constitute a sufficiently representative sample of the variety that characterizes the system of local authorities in Italy.

The documents considered, despite the variety of denominations and methodological approaches, include all urban strategic planning tools, but also any other document that specifically refers to the concept of smart city and that is published on the web as of July 31, 2013. The reference to the documents available online provides useful information on the degree of sensitivity of the specific local administration to the wider dissemination—in terms of accountability—of the information included in its plans.

In general, there is a significant commitment to urban strategic planning (the data shown represent an update to those reported in [20]): 20 out of 21 municipalities (95 %, with the exception of Trieste) have started a strategic process. There is also a high level of disclosure, since 18 municipalities out of 20 (90 %, with the sole exceptions of Potenza and Catanzaro) publish online their urban strategic plans (Table 1).

No less significant is the reading of the data at a demographic level, according to the classes identified by the Ministry of the Interior, and with reference to the geographical areas identified by the Italian Institute of Statistics—ISTAT (Table 2).

From a demographical point of view, the classes of municipalities with the highest level of strategic elaboration and dissemination are those with more than 250,000 inhabitants, where all the institutions establish and publish on the web their strategic planning documents. The next smaller size class (between 100,000 and 250,000 inhabitants) is still characterized by a high degree of strategic disclosure, since this class of cities make available online all the plans they formulated (5 out of 6 bodies, representing 83 % of total local authorities). Relatively smaller, however, is the commitment of the regional capitals of smaller size (up to 100,000 inhabitants), in which only 60 % of the plans are published.

Geographically, the cities in the North–West and Center of the country plus the Islands are those that, overall, are characterized by a larger strategic development and transparency, with the formulation and online publication of strategic plans by all regional capitals. The North–East area still displays a substantial level of strategic planning and disclosure (all 4 strategic plans formulated by the 5 municipalities included in the analysis are published online, representing 80 % of the total). The Southern area, even in the presence of a high level of strategic planning commitment (all regional capitals have begun the process of strategic planning), is characterized by a lower level of disclosure (about 67 %).

In addition to the number of strategic plans produced and disclosed, it's interesting to analyze some other qualifying aspects.

First of all, even if all the documents are characterized by a strategic breath and a medium to long-term perspective (usually 10 years long), 2 out of 17 plans (representing 11 % of the total) focus exclusively on urban-regulation aspects (it's the case of Ancona and Milan), even if they are the result of participative decision-making processes.

It is also important to point out that, although in most cases the process of urban strategic planning and implementation was directly promoted by the local authority, there are cases, like those of Turin and Florence, where the process was initiated, implemented and disseminated by a separate organization (namely '*Strategic Turin Foundation*' and '*Future Florence Association*') gathering both public and private actors and with no management power. In these cases, the plan may contain highly sophisticated analyses and proposals, be perceived as the privileged site for the meeting and engagement of all key-players and for the establishment of an effective communication strategy, but is hardly seen as an authentic instrument of local government.

Table 1 Urban strategic plans of Italian regional capitals: overall framework

Cities	Demographic classes and geographical areas	Title of urban strategic plans	Year
Aosta	*Up to 100,000 inh North–West*	*Future of Aosta: Strategic Plan of Aosta and of La Plaine*	2010
Turin	*From 500,000 to 1,000,000 inh North–West*	*1) City Strategic Plan—International Turin*	2000
		2) 2° Strategic Plan of the Metropolitan Area	2006
Genoa	*From 500,000 to 1,000,000 inh*	*1) Plan of the City of Genoa*	2002
	North–West	*2) The City Changes (UrbanLab)*	2009
Milan	*Over 1,000,000 inh North–West*	*Government Plan of the Territory*	2011
Trento	*From 100,000 to 250,000 inh*	*1) Strategic Plan 2010*	2003
	North–East	*2) Strategic Agenda 'Trento 2020'*	2007
Bolzano	*From 100,000 to 250,000 inh North–East*	*Ideas for 2015: Thinking the City*	2004
Venice	*From 250,000 to 500,000 inh North–East*	*Venice Metropolitan Area*	2004
Trieste	*From 100,000 to 250,000 inh North–East*	*N/A*	N/A
Bologna	*From 250,000 to 500,000 inh North–East*	*Metropolitan Strategic Plan*	2013
Florence	*From 250,000 to 500,000 inh*	*1) Strategic Plan Florence 2010*	2002
	Center	*2) There is More than One Florence*	2009
Ancona	*From 100,000 to 250,000 inh Center*	*A Plan for Ancona: the Changing City*	2009
Perugia	*From 100,000 to 250,000 inh Center*	*Perugia—Europe from 2003 to 2013*	2004
Rome	*Over 1,000,000 inh Center*	*Strategic Plan for the Development of Rome Italian Capital*	2009
L'Aquila	*Up to 100,000 inh South*	*L'Aquila 2020*	2008
Campobasso	*Up to 100,000 inh South*	*Territorial Strategic Plan*	2008
Bari	*From 250,000 to 500,000 inh South*	*BA2015—Metropolitan Area of Bari*	2008
Naples	*From 500,000 to 1,000,000 inh South*	*Strategic Plan*	2006
Potenza	*Up to 100,000 in South*	*Strategic Project of Potenza's Hinterland*	2005
Catanzaro	*Up to 100,000 inh South*	*Strategic Plan*	2011
Palermo	*From 500,000 to 1,000,000 inh Islands*	*Palermo, Capital of the Euro-Mediterranean Area*	2010
Cagliari	*From 100,000 to 250,000 inh Islands*	*Strategic Plan*	2008

Table 2 Urban strategic plans of Italian regional capitals: data by demographic classes and geographical areas

	N. of cities	N. (%) total population		N. (%) of plans approved		N. (%) of plans online	
Total	21	9,732,740	(100 %)	20	(95 %)	17	(81 %)
Demographic classes (interior ministry)—N. of inhabitants:							
Up to 100,000	5	319,897	(3 %)	5	(100 %)	3	(60 %)
From 100,000 to 250,000	6	853,516	(9 %)	5	(83 %)	5	(83 %)
From 250,000 to 500,000	4	1,342,822	(14 %)	4	(100 %)	4	(100 %)
From 500,000 to 1,000,000	4	3,130,918	(32 %)	4	(100 %)	4	(100 %)
Over 1,000,000	2	4,085,587	(42 %)	2	(100 %)	2	(100 %)
Geographical areas (ISTAT):							
North–West	4	2,874,628	(30 %)	4	(100 %)	4	(100 %)
North–East	5	1,076,927	(11 %)	4	(80 %)	4	(80 %)
Center	4	3,403,925	(35 %)	4	(100 %)	4	(100 %)
South	6	1,564,897	(16 %)	6	(100 %)	4	(67 %)
Islands	2	812,363	(8 %)	2	(100 %)	2	(100 %)

One further consideration to make is that most of the urban strategic plans are fairly recent (the oldest one was approved in 2000 and only 9 out of 17 plans, representing 53 % of the total, are more than 5 years old). It would therefore be premature to assess the impact they had on their socio-economic environment. Among the older experiences, four are fairly significant, having already moved to the second generation of urban strategic plans. In the cases of Turin, Trento and Florence the second-generation plan stems from a critical analysis of the structure, content, status of implementation and impact of the first-generation plan. In the case of Genoa, however, the two documents are not sequential and rather highlight a discontinuity of both strategic and administrative nature.

Within this framework and considering the overall high levels of strategic planning and disclosure recorded by the generality of Italian regional capitals, it is interesting to analyze if, how and what of the smart city model is reported in their urban strategic plans (Table 3).

The first thing that can be evidenced is that only 4 of the 18 analyzed urban strategic plans contain specific references to the smart city model. Moreover, these 4 plans refer to individual areas of activity, such as the security of infrastructure, eco-friendly construction activities, energy efficiency, sustainable mobility and the use of ICT in the delivery of services to citizens. They all lack an overall strategic vision of the smart city.

Another thing that can be highlighted is the demographic and geographic distribution of the collected data: first, the 4 cases that cite the smart city model belong to different demographic classes (with weights ranging from 20 % to 50 %), with the sole exception of the class between 100,000 and 250,000 inhabitants; second, each of them belong to a different geographical area (with weights ranging between 17 % and 25 %), with the sole exception of the Islands.

In essence, the distribution of the few urban strategic plans containing specific references to the model of the smart city is numerically rather homogeneous, both demographically and geographically.

Nevertheless, all the plans of the Italian regional capitals contain frequent references to aspects that are considered typical of the smart city model, such as change (e.g. the plan of Bolzano '*Ideas 2015: Thinking the City*', the second plan of Genoa '*The City Changes*', and '*A Plan for Ancona: the Changing City*') and innovation (e.g. '*Venice—City of higher education, research and innovation*', '*Bari—Research & Innovation, The metropolis in a bit*', and '*Cagliari—Knowledge, innovation and development*').

Consequently, it seems that at the time of the preparation of these urban strategic plans, the reference to the smart city model was not yet sufficiently robust and widely known, so as to remain largely unexpressed or marginal. In view of these findings, it is interesting to see whether, beyond the content of the urban strategic plans, the smart city model finds confirmation in other planning documents that the regional capitals have approved and published online (Table 3).

This approach leads to substantially different results, since 13 of these municipalities (62 % of the total) publish on their websites documents where they declare their intention to become smart (mostly in response to bids for funding at the

Table 3 The smart city model in the urban strategic plans and other specific documents of Italian regional capitals

	N. (%) of online documents containing references to the smart city model	Urban strategic plans	Other specific documents
Total	***Overall situation***	**18 (86 %)**	**13 (62 %)**
	of which: without significant content	14 (67 %)	–
	specific fields of activity	4 (19 %)	8 (38 %)
	overall model	–	5 (24 %)
Demographic distribution	***Up to 100,000 inhabitants***	**3 (60 %)**	**2 (40 %)**
	of which: without significant content	2 (40 %)	–
	specific fields of activity	1 (20 %)	2 (40 %)
	overall model	–	–
	From 100,000 to 250,000 inhabitants	**5 (83 %)**	**2 (33 %)**
	of which: without significant content	5 (83 %)	–
	specific fields of activity	–	2 (33 %)
	overall model	–	–
	From 250,000 to 500,000 inhabitants	**4 (100 %)**	**3 (75 %)**
	of which: without significant content	3 (75 %)	–
	specific fields of activity	1 (25 %)	3 (75 %)
	overall model	–	–
	From 500,000 to 1,000,000 inhabitants	**4 (100 %)**	**4 (100 %)**
	of which: without significant content	3 (75 %)	–
	specific fields of activity	1 (25 %)	2 (50 %)
	overall model	–	2 (50 %)
	Over 1,000,000 inhabitants	**2 (100 %)**	**2 (100 %)**
	of which: without significant content	1 (50 %)	–
	specific fields of activity	1 (50 %)	–
	overall model	–	2 (100 %)

(continued)

Table 3 (continued)

	N. (%) of online documents containing references to the smart city model	Urban strategic plans	Other specific documents
Geographical distribution	***North–West***	**4 (100 %)**	**4 (100 %)**
	of which: without significant content	3 (75 %)	–
	specific fields of activity	1 (25 %)	2 (50 %)
	overall model	–	2 (50 %)
	North–East	**4 (80 %)**	**3 (60 %)**
	of which: without significant content	3 (60 %)	–
	specific fields of activity	1 (20 %)	3 (60 %)
	overall model	–	–
	Center	**4 (100 %)**	**2 (50 %)**
	of which: without significant content	3 (75 %)	–
	specific fields of activity	1 (25 %)	1 (25 %)
	overall model	–	1 (25 %)
	South	**4 (67 %)**	**3 (50 %)**
	of which: without significant content	3 (50 %)	–
	specific fields of activity	1 (17 %)	1 (17 %)
	overall model	–	2 (33 %)
	Islands	**2 (100 %)**	**1 (50 %)**
	of which: without significant content	2 (100 %)	–
	specific fields of activity	–	1 (50 %)
	overall model	–	–

national and EU level). Within these 13 cases, the majority (8 out of 13, 62 %) talks of smart interventions in specific fields of activity (the same that were mentioned above), but there are also cases (more specifically 5, which account for 38 % of the total) that refer to a comprehensive model of smart city.

As pointed out when talking of urban strategic planning, even in the development of smart city projects there are both initiatives launched directly by the local authorities (8 out of 13 cases, 62 % of the total) and initiatives launched by separate organizations (mostly associations or foundations) promoted by the same municipalities (5 cases out of 13, 38 % of the total). It should be noted, however, that in no case the launching association or foundation is the same organization that is involved in the urban strategic planning—at the most there are forms of collaboration that develop between the two entities (e.g. '*Turin Smart City Foundation*' vs. '*Strategic Turin Foundation*').

For completeness, it is also worth noting that in four other urban areas (Florence, Potenza, Trento and Trieste), some initiatives aimed at developing smart projects have even been initiated by organizations to which, at least so far, the local administration does not participate directly.

This multifarious framework allows us to develop some critical considerations.

The fact that only one-fifth of the urban strategic plans formulated by the Italian regional capitals refer explicitly to the smart city model can have two complementary meanings. On the one hand, it may signal the weakness or, more simply, backwardness (even only from a terminological point of view) of most of the analyzed urban strategic plans, which overlook a relevant and critical model for the creation of local public value. On the other hand, it may signal the lack of strategic importance that was attributed to the smart city model, at least until the time these plans were approved (which is pretty recent). This could have happened despite the smart city model is formally identified as instrumental in improving the quality of life, safeguarding the environment and promoting economic development.

The latter interpretation seems to be confirmed by the fact that 62 % of the analyzed municipalities pursue, in fact, smart city projects, but mainly in the context of their participation in specific bids for public funding. These are certainly positive for the innovative opportunities they offer, but nevertheless expose to the risk of undertaking occasional or sporadic initiatives that are not included in a clear strategic vision. Although it is too early to evaluate the results that can be achieved in this way, another risk worth mentioning is that these projects, once the funds allocated to them are exhausted, get abandoned, making their socio-economic impact extremely modest and ephemeral.

Moreover, the fact that in a significant number of cases, the pursuit of smart city projects is delegated to organizations outside the local administration (not to mention those cases in which the initiative is promoted by entities to which the municipality does not even participate) may, in turn, be variously evaluated. On the one hand, it is a solution that can support the wide and open involvement of the plurality of public and private stakeholders. On the other hand, it is a situation that, in the absence of specific managerial powers attributed to the delegated organization, can hardly be an effective form of local government (as already noted on the subject of urban strategic planning). This can result in an excellent design of smart city, which, however, cannot be concretely implemented outside some random occurrences.

Finally, the fact that there is a predominance of projects focused on specific fields of activity rather than on a comprehensive model of smart city can, also, be interpreted in different ways. On the one hand, this can be a strength, if it means that only the aspects considered most relevant and critical to the specific urban context are selected. On the other hand, it can be a point of weakness, if these projects are not part of a clear strategic vision.

The latter interpretation seems, unfortunately, more likely, as the areas of activity that are addressed in the smart city projects are often common to several cities, not assuming, at least apparently, a character that is tailored to the specific urban situation. In addition, as already mentioned, since these projects substantially correspond to the activities that are financed with public funds, they seem to reflect an opportunistic behavior rather than strategic choices that are broad and forward thinking. This adds to the fact that in several cases the only chosen area of activity is the development of ICT.

As mentioned earlier, technological innovation is an essential condition for any smart city project. However, such projects run the risk of failing if they are designed to respond to a technological innovation rather than to an actual need. In other words, these projects are likely to propose answers to needs that are not felt by the citizens, perhaps neglecting others that are of greater importance for everyday life.

Even the usability factor of the technological tools that are developed assumes a certain importance. In countries where the average age is rather high, like Italy, it needs to be considered that large segments of the population are not familiar with digital solutions and therefore will tend not to use them, despite having them available, even when they respond to actual needs.

After all, it should not be overlooked that citizens must be made aware not only of the existence and availability of a service, or its ease of use, but also of the concrete benefits that the service itself can bring to each of them individually and to the community. For example, equipping bus stops with digital panels providing passengers with real-time information on the arrival times of buses can even be counterproductive, if first the efficiency and proper frequency of the public transport service is not ensured.

5 Conclusion

To sum up the main points touched in this chapter, a city can be defined smart when the investments in physical, technological, intellectual and social capital nurture a sustainable economic development and a high quality of life, while at the same time wisely managing natural resources and using a participatory model of government. It is important to remark that the quality of being smart does not have to be uniquely related to the presence of ICT, but also to the recognition that the intellectual and social capital as well as the physical capital are important factors in the creation of local public value.

From an infrastructural point of view, it is important that the available resources are used together to improve economic and political efficiency and enable social and urban development. From a social point of view, a smart city is a city whose community has found out how to learn, adapt and innovate, with a particular focus on achieving social inclusion and citizen participation in urban governance. From an environmental point of view, sustainability emerges as a priority; this is a very important aspect in a world where resources are scarce and cities increasingly base their development also on the availability of natural resources. From an economic point of view, a city can be considered smart if, thanks to its competitiveness, is able to attract new businesses and thus to increase local prosperity.

Consequently, research on the smart city is both complex and fascinating and may represent one of the main areas of urban innovation and development in the coming years.

To be effectively set up and implemented, however, the smart city model requires competence and the ability to follow through. It cannot be managed in an improvised or episodic way. It requires a strategic vision that is specific, clear and selective and a system of governance that is authentic, open and engaging.

To this end, it is necessary that the smart city model is clearly stated in the urban strategic plan and, in an integrated and convergent way, in the operational programs and budgets of the local authority. This condition is, in fact, essential to make the municipality's overall system of governance meaningful, relevant and functional and to avoid the proliferation of a multitude of independent and distinct planning tools. The latter could perhaps be singularly well-designed, but likely to compose a too crowded instrumental framework, which can be redundant and wasteful, inevitably rigid, costly and of little value, since its results are essentially alien to the effective processes of government and management.

With specific regard to the smart city orientation in urban strategic planning, there are many other weaknesses that should be adequately addressed and that concern both methodological and substantive issues. For what concerns the latter, at least two perils must be avoided: first, the excessive generality of the strategic objectives, which is typical of settings that tend to be all-inclusive; second, the opaque definition of the contents of the plan, which is the result of non-rational or non-transparent choices. For what concerns methodological issues, especially the way in which decisions are taken, the main risks and limits concern the only apparent openness of the planning process and the purely fictitious involvement of civil society. This corresponds to a decision-making process that is circumscribed to the narrow political and administrative boundaries or, no less seriously, to a privileged and non-transparent relationship among strong powers.

Another risk that is not to be underestimated is the lack of coherence, both in terms of harmony and synchrony and of horizontal and vertical integration, between the smart orientation of a local authority and (1) that of contiguous territorial contexts (either geographically close or more generally united by the same socio-economic problems) and (2) that of other levels of government (provincial, regional, national). This aspect is particularly important for the urban realities of smaller size, which are increasingly, and per se praiseworthy, testing smart solutions. If the need for an integrated approach is not taken into account, these initiatives might be characterized more by their audacity than by their probability of success.

In all such cases, the governance tools that have been adopted are often only formally ‘for governance’. In reality, they are dominated by rhetoric, fashion or fiction, they can be self-referential, shortsighted, emulative, unrealistic, bent to particular interests, and, in any case, unable to contribute to the creation of local public value. In other words, they tend to be irrelevant to the directions of change of the corresponding socio-economic system.

On the contrary, in order to be useful to the development of a smart city, urban strategic planning requires the prior definition of appropriate rules concerning openness, transparency of information and communication flows, solutions for the involvement and participation of social actors, partnership arrangements and the exercise of leadership. These are essential rules to try to reduce and overcome—with the awareness of never succeeding completely—many areas of risk inherent to the innovation process of urban contexts. These risks include actors not being open to dialogue and exchange, information asymmetries, power imbalances, divergence of interests, unstated priorities, lack of resources, inertial activities, and unforeseen emergencies.

Despite these risks, if carried out according to the above-mentioned system of rules, the urban innovation process allows giving answers to the problems that the vast majority of stakeholders consider most appropriate. In other words, it provides answers that are largely shared across all interested actors. In order to do so, it is necessary to build a clear, strong, distinctive and long-term vision and to formulate specifically selected yet at once flexible and adaptive goals and projects.

The result will be a smart agenda for local government that is significant enough to make a difference and streamlined enough to be effectively implemented and shared among relevant actors. This will allow the municipality to mobilize interests, build consensus, attract resources, and produce positive results. The actual achievement of positive results—obtained through the implementation of strategies, the activation of processes of collective learning, the higher cohesion among social actors, better ownership of new policy initiatives, and the progressive realization of the desired idea of smart city—can effectively contribute to the creation of local public value.

References

1. Amato, G., Varaldo, R, & Lazzeroni, M. (Eds.) (2006). *La Città nell’Era della Conoscenza e dell’Innovazione*. Milano: Franco Angeli.
2. Anselmi, L. (Ed.). (2005). *Principi e Metodologie Economico-Aziendali per gli Enti Locali. L’Azienda Comune*. Milano: Giuffrè.

3. Borgonovi, E. (Ed.). (1984). *Introduzione all'economia delle amministrazioni pubbliche*. Milano: Giuffrè.
4. Borgonovi, E. (2004). *Principi e Sistemi Aziendali per le Amministrazioni Pubbliche*. Milano: Egea.
5. Bright, J. (1995). The Smart City: Communications Utopia or Future Reality? *Telecommunications, 29*(9), 175–181.
6. Buccellato, A., Asquer, A., & Spano, A. (2004). *Il Governo delle Aziende Pubbliche*. Milano: Giuffrè.
7. Camagni, R. (1993). *Principi di Economia Urbana e Territoriale*. Roma: Carocci.
8. Capello, R., & Nijkamp, P. (Eds.). (2004). *Urban Dynamics and Growth*. Amsterdam: Elsevier.
9. Carrillo, F. J. (Ed.). (2006). *Knowledge Cities*. Boston: Elsevier/Butterworth-Heinemann.
10. Choi, J. H. J. (2010). The City is Connections: Seoul as an Urban Network. *Multimedia Systems, 16*(1), 75–84.
11. Cretu, L. G. (2012). Smart Cities Design using Event-driven Paradigm and Semantic Web. *Informatica Economică, 16*(4), 57–67.
12. Deidda Gagliardo, E. (2002). *La Creazione del Valore nell'Ente Locale*. Milano: Giuffrè.
13. Doherty, P. (2013). *Smart Cities. How to Build Sustainable and Resilient Environments in an Increasingly Urbanized World*. McGraw-Hill Financial Global Institute. www.mhfgi.com
14. Donna, G. (2010). La Pianificazione Strategica nell'Ambito Pubblico. *Impresa Progetto—Electronic Journal of Management*, *2*. http://www.impresaprogetto.it
15. Edvinsson, L. (2006). Aspects on the city as a knowledge tool. *Journal of knowledge management, 10*(5), 6–13.
16. Ergazakis, E., Ergazakis, K., Askounis, D., & Charalabidis, Y. (2011). Digital cities: Towards an integrated decision support methodology. *Telematics and Informatics, 28*(3), 148–162.
17. Ergazakis, K., Metaxiotis, K., & Psarras, J. (2004). Towards knowledge cities: Conceptual analysis and success stories. *Journal of Knowledge Management, 8*(5), 5–15.
18. Farneti, G. (1995). *Introduzione all'Economia dell'Azienda Pubblica*. Torino: Giappichelli.
19. Fontana, F. (2009). Capitale Intellettuale e Creazione di Valore Pubblico Locale. *Impresa Progetto—Electronic Journal of Management*, *2*. http://www.impresaprogetto.it
20. Fontana, F. (2012). The intellectual capital in urban strategic planning. *Journal of U.S.-China Public Administration, 9*(7), 791–811.
21. Gibelli, M. C., & Curti, F. (Eds.). (1996). *Pianificazione Strategica e Gestione dello Sviluppo Urbano*. Firenze: Alinea.
22. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., et al. (2007). Smart Cities: Ranking of European Medium-sized Cities. http://www.smartcities.eu
23. Granelli, A. (2012). *Città Intelligenti?*. Roma: Luca Sassello Editore.
24. Hall, R. E. (2000). The vision of a smart city. In *Proceedings of the 2nd International Life Extension Technology Workshop*, Paris, France, 28 Sept.
25. Harrison, C., & Donnelly, I. A. (2011). A theory of smart cities. In *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences*. Hull.
26. Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., et al. (2010). Foundations for smarter cities. *IBM Journal of Research and Development, 54*(4), 1–16.
27. Hospers, G. J. (2003). Creative cities in Europe. *Intereconomics, 38*(5), 260–269.
28. Kickert, W. J. M. (1997). Public governance in the Netherlands: an alternative to Anglo-American 'Managerialism'. *Public Administration, 75*(Winter), 731–752.
29. Kwon, O., & Kim, J. (2007). A Methodology of identifying ubiquitous smart services for U-city development. In J. Indulska, L. T. Yang, J. Cao, J. Ma, & T. Ungerer (Eds.), *Ubiquitous Intelligence and Computing Proceedings* (pp. 143–152). Berlin: Springer.
30. Landry, C. (2000). *The Creative City: a Toolkit for Urban Innovators*. London: Earthscan.
31. Lee, J., Baik, S., & Lee, C. (2011). Building an integrated service management platform for ubiquitous cities. *Computer, 44*(6), 56–63.

32. Loukis, E., Charalabidis, Y., & Scholl, J. (2011). Editorial of the special issue on digital cities. *Telematics and Informatics, 28*(3), 144–147.
33. Mazzara, L. (2009). *Il Piano Strategico nell'Ente Locale*. Milano: Ipsoa.
34. Moore, M. H. (1995). *Creating Public Value*. Cambridge: Harvard University Press.
35. Mussari, R. (2002). *Economia dell'Azienda Pubblica Locale*. Padova: Cedam.
36. Nam, T., & Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th Annual International Digital Government Research Conference*: *Digital Government Innovation in Challenging Times* (pp. 282–291). New York.
37. Naphade, M., Banavar, G., Harrison, C., Paraszczak, J., & Morris, R. (2011). Smarter cities and their innovation challenges. *Computer, 44*(6), 32–39.
38. Passaponti, B. (1986). *I Prezzi Politici nei Servizi di Pubblica Utilità*. Pisa: Servizio Editoriale Universitario.
39. Pendenza, M. (2000). *Cooperazione, Fiducia e Capitale Sociale*. Napoli: Liguori Editore.
40. Pollitt, C., & Bouckaert, G. (2000). *Public Management Reform*. Oxford: University Press.
41. Pugliese, T., & Spaziante, A. (Eds.). (2003). *Pianificazione Strategica per le Città*. Milano: Franco Angeli.
42. Putnam, R. (2005). *The Evolution of Social Capital*. Oxford: University Press.
43. Rur/Censis. (2006). Strategie per il Territorio. In *Proceedings Urbanpromo 2006*. Venezia.
44. Schuurman, D., Baccarne, B., De Marez, L., & Mechant, P. (2012). Smart ideas for smart cities: Investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. *Journal of Theoretical and Applied Electronic Commerce Research, 7*(3), 49–62.
45. Sòstero, U. (2003). *L'Economicità delle Aziende*. Milano: Giuffrè.
46. Tanese, A., Di Filippo, E., & Rennie, R. (Eds.). (2006). *La Pianificazione Strategica per lo Sviluppo dei Territori*. Soveria Mannelli: Rubbettino.
47. Toppeta, D. (2010). The smart city vision: How innovation and ICT can build smart, "livable", sustainable cities. *The Innovation Knowledge Foundation*. http://www.thinkinnovation.org
48. Volpatto, O. (1987). *Amministrare Oggi l'Ente Locale*. Milano: Giuffrè.
49. Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, L. E. (2010). *Helping CIOs Understand "Smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO*. Cambridge: Forrester Research Inc.
50. Zangrandi, A. (1994). *Autonomia ed Economicità nelle Aziende Pubbliche*. Milano: Giuffrè.

Performance Measurement in the Smart Cities

Mara Zuccardi Merli and Elisa Bonollo

Abstract A successful smart city needs an adequate performance measurement system to have all the information required to develop an effective involvement of stakeholders. Indeed the concept of smart city is connected no longer just to the presence and use of digital infrastructure but also to the role of human, social and relational capital and to the participation of all stakeholders, who, to be really involved, must be adequately informed about goals, activities and results achieved. In this work, after an introduction of the smart city concept, a new model to measure the performance of a smart city is proposed and the results of an empirical study on a sample of smart cities in Italy and Europe are reported. The empirical study aims to analyze how smart cities included in the sample are used to measure their performance and the capability of the new model to meet all the information needs.

Keywords Smart city • Performance indicators

1 Smart Cities from the Perspective of Participatory Government

The term "smart city" was coined in the 2000s, as part of a marketing idea of US multinationals, IBM and Cisco. In coordinating the marketing of their products and services, they came up with a vision of the perfect city, which featured a high

---

This research work is carried out from all two authors; however the paragraphs n. 2 and 4 can be attributed to M. Zuccardi Merli, paragraphs n. 1 and 3 to E. Bonollo.

M. Zuccardi Merli (✉) · E. Bonollo
Department of Economics and Business Studies, University of Genoa, Genoa, Italy
e-mail: zuccardi@economia.unige.it

E. Bonollo
e-mail: bonollo@economia.unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_7,

level of automation and "intelligence", thanks to the widespread use of information communication technology (ICT) tools [1].

Over time, smart city has become a widely used term in the vocabulary and in the actions of European Union policy, influencing its priorities as well as the mechanisms to allocate community funds; it has also been the object of interest in management studies.

In the Communication of the European Commission no. 519 of 2009, smart cities are defined as cities based on intelligent networks, on a new generation of buildings and on low emission transport systems that can change the future of our energy.

More specifically, as part of the "Strategic Energy Technology Plan", and then the "Smart Cities and Communities-European Innovation Partnership" in 2012, the European Commission identified the concept of smart city as a place to catalyse progress in energy production, distribution and use, transport and ICT, in order to reduce energy consumption [2].

The Italian Government's "National Research and Competitiveness Operational Programmes of 2007–2013" also headed in the same direction, and identified the area of action of smart cities in operations spanning many areas, including mobility and logistics, health services, education and training system, e-government, cultural and tourism services, energy efficiency, use of renewable energy sources and rational use of natural resources.

On the other hand, in management studies, the significance of the smart city concept is attributed to the vision of the local government, in other words a new way of interpreting the institutional purposes of government, leading to recognition of certain priority areas of action [3].

Still, the literature shows that there is no single, widely accepted vision of smart city.

Hence, in the 2007 study carried out by the Vienna University of Technology in collaboration with the University of Ljubljana and the Delft University of Technology, the smart city has this definition: "a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" [4]. The characteristics that distinguish smart cities are identified in the areas of economy, mobility, environment, people, living and governance, thereby taking in many of the activities of a local government.

Many other definitions have also been published, including:

- the "smart community" where "public administration, enterprises and residents have understood the opportunities offered by IT and attempt to use those technologies to improve their day-to-day life and work in a significant and efficient manner" [5];
- the cities that exploit the opportunities of information technology to promote their economic and social development [6];
- the places where ICT is incorporated into the living and work environments [7];
- the "areas which have the ability to support learning, technological development, and innovation procedures on the one hand, with digital spaces, information processing, and knowledge transfer on the other hand" [8].

These definitions focus on the technological component of smart cities, while other, more recent studies emphasise the need to adopt a different approach, where there is more involvement of citizens. In this case, smart cities are defined as cities where "investments in human and social capital and traditional (transportation) and modern (ICT-based) infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory government" [9].

So, the smart aspect is progressively connected no longer just to the presence and use of digital infrastructure but also to the role of human, social and relational capital. It is therefore linked to the active participation, already in the planning phase, of everyone who lives and works in the territory in order to integrate the applications, suggestions and needs of the various actors of the local government context, as part of the strategic path inspired by the smart city vision [10–13].

Empowerment and participation of citizens, enterprises and other stakeholders, in a bottom up approach, therefore becomes an essential requirement for the success of smart cities [12]. If the community is not involved, the "smart" innovation projects remain the dominion of the few and risk being perceived as elitist [10]. Indeed, it is inconceivable to initiate a process that involves major changes in the lives of citizens without them being adequately informed, prepared and motivated as regards the potential and advantages of those changes. Information is the key both to acquire consent and to disseminate the benefits to the whole community.

Local governments that want to be a smart city must act as mediator/coordinator/director/lead actor with the numerous subjects that operate in their territory, including public administrations, enterprises, Universities, research centres, but more than anything else, the community, to be able to implement value coproduction systems in public services [14, 15]. In actual fact, coproduction of value occurs for smart cities as part of the services provided by the local government for the territory, and as a consequence for the citizens, which means the local government is forced to operate in terms of public governance and specifically participatory government [16–21].

Indeed in public administration, participatory government means involving stakeholders—the first being the community—in the activity of producing services, and the programming and control process is one of its inevitable spinoffs. In other words, participatory government means that the local government performs its activity using a different basis from the past, so participatory government leads to the development of:

- participatory planning;
- relational control, expressing the relationships between the various actors involved in the production of public services;
- participatory control, expressing the relationships with citizens in the perspective of getting them more involved in progressive and final monitoring activities.

Lastly, participatory government also requires evolved forms of external accountability on the operations of the local government and on its real capacity to involve the community and stakeholders through the use of appropriate tools in the reporting phase.

Therefore, planning, relational and participatory control and forms of external accountability means the local government that aspires to be a smart city needs to develop a solid performance measurement system in terms of concept, with shared and clear functions.

2 Performance Measurement for Accountability

A successful smart city needs an adequate performance measurement system to have at its disposal the information required to create and develop effective involvement of all the actors operating in its context. Therefore, it is necessary to involve actively stakeholders in the planning phase (as contacts in setting priorities, strategies and goals), in the implementation phase of the prepared smart projects (as partners in the coproduction of public services) and in the reporting phase (as recipients of the communication on performance targets achieved).

The definition of an adequate performance measurement system aimed at activating a procedure to collect and make available data and information is closely connected to the "why" and to the "what" to measure [22].

The prevailing theory is that the "why", in other words the motivations that the local government wants to achieve by collecting and processing performance measurements, is mainly ascribable to the following requirements [23]:

- learning, to support improvement at the strategic and operational level in order to redefine the priorities and solutions adopted by the local government to meet the needs of the community;
- planning and control, to make decisions on the allocation of resources, on making the organizational units and the individual employees responsible for achieving results and on the ways services are provided, evaluating possible outsourcing;
- external accountability to all stakeholders operating outside the local government so the activities performed can be explained and verified as well as its responsibility towards the various stakeholders, so they can judge the work of the local government and take action to influence its decisions.

With reference to the "what" to measure, the prevailing theory is that performance in local government, like in all public administrations is a complex concept due to the variety of activities performed, the impossibility of linking the value of production to earnings achieved, the many interests that gravitate around public administrations and the interconnection of their activities. This makes it necessary to appreciate the concept of performance in multi-dimensional terms, distinguishing between the depth and the span of the performance [24].

The depth of the performance in local governments concerns the different levels in which it can be observed and measured: at the level of local government as a whole, at the level of organizational unit and at the level of the single individual. On the other hand, the span of the performance refers to the possible performance content dimensions, classified in various ways, but generally ascribable to activities, resources, effectiveness, efficiency, outcomes, etc.

As far as the motivations mentioned earlier are concerned, external accountability becomes particularly important in a smart city, because in order to develop involvement of the stakeholders in its smart projects, the local government must provide prompt and transparent communications about the performance achieved.

The stakeholders, potential users of this information, are represented by the actors of the local government context, including other public administrations, enterprises, citizens, etc. These players can take the role of:

- customers/users and/or co-producers of the smart services provided;
- electors who use their democratic vote to express their opinion on the priorities of politicians, therefore also as regards smart projects;
- financing entities through taxation, with the need to be informed on the use of financial resources taken from the public administration.

All of these stakeholders must be given detailed information about the resources used, the activities performed and the results achieved: the more this accountability meets the various information needs, the more the smart city local government strengthens relations with the various actors in its context and the more it increases its social legitimization and the probability of lasting success of its smart city projects (that is not tied to obtaining considerable but occasional financing).

On the other hand, as far as the "what" to measure is concerned—so the depth and span of the performance—the level of the local government as a whole becomes important; this is because, as we stated earlier, the local government plays both the lead role and acts as the director in the smart city.

With reference to the span of the performance, to define the so-called content dimensions, we need to examine some observations. In actual fact, in recent years, studies and research propose the adoption of different performance measurement models for smart cities, characterized by different dimensions to consider as the object of measurement.

A succession of models has emerged over time, and basically they are reported in the 2007 study by the Vienna University of Technology, "Smart cities-Ranking of European medium-sized cities" [4], in the Komninos study published in 2008 [25] and in the research carried out in 2008 by "The European House-Ambrosetti" for ABB [10].

As part of its research performed in 2007, the Vienna University of Technology, in collaboration with the University of Ljubljana and the Delft University of Technology developed a tool to rank the degree of smartness of 70 medium-sized European cities, with a population of under 500,000 inhabitants. Specifically, six performance dimensions were associated with the six characteristics of a smart city already nominated in this research (economy, mobility, environment, people, living and governance): competitiveness, social and human capital, participation, transport and ICT, natural resources and quality of life. In turn, 33 factors were selected to describe the dimensions and 74 indicators were chosen to analyse the performance in each factor. For all the dimensions considered, the purpose of the indicators was to measure and then to compare the impact of the smart projects on the competitiveness of enterprises, on the cultural level and quality of life of the population, on the participation of citizens in public life and on the environmental conditions.

Instead, in his study, Komninos [25] identifies four dimensions of the smart city: three are relative to inputs (skills, knowledge and digital spaces), and the fourth concerns outputs (innovation performance). The purpose is to define an ideal smart city model, pinpointing what makes a local government smart, and therefore what its internal dynamics might be, its weaknesses and the impacts in terms of innovation, economic development and wellbeing of the community.

For each of the dimensions identified, Komninos proposes constructing a total of 35 indicators. These are mainly outcome indicators to measure the impact that the smart city projects may have on the variables characterizing its context: for example, "business R&D expenditure (as per cent of GDP)", "number of incubators (per million of population)" and "researchers in industry and services (per cent of total workforce)", measured before and after the creation of a smart city should increase significantly.

Lastly, the study of "The European House-Ambrosetti" [10] points out three dimensions that express the benefits to citizens deriving from the actual creation of a smart city, in order to evaluate the progress and/or the criticalities detected by the local governments in their pathway of development towards the smartness. The study refers to a representative sampling of the most populous cities in Italy, in which the concept of smartness refers to the ability of the urban fabric—not just the infrastructure and services provided by the local government but also, and above all, the social and economic fabric—to free up and manage resources in an efficient, shared way, also by applying innovative processes and technological options. So, the dimensions that are particularly relevant in terms of influence on the level of smartness are: mobility management, resource management and quality of life for citizens. Each dimension is then associated with a total of nine performance indicators. These performance indicators focus mainly on outcome, to express the benefits that the creation of a smart city should give to citizens. Smart services or infrastructure facilities are not considered in the metric, since according to this research the services offered or specific infrastructure do not necessarily translate into real benefits for the daily lives of citizens. Each performance indicator is then connected with two drivers, considered to be relevant as policy indices for local governments to improve their level of smartness.

The performance measurement models described above have been constructed to compare the smart cities in one country or in several European and non-European countries, or to propose an ideal smart city model, defining its distinguishing features (Table 1). As we said earlier, these models include mainly outcome indicators that, by their nature, involve medium-long term observation and detection times.

The performance measurements identified in the different models do not appear to be exhaustive. Indeed, outcome indicators alone cannot be considered enough in terms of participatory government for adequate external accountability; this requires a continuous interactive process between the various stakeholders, supported by a timely, accurate information system.

Table 1 Performance measurement models of smart city

Models	Vienna University of Technology—2007 [4]	Komninos—2008 [25]	The European House-Ambrosetti—2012 [10]
Dimensions	Competitiveness	Education and skills of the population	Mobility management
	Social and human capital	Knowledge and innovation institutions	Resource management
	Participation	Digital infrastructure and e-services	Quality of life for citizens
	Transport and ICT	Innovation performance	
	Natural resources		
	Quality of life		

Table 2 Proposal of a new performance measurement model

Dimensions	Focus	Types of indicators
Production	Quantity and quality of smart public services provided and resources used	Input Activity Quantitative effectiveness Qualitative effectiveness Efficiency
Technological innovation	Innovative outputs	Activity of innovative outputs Effectiveness of innovative outputs Efficiency of innovative outputs
Quality of life of the community	Living conditions of population and local economic development	Outcome
Eco-sustainability	Environmental impact	Environmental outcome Environmental outcome/ economic and financial variables

In order to have a performance measurement system that can provide timely, accurate, externally-oriented information and to harmoniously combine the strategic and short term aspects, it becomes significant to create a new performance measurement system model that considers at least the following dimensions (Table 2):

- production, focused on the number of smart services provided, on the level of liking by the community, on the resources used (inputs) and, therefore on the construction of indicators relative to the inputs used and the activities performed (in quantitative terms) by the local government, to the quantitative and qualitative effectiveness and to the efficiency;
- technological innovation, to stress the innovative outputs and to measure their effectiveness in terms of improving quantity and quality of smart services, and

the efficiency, comparing the costs incurred with the technological solutions introduced and then arriving at the construction of indicators of activity, effectiveness and efficiency;
- quality of life of the community, both in terms of improving the living conditions of the population and of local economic development thanks to the smart projects, and therefore, arriving at the construction of outcome indicators;
- eco-sustainability, to highlight both the environmental impact of the activity carried out with environmental outcome indicators and any trade-off between these outcome indicators and economic and financial variables.

These dimensions are therefore closely connected. The production dimension allows, in the absence of market exchanges, to program, monitor and communicate the co-production of smart services and the level of efficiency. The technological innovation dimension is connected to the production because it considers the exploitation of the technological skills to generate service innovations for the community served. Finally, the remaining dimensions are linked together, but also to the preceding dimensions as in a smart city the production of innovative services should result in an improvement in the quality of life in term of social, economic and environmental sustainability.

As regards the suggested indicators of the dimensions proposed, they can be classified into 5 types (Table 2):

- input indicators designed to report the amount of financial, human and material resources used for smart services;
- activity indicators, concerning the quantity of smart services provided by a smart local government or the amount of work performed; they can be measured also for innovative outputs;
- effectiveness indicators, measuring the degree which predetermined goals of a particular activity or program are achieved; they are related to the smart city capacity to satisfy citizens' needs expressed in a quantitative and qualitative manner (quantitative and qualitative effectiveness); they can be measured also for innovative outputs;
- efficiency indicators, deriving from the relationship between inputs and outputs, so highlighting the ability of maximizing the quantity and/or quality of the smart services provided in relation to the resources used; they can be measured also for innovative outputs;
- outcome indicators, describing the positive and negative effects on stakeholders; they can be referred to social and economic aspects (outcome) or focused only on environmental aspects (environmental outcome); if we consider the relationship between environmental outcome and economic and financial variables, we highlight the environmental cost/benefit of a smart city initiative.

We must point out that this performance measurement system proposed for smart cities must not consist of simply gathering data. It must be characterized by measurements that express the diversity and complexity of what is being measured, but at the same time are simple to understand, easy to communicate and to satisfy the information needs of stakeholders.

3 An Empirical Study: Evidence from Some European Smart Cities

In recent years, thanks to funds provided by the European Union, and by national and local governments, we have seen an increase in smart city projects. Indeed, many local governments are developing activities to save energy and to produce energy from renewable sources, for sustainable mobility, for improvements to the quality and quantity of public services through the extended use of ICT, all with the active involvement of citizens.

In relation to the description of participatory government provided above (participatory planning, relational control, participatory control and external accountability) and to the connected performance measurement system, this work provides the results of an empirical study whose object is to measure performance in smart cities.

In particular, the study aimed to detect whether achieved performance was measured and communicated in smart cities, and if it was, what defining or differentiating elements can be found in this activity. All of this aims to establish whether it is possible to identify any emerging performance measurement models to use as a reference for external accountability and if these models differ from or are traceable to the model proposed previously.

In other words, the study focused on "how" and "what" smart cities communicate in terms of performance measurement.

The work is developed in two parts and looked at the local governments in Italy as well as at significant smart cities at the European level, carrying out an empirical study in May–July 2013 on the websites of the local governments involved in the study.

At first, the study concerned Italian local governments involved in smart city projects, as:

- winners of invitations to apply for European Union or Italian government funding for smart projects;
- participants in the smart city project entitled "Le città ad alto potenziale di innovazione" (Cities with high potential for innovation) promoted by the Associazione Nazionale dei Comuni Italiani (ANCI—National Association of Italian Municipalities);
- participants in "City Protocol", an agreement amongst local governments around the world to create the first smart city certification system;
- winners of the 2013 "Smart City Road show" prize linked to the realisation of a project inspired by the vision of a smart city, awarded by Smau Observatory-Milan University of Technology.

This adds up to 24 local governments of very different sizes, with populations of between 27,000 and 2,600,000.

With reference to "how" these local governments communicate the performance measured as part of the smart projects, we found that this took place through:

- dedicated website;
- organisation of and/or participation in workshops and conferences on this theme;
- the use of traditional planning documents (Strategic plan, Forecasting and programming report, Performance plan, Management executive plan) and reporting documents (Annual report, Performance report);
- the use of social reporting (social report, sustainability report, environmental balance sheet).

These channels and document types for external accountability must be chosen in relation to the audience to be reached, the accessibility of information, the attractiveness and the speed of the message. In all cases, the aim is to develop a dialogue with the stakeholders, in the perspective of participatory government [15, 26].

The use of a dedicated website makes information accessible to the community and can become a tool of strong interaction with citizens at a relatively low cost [27]. Conversely, the organization of and/or participation in workshops and conferences make it necessary greater investments in human and financial resources and require more technical information because of the specialist audience of these events [26].

The use of traditional planning and reporting documents for external accountability of a smart city highlights the smart vision of the local government, leading to integration between the smart projects and the other programs of the administration. However the literature shows different opinions on the role of traditional planning and reporting documents as tools of external accountability. Some authors highlight their importance to make local governments accountable [28–30], but others stress their complexity and their not easy availability. On this matter, the social reporting can be an effective tool for communicating results and outcome of the smart city projects in an easy-to-read manner, in order to allow citizens to evaluate the impact of the smart projects on the economic and social context [31–33].

The study showed that only nine of the Italian local governments examined (37 %) have a dedicated website, in other words, one created specifically for communications about smart city projects (Bari, Bologna, Florence, Genoa, L'Aquila, Milan, Pavia, Potenza and Turin).

The way of communicating through speeches and participations at workshops and conferences was the most frequent, probably because the local governments felt the compelling need not only to communicate the performance achieved to the outside world, but also to share and compare with other realities that were heading in the same direction.

Conversely, communication through traditional planning and reporting documents does not appear to be particularly common. Indeed, it was found that objectives and results measured by performance indicators specifically connected to programmes relative to the realisation of a smart city were communicated in the Strategic plan, Forecasting and programming report, Performance plan and/or Performance report, only in five cases (Genoa, L'Aquila, Modena, Reggio

Emilia and Turin). In other fifteen cases, these documents only showed indicators generally referring to typical smart city themes (such as ICT application in providing public services, energy saving, environmental sustainability etc.), as part of the local government's various programmes of activity. Lastly, in the remaining four cases, the traditional planning and reporting documents do not mention smart projects at all or are not available on line.

Most of the Italian local governments involved in the study prepare the "Sustainable Energy Action Plan" and make it available on their website. This plan includes strategies, objectives, timeframes, resources and responsibilities specifically relating to the environment, to energy and to quality of life. This planning document is not compulsory and is prepared as part of a European Initiative called the "Covenant of Mayors", which aims to involve European cities in a pathway to energy and environmental sustainability and that for many of the Italian local governments considered, actually represented their first step towards smartness.

With reference to the social reporting documents, only the municipality of Venice published, in its social report, the objectives and the results relative to projects referring to typical smart city themes (environmental sustainability, energy saving, mobility, e-government).

As regards the "what", the contents of the dedicated websites, the traditional planning and reporting documents and the social reporting documents were studied in order to identify which of the performance dimensions identified in the paragraph above (production, technological innovation, quality of live of the community, eco-sustainability) were considered and what type of indicators were constructed (indicators of input, activity, qualitative and quantitative effectiveness, efficiency, outcome, etc.).

The study showed that only the municipality of Turin regularly publishes and updates a "smart city dashboard" in its dedicated smart city website. This information is summarised, immediate and easy to read; it aims to describe the progress of some variables considered particularly significant as part of the creation of smart Turin. At the moment, these variables are measured by environmental indicators, only concerning the quality of the air and the energy certifications of buildings (for example, "PM10 air pollution index" and "number of energy performance certificates of buildings according to energy class").

Most of the other local governments under observation only report general information about the organisation of events and the realisation of specific smart initiatives aimed at improving the public services provided on their institutional website.

With reference to which performances are measured and communicated in the traditional planning and reporting documents and in the social reporting documents, it emerged that the main dimensions considered are production and technological innovation (Table 3). Conversely, there is poor disclosure of performance relative to eco-sustainability and to quality of life of the community.

In particular, communication regarding the production dimension mainly concerns indicators relative to the activity produced, expressed in quantitative terms, and to the financial resources used (such as "users of bike sharing service", "number of photovoltaic installations at schools", "contributions to encourage the

Table 3 Types of indicators of the local governments examined (%)

Local governments	Production					Technological innovation			Quality of life of the community	Eco-sustainability	
	Input (%)	Activity (%)	Quantitative effectiveness (%)	Qualitative effectiveness (%)	Efficiency (%)	Activity (%)	Effectiveness (%)	Efficiency (%)	Outcome (%)	Environmental outcome (%)	Environmental outcome/economic financial variables (%)
Bari	16.30	25.68	8.40	1.48	0.49	11.60	0.49	0.00	13.83	21.73	0.00
Bergamo	27.36	24.53	0.94	0.94	0.00	7.55	1.26	0.00	0.94	36.48	0.00
Bologna	11.14	21.75	0.27	0.00	0.00	10.61	0.00	0.00	0.00	56.23	0.00
Brescia	5.30	15.23	0.00	0.66	0.00	66.23	3.97	0.00	0.00	8.61	0.00
Cesena	9.35	19.42	2.88	6.47	0.00	9.35	2.16	0.00	0.72	41.73	7.91
Cosenza	0.00	47.62	0.00	0.00	0.00	42.86	0.00	0.00	6.35	3.17	0.00
Florence	23.47	30.02	0.63	0.00	0.00	21.78	2.54	0.00	1.90	19.66	0.00
Genoa	6.70	27.88	0.00	5.27	0.00	10.32	0.11	0.00	0.00	49.73	0.00
L'Aquila	18.69	38.32	0.00	0.00	0.00	0.93	0.00	0.00	3.74	38.32	0.00
Lecce	0.00	33.33	0.00	0.00	0.00	66.67	0.00	0.00	0.00	0.00	0.00
Livorno	39.49	17.03	0.00	0.00	0.00	41.67	0.36	0.00	0.00	1.45	0.00
Milan	0.00	33.33	0.00	0.00	0.00	66.67	0.00	0.00	0.00	0.00	0.00
Modena	7.07	32.25	0.00	0.18	0.00	28.80	0.72	0.00	1.63	29.35	0.00
Naples	12.98	49.47	0.00	2.29	0.00	2.29	0.00	0.00	2.44	30.53	0.00
Pavia	0.00	25.00	0.00	0.00	0.00	59.62	7.69	0.00	0.00	7.69	0.00
Potenza	22.03	49.57	0.00	0.29	0.00	0.29	0.00	0.00	0.00	27.54	0.29
Reggio Emilia	10.73	39.02	0.98	1.46	0.00	4.88	1.95	0.00	2.93	38.05	0.00
Rome	8.66	46.06	0.00	0.00	0.00	15.35	0.39	0.00	0.00	28.74	0.79
S.Giovanni Persiceto	0.00	18.75	12.50	6.25	6.25	50.00	0.00	0.00	0.00	6.25	0.00

(continued)

Table 3 (continued)

Local governments	Production					Technological innovation			Quality of life of the community	Eco-sustainability	
	Input (%)	Activity (%)	Quantitative effectiveness (%)	Qualitative effectiveness (%)	Efficiency (%)	Activity (%)	Effectiveness (%)	Efficiency (%)	Outcome (%)	Environmental outcome (%)	Environmental outcome/economic financial variables (%)
Senigallia	18.18	9.09	0.00	0.00	0.00	72.73	0.00	0.00	0.00	0.00	0.00
Turin	22.64	55.97	0.63	0.00	0.00	18.24	2.52	0.00	0.00	0.00	0.00
Treviso	47.22	13.10	0.00	0.00	0.00	13.49	0.00	0.00	0.00	26.19	0.00
Venice	18.09	44.33	0.00	0.00	0.00	11.53	0.00	0.00	0.00	26.04	0.00
Verona	19.61	29.02	1.18	0.00	0.00	15.29	0.00	0.00	0.00	30.59	4.31
Mean	*14.38*	*31.07*	*1.18*	*1.05*	*0.28*	*27.03*	*1.01*	*0.00*	*1.44*	*22.00*	*0.55*
	47.97					*28.04*			*1.44*	*22.56*	

replacement of old electric household appliances”). Technological innovation is also measured mainly by indicators of activity of the public services involved in dematerialisation and e-government projects (such as “number of services with on-line payment”, “users of Wi-Fi area”, “number of on-line certificates”).

Instead, the eco-sustainability dimension is clarified with environmental outcome indicators, generally relating to harmful emissions and energy saving (such as “reduction of CO_2 emissions related to replacement vehicles Euro1”, “electricity production from renewable sources”, “electricity savings from new led-based public lighting”). As far as this is concerned, we would like to point out the case of the municipality of Cesena, which also reports indicators that highlight the trade-off between the amount of CO_2 emissions saved through the realisation of certain initiatives and the relative cost incurred, providing an indication of the cost required to reduce a single unit of carbon dioxide.

When looking at the quality of life of the community (in terms of economic development and better living conditions for the population), the cases of the municipalities of Bari and of Reggio Emilia stand out. The former constructed indicators, corresponding to smart initiatives, on the increase in employment levels and on the rise in the added value produced, to highlight the positive direct effects on the economic and social fabric of its territory. On the other hand, as part of the “Reggio Smart” programme, the performances to measure and communicate identified by the municipality of Reggio Emilia included the amount of investments in research and development and the number of start-up enterprises established after smart projects were implemented.

In the part of the study concerning experiences at the European level, Amsterdam, Tallinn (Estonia) and Helsinki were examined because they are cases of excellent smart cities.

The study showed that the growth direction of all of these local governments has for some time been implemented as part of the smart city vision, developing broad concordance with all the stakeholders as regards the policies adopted and the actions taken. The planning and reporting documents, always available online, show what are often also disclosure contents, explaining the best practices realised. All of this is to involve all the stakeholders, based on the logic of participatory government.

The City of Amsterdam in particular is one of the most evolved examples of a smart city due to the many smart projects realised; indeed, all the activity of the local government is developed on the basis of programmes inspired by the smart city vision. The website publishes the planning documents on the subject of mobility using electric-powered vehicles, on sustainable urban development, on actions in the environmental area to reduce CO_2 emissions etc. It also includes reports on the results of the main projects realised in recent years, highlighting how smart projects can provide the opportunity for economic development and are also a way of making technological innovation accessible to citizens, hence improving their quality of life.

For their part, Tallinn and Helsinki focus their smart activities on more restricted areas, sustainable mobility and the development of digital urban services respectively. In particular, the municipality of Helsinki, through a dedicated website, provide information on completed and in progress projects, creating an efficient communication channel with its stakeholders.

Therefore, the dimensions monitored in these three cases are basically eco-sustainability, with reference to environmental outcome, and technological innovation.

In conclusion, we can state that the performance measurement by the local governments examined during the study is traceable to the theoretical model proposed, although in most cases the constructed indicators are activity and environmental outcome indicators that refer to the dimensions of production (for Italian local governments) and eco-sustainability (for European smart cities).

4 Conclusion

In recent years, the realities of smart cities—those local governments, on the basis of a smart vision, that adopt "intelligent and innovative solutions" for energy saving and energy production from renewable sources, for mobility, for environmental sustainability and for providing public services in new ways by using ICT—are becoming more and more important. All of this requires the use of considerable human and financial resources but more than anything else the widespread involvement of the community, in other words the development of so-called participatory government.

The reasons behind considering active participation of the community as an essential premise are connected both to the use of large amounts of public resources to realise smart cities (the same resources that may be used to develop other social, cultural projects etc.), and to the need for the various stakeholders to become coproducers of public services precisely due to the diffusion of technological solutions linked to the implementation of smart projects.

For involving the local government stakeholders is necessary the implementation of a performance measurement system, specifically projected for the smart city, in order to plan the activities to put in place and the goals to achieve, monitor their progress and be accountable for the results achieved.

In a smart city, the measurement of the performance should at least concern the dimensions of production, technological innovation, quality of life of the community and eco-sustainability and should be effected through the construction of a set of input, activity, effectiveness, efficiency and outcome indicators.

The empirical study highlighted that the theoretical model proposed is more complete than the ones applied in practice, which seems to focus only on the dimensions of production (for Italian local governments) and eco-sustainability (for European smart cities). Indeed, the study showed that in the traditional planning and reporting documents and in the social reporting documents the Italian local governments gave information mainly on the activities developed for the smart services provided (activity indicators). Conversely, the European smart cities focused on the environment outcomes of their activities (environmental outcome indicators).

Nevertheless the theoretical model can be easily adapted to most of the smart cities taken into consideration by the study and his application may provide more significant results without an excessive extra work as the additional information to be collected are easily available.

References

1. Harrison, C., & Donnelly I. A. (2011). A theory of smart cities. In *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences*. Hull, UK.
2. Granelli, A. (2012). *Città intelligenti?*. Roma: Luca Sassello Editore.
3. Schaffers, H., Ratti, C., & Komninos, N. (2012). Special issue on smart application for smart cities–New approaches to innovations: guest editors' introduction. *Journal of Theoretical and Applied Electronic Commerce Research, 7*(3), II–IV.
4. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., & Meijers, E. (2007). *Smart Cities. Ranking of European Medium-Sized Cities*. Vienna, Austria: Centre of Regional Science of Vienna, Vienna University of Technology.
5. Morse, S. (2004). *Smart Communities: How Citizens and Local Leaders Can Use Strategic Thinking to Build a Brighter Future*. New York: Jossey-Bass.
6. California Institute for Smart Communities. (2001). *Smart Communities Guidebook*. California: San Diego State University.
7. Steventon, A., & Wright, S. (Eds.). (2006). *Intelligent Spaces: The application of Pervasive ICT*. Berlin: Springer.
8. Komninos, N. (2002). *Intelligent Cities: Innovation, Knowledge systems and digital spaces*. London and New York: Spoon Press.
9. Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). *Smart Cities in Europe, Series Research Memoranda 0048*. Free University Amsterdam, Faculty of Economics, Business Administration and Econometrics (2009).
10. Fondazione Ambrosetti. (2012). *Smart Cities in Italy: An Opportunity in the Spirit of the Renaissance for a New Quality of Life*. ABB-The European House Ambrosetti.
11. Anttiroiko, A. V., Valiamo, P., & Bailey, S. J. (2013). Smart cities in the new service economy: Building platforms for smart services. *AI & Society*.
12. Schaffers, H., Komninos, N., & Pallott, M. (Eds.) (212). *Smart Cities as Innovation Ecosystems sustained by the Future Internet*. White paper, Firewall.
13. Schaffers, H., Komninos, N., Pallott, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In J. Domingue, et al. (Eds.), *The Future Internet*. Berlin: Springer.
14. Fung, A. (2001). Varieties of participation in complex governance. *Public Administration Review, 66*(S1), 66–75.
15. Donato, F. (2010). *Le amministrazioni pubbliche verso logiche di governo partecipato*. Milano: Giuffrè.
16. Ostrom, E. (1996). Crossing the great divide: Coproduction, synergy, and development. *World Development, 24*(6), 1073–1087.
17. Kickert, W. J. M. (1997). Public governance in the Netherlands: An alternative to Anglo-American managerialism. *Public Administration, 75*(4), 731–752.
18. Kooiman, J., & Van Vliet, M. (1993). Governance and public management. In K. Eljassen & J. Kooiman (Eds.), *Managing Public Organizations: Lesson from Contemporary European Experience*. London: Sage.
19. Ongaro, E. (2009). *Public management reform and modernizations*. Cheltenham: Edward Elgar.
20. Rhodes, R. A. W. (1997). *Understanding Governance. Policy Networks, Governance, Reflexivity and Accountability*. Maidenhead: Open University Press.

21. Hughes, O. (2010). Does governance exist? In S. P. Osborne (Ed.), *The New Public Governance? Emerging Perspectives on the Theory and Practice of Public Governance*. London: Routledge.
22. Lebas, M. J. (1995). Performance measurement and performance management. *International Journal of Production Economics, 41*, 23–35.
23. Behn, R. D. (2003). Why measure performance? Different purposes require different measures. *Public Administration Review, 63*(5), 586–606.
24. Bouckaert, G., & Halligan, J. (2008). *Managing Performance. International Comparisons*. London: Routledge.
25. Komninos, N. (2008). *Intelligent Cities and Globalisation of Innovation Networks*. New York: Taylor & Francis.
26. Levi, N. (2004). *Il piano di comunicazione nelle amministrazioni pubbliche. Dipartimento della Funzione Pubblica*. Napoli: Edizioni Scientifiche Italiane.
27. Mussari, R., & Steccolini, I. (2010). Using the internet for communicating performance information. *Public Money & Management, 26*(3), 193–196.
28. Boyne, G., & Law, J. (1991). Accountability and local authority annual reports: The case of welsh district councils. *Financial Accountability and Management, 7*(3), 179–194.
29. Ryan, C., Dunstan, D., & Mack, J. (2001). Local Government Annual Reports: Australian Empirical Evidence on Recipients, Paper presented at the APIRA Conference, July, Adelaide.
30. Taylor, D. W., & Rosair, M. (2000). The effects of participating parties, the public, and size on government departments' accountability disclosures in annual reports. *Accounting, Accountability and Performance, 6*(1), 77–97.
31. Rusconi, G. (1988). *Il bilancio sociale d'impresa. Problemi e prospettive*. Milano: Giuffrè.
32. Steccolini, I. (2004). Is the annual report an accountability medium? An empirical investigation into italian local governments. *Financial Accountability and Management 20*(3), 327–350.
33. Low, W., & Davenport, E. (2001). Parallel lines—The development of social auditing and triple bottom line reporting in New Zealand. In *Proceedings of the Governance and Corporate Social Responsibility in the New Millennium. Governance and Social Responsibility Conference: Proceedings of the 2001 Conference*, Burwood, Victoria.

Empowered Cities? An Analysis of the Structure and Generated Value of the Smart City Ghent

Bastiaan Baccarne, Peter Mechant and Dimitri Schuurman

Abstract Smart cities have gained momentum as a conceptual model which embodies a fresh wave of techno-optimism and emphasizes the positive effects of ICT and other innovative technologies in a city, often in combination with multidisciplinary collaborative partnerships. This article assesses a series of six smart city initiatives within one local city ecosystem by proposing a conceptual framework which is then used to analyze the architecture, value flows and contextual dimensions of the smart city Ghent. The results of our analysis show the multi-level collaborative value creation potential in a smart city and shed light on the complexity of these processes. The main conclusion is that current smart city initiatives face the challenge of evolving from demonstrators towards real sustainable value. Smart cities often have a technological deterministic, project-based approach, which forecloses a sustainable, permanent and growing future for the project outcomes.

Keywords Smart city • Multi-stakeholder network • Collaborative value creation • Living labs • Innovation ecosystems

1 Introduction

Cities are becoming the main locus of society. Worldwide, population has been steadily concentrating in cities. In Europe, more than 70 % of the population now lives in urban areas [1]. These demographic changes have an impact on the way society is being organized. On the policy level, cities are increasingly positioned as the main center of political action. To quote New York's major Bloomberg: "while nations talk, cities act" [2]. Cities indeed play an increasingly important role in the lives of the vast majority of people and are becoming a central platform for

B. Baccarne (✉) · P. Mechant · D. Schuurman
iMinds—MICT, Ghent University, Korte Meer 11, Ghent, Belgium
e-mail: Bastiaan.Baccarne@UGent.be

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_8,

knowledge exchange and value generation. At the same time, we are facing grand societal challenges such as global warming, congested traffic, ecological challenges, aging populations, economic challenges, etc. Although these challenges transcend regions, nations and continents, cities are often seen as the main driver for change and most relevant when it comes to tackle these challenges.

In this article, cities are approached as organic ecosystems, which strive to become 'greener' (with smart energy, smart environments and smart mobility), and more 'liveable' (with smart health, smart education and smart living/working), increasing the overall quality of life for city inhabitants [3, 4]. Recent technological evolutions have also fostered a fresh belief in the positive effects of ICT and other innovative technologies in a city. The combination of smart (technology enabled) solutions to meet the grand societal challenges and the focus on the city as the main driver of change led to the concept of the 'smart city'. Although its definition is still subject of debate, it has been increasingly stimulated by (trans)national governments (e.g. the European Commission) and international networks (e.g. EuroCities) over the past years. The availability of funding and emerging enthusiasm about the first smart city success stories has led to a boost in smart city initiatives worldwide. Despite the support for these initiatives, however, only little research exists on the actual value creation and value creation potential of smart cities.

This article assesses a series of six smart city initiatives in Ghent (Flanders, Belgium) to determine in which way and to what extent public and economic value is being created. First, the article provides a brief overview of the evolution towards a smart city and the different definitions of the concept. Next, we analyze some of the main dimensions which appear in smart city (related) literature and propose a conceptual framework, mapping the different actors and the setup of smart city initiatives. This enables us to assess six smart city projects within the city of Ghent with a focus on how value is being generated and processed.

2 The Journey Towards a Smart City

In the second half of the 1990s, Internet caused huge optimism regarding the possibilities of ICT for the improvement of everyday life. For the relation between the citizens and the city, the most prominent example of this uncurbed techno-optimism was the 'e-government' hype [5]. Although the concept of e-government is steadily fading away on the academic and public agenda, most of the promises related to this concept were not realized. The emergence of the next generation web platforms [6] fostered a new era of promises, this time focusing on the democratic potential (e.g. transparency and participation) rather than on governmental services [7]. Democratization of data, for example, allows increased transparency and stimulates participation and interaction between governments and their citizens. Also important in the evolution towards a smart city is the emergence of new technologies to measure and interconnect different dimensions of everyday life, the so-called internet of things.

Besides changing demographics, politics, technological evolutions and societal challenges, economic reality is changing as well. Especially in the domain of

Table 1 Main catalysts for the emergence of smart cities

Changing demographics	A strong rise of people living in urban areas
Changing politics	Cities becoming central actors for social, economic and political change
Grand societal challenges	Climate, mobility, ecological challenges, aging populations, economic challenges, etc.
Techno-optimism	Internet, e-government, web 2.0, internet of things, (linked) Open Data, etc.
Pressure to innovate	Open innovation, increased competition, innovation spiral, etc.
Policy support	The importance of funding and governmental support
City marketing	'Smart' as an appealing attribute for the city as a brand

new media & ICT, rapid technological evolutions, shorter product life cycles, globalization and increased competition have put high pressure on companies, forcing them to innovate in order to survive. This has led to an 'innovation spiral', which means that ever more innovations come to the market, although this also implies an increasing amount of failures [8]. Frissen and van Lieshout [9] refer to this phenomenon as an 'interesting mix' between massive market failures and groundbreaking innovations. In this context, smart cities are trying to stimulate innovation and tailor innovations to the needs of their citizens by stimulating collaborative development of innovations with multiple stakeholders.

Another catalyst in the emergence of smart cities is policy support. Smart city projects are most often relying on funding (see later). Also, and finally, the notion 'smart' is becoming a popular attribute which a lot of cities want to identify themselves with, relating the phrase 'smart city' to city marketing as well (see Table 1).

3 Defining Smart Cities

Literature on urban development shows various concepts for labeling the integration of ICT in civic planning and management, such as 'intelligent cities', 'digital cities', 'ubiquitous cities' or 'smart cities'. This section elaborates on these closely interconnected concepts.

The concept '*smart cities*', although often used as a marketing concept by both cities and businesses to envision a city of the 'future', emphasizes the growing importance of digital technologies in the city to make it more 'green', more 'accessible' and more 'liveable'. Caragliu et al. [3, p. 50], state that a city is smart when "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance". In other contexts 'smartness' refers to context-aware systems, ubiquitous computing and Internet-of-Things technologies [10].

Other authors use the concepts '*ubiquitous cities*' or '*U-cities*' to refer to "a next generation urban space that includes an integrated set of ubiquitous services: a convergent form of both physical and online spaces" [11, p. 143], emphasizing the importance of involving the citizens in development of U-City services (e.g. Helsinki's Virtual Village, U-Seoul and the Lower Manhattan project) [12]. Finding a match between the needs of the citizens of U-cities and the right ubiquitous services is put forward as a critical success factor [11, 13].

'*Digital cities*' are "extensive information systems (including network infrastructures and applications running on them) that collect and organize the digital information of the corresponding 'physical cities' and provide a public information space for people living in and visiting them" [14, p. 144]. Ergazakis and Ergazakis [15] state that these 'digital cities' should offer innovative services targeting various stakeholders that are inherent to a city environment (administrations, citizens and businesses), focusing on interactions between different city stakeholders [15, 16]. Similar to the notion of digital cities is the idea of '*intelligent cities*', which aims at uniting, promoting, acquiring and stimulating diffusion of information. In order realize this, an 'intelligent city' should develop and implement electronic and digital technologies in the city [17].

In smart cities, these collaborative digital environments facilitate the development of innovative applications, starting from the human capital of the city, rather than believing that technology as such can transform and improve cities. Another important dimension is the collection of all sorts of data and information through sensors and sensor networks. Under the moniker 'Open Data', this information is made public and put to use in 'smart city' applications and technologies that visualize, transform and utilize this data [18]. Smart cities focus on the involvement of all relevant stakeholders, whereas 'digital cities', 'wired cities' or 'ubiquitous cities' stress the presence of technological infrastructure. In other words, a city needs to be 'digital', 'wired' and 'intelligent' in order to become 'smart', although being 'digital', 'wired' and 'intelligent' does not automatically imply that the city will become 'smart' by itself.

While both research and policy often promise disruptive solutions, improvement of life in the city and economic growth, there is a vast lack of evidence concerning the actual value that is being created in a smart city and the processes that allow the exchange of value and knowledge. In this article, a smart city is considered as a collaborative ecosystem allowing for the co-creation of sustainable, future proof innovations that improve life in the city and boost the economy, in which technology plays an enabling role. Because it is often difficult to assess or define this concept in actionable, tangible elements, we will make this assessment based on six smart city projects in the city of Ghent.

4 A Framework for Analyzing the Structure and Generated Value of a Smart City

4.1 Smart Cities as an Ecosystem

The collaborative nature of smart cities is related to the Living Lab-concept and the quadruple helix-models for innovation. Triple and quadruple helix-models, deal with collaboration between universities, government, industry, and end-users, in this context citizens [19]. Co-operations like these have been claimed to facilitate exchange of ideas and technologies, with fewer barriers between academia, end-users, policy and industry [20]. This approach is very similar to Living Lab literature. Living Labs are ecosystems in which end-users and other relevant stakeholders are involved in the development of an innovation over a longer period of time using a combination of different research methods, following an iterative process [21]. Living Labs facilitate university–industry relationships, but also relationships between large companies and SME's, start-ups, entrepreneurs, and, most importantly, involve the end-users themselves, commonly referred to as public–private–people partnerships (4P's) [22]. Various Living Lab authors stress the importance of collaboration and knowledge support activities as cardinal to a successful Living Lab [23, 24]. These collaborative ecosystems promise to contribute to the facilitation of knowledge exchange among the ecosystem actors. In line with the above collaborative ecosystem literature, this chapter conceptualizes knowledge as both information (e.g. data), expertise (latent) and skills (e.g. coding).

Cosgrave et al. [25] connect the multi-stakeholder aspect of Living Labs to the concept of '*innovation districts*', small regions which cluster innovative actors such as start-ups, creative industries and venture capitalists. These "pockets of growth" are characterized by inter-firm collaboration and governmental support. In EU programs such as i2010 and Europe 2020, the importance of smart cities is highlighted, and the Living Lab-approach is considered a best practice in this context as it enables structuring user interaction by keeping users continuously involved in making better products and services while their expectations are continuously monitored and reflected upon in a systematic process [26]. Consequently, collaboration between all smart city stakeholders requires a user-driven and user-centric research approach to replace a more technology-centric approach. Based on these concepts, the proposed smart city framework includes four types of actors (1) *policy*, (2) *citizens*, (3) *research* and (4) *private partners* (see Fig. 1).

4.2 Policy

The policy actor is present at several levels. The most active policy level is the city government, but smart cities are also being supported on a regional level and on the (inter)national level as well. Smart city initiatives help these governmental levels to reach policy goals. An important actor is the European Commission, which put the idea that European cities should become 'empowered' or 'smarter' forward as one of the core inspirations of the European Digital Agenda, "which seeks to recognize the power of urban planning and the role of ICTs in managing infrastructures" [27]. Horizon 2020, the EU's new research program for 2014–2020 encompasses a €80 billion package for research and innovation funding. Horizon 2020 will support the development of ICT in Science (in future and emerging technologies or e-Infrastructures); in industrial leadership (such as smart systems, robotics, photonics, etc.) and in societal challenges (such as eHealth, eGovernment and eSkills.) Also, international organizations such as the OECD (Organization for

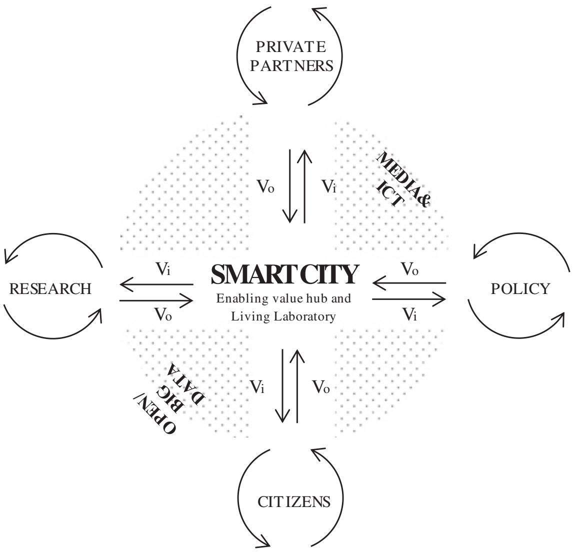


Fig. 1 Conceptual model of a smart city

Economic Co-operation and Development) [28], and UNESCO [29] have started to promote open access to information and knowledge, thus stimulating open innovation and smart city initiatives.

4.3 Citizens

End-users and citizens have been increasingly emancipated on different levels. In the domain of new product development, R&D departments rely increasingly on user input and collaboration (e.g. the use of *Lead Users* [30]). Innovations are no longer (solely) developed top-down, but are increasingly shaped and molded bottom-up [31]. End-users and citizens have also become emancipated when it comes to the creation and distribution of products, services and media themselves, indicating a power shift from traditional industries towards the people [32]. Another evolution that supports more citizen or user-centric paradigms and projects is the criticism on technological-deterministic discourses [33]. In smart city projects, one of the challenges is to transcend the technological-deterministic discourse by actively involving all stakeholders that can provide substantial input for developing a more accessible, information based, interactive and participatory urban environment.

In this context, *Web 2.0* is an important medium that creates a new degree of agency in constructing engagement with online resources, with other internet users, with open innovation [34] and with 'collective creativity' [35]. Web 2.0 also demolishes the idea that innovation is a proprietary activity conducted inside organizations in series of managed steps and entails ceding control over decisions about the content of products or services to networks of (online) citizens who interact with one another. Web 2.0 is "characterized by new forms of interaction with users who now play a key role in the content-creation and innovation processes" [36, p. 43], and consists out of a set of tools and a collection of social processes originating out of online communities and networks [37].

4.4 Research

At the academic level, smart cities have been looked at from different domains and backgrounds. It is a cross-disciplinary concept which covers urban studies, economics, political studies, city planning, engineering, sociology, communications as well as user research. This is one of the main reasons why it is difficult to find consensus on the actual definition of the concept. When it comes to the role of the research actor in the smart city ecosystem, [38] consider academic researchers as a necessary actor because they provide expertise in user research and knowledge. The triple and quadruple helix concepts also stress the importance of universities as a distinct actor in the innovation ecosystem [19, 20, 25, 39]. Moreover, the contribution of academia is not limited to user research; it can also include research on technical topics or policy and business related issues.

4.5 Private Partners

Innovation is becoming increasingly important for companies to remain competitive. However, high flop-rates still illustrate the need for an adequate management of innovation, which includes selecting the right tools and methods in order to structure and optimize innovation processes [40]. Traditionally, innovation was viewed as an inherently closed process with most operations running inside the boundaries of the company and R&D processes taking place in secretive in-house laboratories. More recently, this closed, vertically integrated model has been challenged and replaced by a distributed view on innovation and innovation management [41]. Smart cities serve as an innovation broker, connecting different stakeholders, allowing for real-life validation, ideation and co-creation. They create a framework for open innovation [34] continuous innovation [42] and systemic innovation [23].

In the smart city as an ecosystem, value and affordances flow between the different actors (see Fig. 1, indicated as V_i and V_o). In our conceptual framework value consist out of two dimensions: *socio-economic value* and *affordances*. Affordances can be conceptualized as 'what one system provides to another system', in the case of this article, as what a city system provides to its users, its citizens or other smart city actors. An affordance also encompasses the perceived functional significance of that system for an individual. For our purposes, we use the definition of affordances by Norman [43], describing them as: “the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (p. 9). An illustration in a smart city context could be the online co-creation of a city service, which enables citizens to interact with their city (affordance 1), opening this process to local entrepreneurs, which enables them to generate business out of this (affordance 2). In our analysis, these affordances are approached as ‘enabling dimensions’.

A relevant conceptual model for ‘*value*’ can be found in literature on business modeling. For example, [44] proposes a tool to model the relationship between the value of new ICT products or services and the control over new ICT products or services. In our analysis, a distinction is made between the generation of public value (e.g. safer streets) and economic value (e.g. generation of revenue). The concept of ‘*public value*’ refers to the value that is generated through the creation and implementation of services and technologies that adequately harness opportunities within the city, tackle societal challenges and/or realize policy goals [33]. It refers to, for example, reducing traffic jams, emancipating citizens, increasing neighborhood cohesion, etc. ‘*Economic value*’ on the other hand covers economic metrics such as the annual economic growth of cities and companies within the city, a decrease in unemployment, the extent to which new businesses (start-ups) are being generated and able to survive, a reduction of bankruptcies, an increased competitive advantage, attracting existing businesses to the city, etc.

As discussed in the introduction, two other frequently occurring smart city attributes are the use of technology (ICT, internet of things, etc.) and the integration of Open/Big Data. Therefore we also take these contextual dimensions into account when analyzing smart city ecosystems.

5 Methodology

In the next section, we will apply this conceptual framework on the city of Ghent as a smart city ecosystem. Because of the long-term nature of smart city projects, the exploratory nature of our research a multidimensional comparative case-study analysis seems the most suitable approach to make the assessment [45]. Case study research excels at bringing an understanding of a complex issue and can extend knowledge or add strength to what is already known through previous research. On top of that, case studies are most suited for processes which are poorly understood and lack a (solid) theoretical foundation [46], allow to analyze the process open-ended and on multiple levels [45] and gain deeper qualitative insights. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used. Given the complexity of the studied phenomenon, the multiple levels of analysis and the participation of the author team in the studied smart city projects, the multidimensional comparative case-study design seems most appropriate.

For our case study analysis, six smart city projects were selected using three criteria, the project had to (a) take place in the city of Ghent; (b) be referred to as a 'smart city project' in the project documents and (c) have a collaborative nature. Both finished projects and running projects were taken into account. As research partners in the selected projects, we were able to use both research results (documents) as well as our own experiences (participatory observation/action research) and lessons learned (soft data). The following hard data sources were used for our analysis: (a) meeting reports of steering committees, (b) the initial project proposal and project reports and (c) deliverables from the projects.

The presented conceptual model is applied in three ways. First, the ecosystem architecture (actors) is studied for each of the six smart city projects. Next, the incoming and outgoing value is studied. Finally, the six cases are analyzed on eleven parameters;

- involvement of the full smart city ecosystem
- intensity of the network collaboration
- reuse of knowledge
- importance of Big Data
- importance of Open Data
- importance of technology
- generated economic value
- generated public value
- potential for civic engagement
- knowledge valorization
- sustainability.

5.1 Research Context

The City of Ghent has developed a long-term strategy until 2020, comprising five strategic goals. Knowledge and innovation is one of these goals. In the light of the development of smart cities and the empowerment of smart citizens, a long-term strategic program 'Digitaal.Talent@Gent' has been set up. This program supports the strategic mission of the administration and the city council: "Ghent, a creating city in the development of a sustainable, solidarity and open society by uniting all creative forces" [47, p. 1] . In this regard, different objectives have been formulated around 'knowledge, innovation and creativity', 'social sustainability', 'economic sustainability' and 'ecological sustainability'. In specific, Ghent is involved in setting up open platforms to help develop innovation ecosystems (for and by active user involvement) accelerating the move towards smart cities and providing a wide range of opportunities for sustainable services that are developed, implemented and used for and by citizens and businesses as co-producers.

5.2 Selected Smart City Projects

Citadel.[1] Citadel (on the Move), is a European project that aims to make it easier for citizens and application developers to use Open Data to create innovative mobile applications they want and need. Currently, open governmental data is often difficult to access and use, even by the developer community. Citadel aims to lower this barrier by (a) creating formats that make it easier for local governments to release data in useable, interoperable formats and by (b) providing templates that simplify creating mobile applications. These templates should provide a simplified route to smart service development for non-developers who have great service ideas.

Ghent Living Lab.[2] Ghent Living Lab (GLL) is an open collaborative network led by the City of Ghent. Key partners include the local government and its service partners, iMinds (Flemish organization that supports innovation in media and ICT), all major colleges and universities in the city and local (developer) networks and community organizations. GLL acts as a facilitator between the different parts of the collaborative network that has been established between the research community, businesses, the public sector, citizens and the wider community. Its primary focus is on smart cities and the development of Future Internet related services to support the further development of smart cities. GLL serves as a learning platform and as a test and development environment in a real-life environment. In this way, GLL becomes a tool to work with researchers, entrepreneurs, citizens, digital creative forces and the City of Ghent on joint trajectories in function of product development, research, service delivery and policy strategy. GLL is also an effective member of the European Network of Living Labs.[3]

Zwerm.[4] Zwerm was part of the European project SMARTiP.[5] This city intervention/game took place in two neighborhoods in Ghent. It wanted to support 'smart engagement' and establish a meaningful and stimulating contact between citizens and their neighborhood. Zwerm had two overarching objectives: (a) activate citizens around urban places of interest and motivate them to carry out assignments that are beneficial to the community, meanwhile emphasizing neighborhoods as the place where citizens can meet each other, and (b) encourage a better take-up and use of ICT while helping to develop the information society.

Mijn digitaal idee voor Gent[6] **(MDIVG)**. In the same SMARTiP project, a crowdsourcing platform was launched to gather and generate 'wild' ideas on smart engagement, but also on mobility and environmental solutions for cities. MDIVG

1 http://www.citadelonthemove.eu/

2 http://www.ghentlivinglab.be/en

3 http://www.openlivinglabs.eu/

4 https://www.zwermgent.be/

5 http://www.smart-ip.eu/

6 For academic research on this project see [65, 66].

involved about 5,500 citizens, the city of Ghent and iMinds (looking to benefit from the crowd input). The intermediation platform or 'crowdsourcing enabler': Mijndigitaalideevoorgent.be enabled selective and creative crowdsourcing (see [48]) based on the proprietary software of UserVoice (http://www.uservoice.com). The platform was open to answers on the question 'How can ICT make it even more pleasant to live in Ghent?' between April 1st and May 15th 2011. In this period the website was visited by 5,451 unique visitors and counted 17,873 page views. More than 1,400 people registered their e-mail on the platform, enabling them to submit an idea or cast votes on already submitted ideas. A total of 128 ideas were submitted, which received more than 4800 votes.

Apps for Ghent.[7] This hackaton event, organized by the City of Ghent, iMinds Multimedialab (Ghent University) and OKFN[8] wanted to stimulate the use of Open Governmental Data provided by the City of Ghent. By doing so, the city wanted to increase governmental transparency and stimulate citizen entrepreneurship. The idea is that by providing both professional and amateur developers with data, it will fuel the creation of innovative applications. The event was a 'hackaton' where developers are challenged to create the best application. Participating teams were brought together and allotted a fixed timeframe to develop a prototype or mock-up of an innovative application within a city context. The winning team of the 2012 edition created an application which connects neighborhoods to cultural activities.

Future legends.[9] Future Legends was a Living Lab project, instigated by the City of Ghent, which capitalizes on the lifestyle of Flemish young people from urban areas and the outskirts of the city. These young people are often low skilled and mostly, but not exclusively, of immigrant origin. Research of the REC Radio Centre and the VRT Radio showed that these 'urbans' show limited engagement with the mainstream media landscape. In other words, their own rhythm of life requires an own media pattern and offerings. The bottom up 'Future Legends'-project resulted in a media platform called 'Chase—Music From Scratch' (www.chase.be). This online radio station offers youngsters a platform to express their creativity by participating in the show. Together with professional artists they can compose a playlist and air their own creations.

6 Application of the Framework, Case Study Ghent

In this section, we apply the proposed smart city framework on the different actors for each of the projects (Table 2). We then analyze the different flows of value and affordances between these actors (Table 3). Finally, we compare the selected smart city projects on the different dimensions described before (Table 4).

[7] http://appsforghent.be/

[8] http://www.okfn.be/

[9] http://www.mediatuin.be/projecten/future-legends

Table 2 Application of the framework: actors

	Policy	Citizens	Private partners	Research
Citadel	City government + EU (funding & collaboration)	Low involvement, mainly citizen developers	Providing programming services	Social sciences
Ghent living lab	City government + EU (funding) + ENoLL (EU network)	Focus on citizen participation and empowerment	Involved as project partners (mainly ICT)	Multidisciplinary (technical, creative and social)
Zwerm	City government + EU (funding)	Citizen as a topic of research and co-creator (two neighborhoods)	Providers of technology	Social sciences
Mijn digitaal idee voor Gent	City government + EU (funding)	Citizen as an external source of information	No involvement	Social sciences
Apps for Ghent	City government	Citizen developers	Invited to participate, sponsor and scout talent	Engineering (organizational support)
Future legends	City government + public organizations	Urban youngsters	No involvement	Social sciences

The policy level plays a central role in all six cases, especially the city government, which is part of every project in our selection. The policy actor uses funding schemes and collaborative partnerships to meet its policy goals. Besides the city government, smart city projects are supported by the regional government (Flemish government, through IWT and IWT funded organizations) and the transnational government (European Commission, through special project funding) as well.

Smart city projects do not always approach citizens in the same way. This difference exists on two levels. First, the selected projects *target* different populations. In only two projects, all city inhabitants are being targeted. The other projects target specific niche groups in the city. This subset of citizens can be determined by geographical parameters (such as Zwerm, which was targeted on two neighborhoods), by skills (such as citizen developers) or by sociodemographic profile (such as the Future legends project). Second, *citizen involvement* can be of a different nature. Citizens can be approached as a source of information (GLL, MDIVG), as a provider of services (Apps for Ghent, Citadel) or as a research subject (Zwerm, Future Legends).

Private partners are not always involved in smart city projects (MDIVG, Future Legends). If commercial enterprises are involved, they are providing technological *infrastructure* (Zwerm), *services* (Citadel) or they function as a *partner* that can potentially benefit from the project (GLL, Apps For Ghent). In some of the projects, research actors are *part of the project* and have their own work packages, central in the project (Citadel, Zwerm). In other projects, research activities should rather be considered as a *side track* of the project (GLL, MDIVG, Apps For Ghent, Future Legends). For the latter, research partners only use the data which is generated within the project for academic analysis, but the research results are not being processed within the project.

Table 3 provides an overview of the incoming (Vi) and outgoing (Vo) value flows between actors in a smart city ecosystem. Most of the flows enable other actors to perform certain tasks and can therefore be considered as *affordances*. These enabling flows or affordances differ in nature. Within the studied projects, we distinguish enabling *funding* (financial support), enabling *environments* (an ecosystem or working space), enabling *services* (activities), enabling *knowledge,* (data and expertise), enabling *networks* (brokerage) and enabling *policy* (stimulation by policymakers). Different scenarios exist in which the four smart city actors play a different role in transforming one affordance to another.

Each 'chain of affordances' starts with the instigation of the policy actor (city), which seeks for enabling funding at the European level (except Future Legends, which was supported by city resources), brings together relevant smart city actors (enabling network or environment) and sometimes provides enabling information (e.g. open governmental data). Next, each case follows a distinct chain of affordances, depending on the goals and configuration of the project. *Cities* pursue creation of public and economic value but only generate public value themselves (implementing city improvements). C*itizens* pursue creation of public value and also generate public value themselves (creating apps or services). *Private partners* pursue creation of economic value but generate public value instead (creating free apps and services). R*esearchers*, finally, pursue creation of public value, but generate no value directly, since this actor only plays an enabling role. Overall, the potential generation of economic value is not (yet) realized.

Besides the different roles in a smart city and the flows of affordances between them, some higher level units of analysis remain to be tackled. Table 4 shows the results of our multidimensional comparative case study analysis. We distinguish four main clusters (a) the collaborative nature of a smart city, (b) the role of knowledge and technology, (c) the overall creation of value, and (d) the future of smart city initiatives after the project ends. The performance levels were coded by the author team, based on project documents and insights gathered through project participation.

6.1 The Smart City Ecosystem

The first dimension assesses whether the full smart city ecosystem is involved in the project or not. As was discussed above, an important element in smart cities is the way research, policy, private partners and citizens collaborate and share knowledge and services in order to optimally develop future products and services with a high sustainability. Nevertheless, only three out of six projects involve all four smart city actors. On top of that, one of these two (GLL) has only set up this collaboration on paper and has not yet rolled out full collaborative projects. The role most often

Table 3 Application of the framework: flows

		Policy (city government)	Citizens	Private partners	Research
Citadel	Vi	Applications for an improved city environment (public value and potential economic value) and policy advise (enabling knowledge)	Opportunity to create own applications (enabling environment, enabling knowledge and enabling policy)	EU funding (enabling funding) and research insights (enabling knowledge)	EU funding (enabling funding)
	Vo	Open governmental data (enabling knowledge)	Applications for an improved city environment (public value and potential economic value)	Creation (enabling service) of an empowering platform (enabling environment)	User research (enabling service) + policy and development advise (enabling knowledge)
Ghent living lab	Vi	Ideas of citizens and SME's towards policy (enabling knowledge) + potential economic and public value creation	Potential to transform ideas into reality (enabling network)	Easy access collaboration with policy, citizens, other SME's and research (enabling network) + ideas & user insights (enabling knowledge)	Potential use cases (enabling network and enabling knowledge)
	Vo	Brokerage/networking ideas with creators (enabling network)	Ideas, feedback, suggestions, opinions, willingness to collaborate (enabling knowledge)	Economic growth/entrepreneurship, (potential economic value) products & services (potential public value)	Enabling user research and product development for non-academic projects (enabling service and enabling knowledge)
Zwerm	Vi	Policy advise (enabling knowledge)	Experimental socio-technical environment (enabling environment)	EU funding (enabling funding) + Information on economic potential for enabling technology (enabling knowledge)	EU funding (enabling funding) + Raw data on citizen behavior (enabling knowledge)
	Vo	Facilitating the city as a laboratory (enabling environment)	Participation and behavioral data (enabling knowledge)	Provision of technical components (enabling environment)	Knowledge on human behavior and policy advice (enabling knowledge)

(continued)

Table 3 (continued)

		Policy (city government)	Citizens	Private partners	Research
Mijn digitaal idee voor Gent	Vi	Ideas of citizens (enabling knowledge)	Empowerment platform (enabling environment)	–	Reuse of citizen input for academic analysis (enabling knowledge)
	Vo	City improvements (enabling policy) + city improvement (public value)	Ideas (enabling knowledge)	–	Insights on citizen participation (enabling knowledge)
Apps for Ghent	Vi	Applications for an improved city environment (public value and potential economic value)	Open governmental data (enabling knowledge)	Open governmental data (enabling knowledge)	Low
	Vo	Open governmental data (enabling knowledge) and stimulate app development (enabling policy)	Apps based on governmental Open Data (public value and potential economic value)	Apps based on governmental Open Data (public, and potential economic value)	Low
Future legends	Vi	Policy advise (enabling knowledge)	Experimental environment (enabling environment)	–	Raw data on citizen behavior (enabling knowledge)
	Vo	Project funding (enabling funding)	Project participation (feedback + behavioral data) (enabling knowledge) and creation of their own radio service (public value)	–	Knowledge on human behavior and policy advice (enabling knowledge)

Table 4 Multidimensional comparative analysis of six smart city projects

	Citadel	Ghent living lab	Zwerm	Mijn digitaal idee voor Gent	Apps for Ghent	Future legends
Involves total smart city ecosystem	Yes	Yes	Yes	No	No	No
Network collaboration	Medium	t.b.d.	Medium	Medium	Medium	High
Reuse of knowledge	Yes	No	Yes	No	No	No
Importance of big data	Medium	Low	Low	Low	Medium	Low
Importance of open data	High	Medium	Low	Low	High	Low
Importance of technology	High	Medium	High	High	High	Low
Created economic value	t.b.d.	Low	Low	Low	Low	Low
Created public value	t.b.d.	Medium	High	Medium	Medium	High
Potential for civic engagement	High	High	High	High	High	High
Knowledge valorization	t.b.d.	Medium	Medium	Medium	Medium	High
Sustainability	t.b.d.	Medium	Low	Medium/high	Medium/low	High
Potential for economic growth	High	High	Low	Low	High	Low
Importance of funding	High	Medium	High	Medium	Low	Medium

neglected is that of the private partner. This is challenging when the aim is to create economic value and forecloses the sustainability of the developed products and services. Without a private partner, smart city projects have to rely on 'citizen entrepreneurs' or continuous project support by the city government.

6.2 Collaborations

Besides the involvement of all four smart city actors, it is also interesting to elaborate on the intensity of the collaboration between smart city project partners. The downside of involving the full ecosystem is that collaboration between partners becomes much more difficult and more likely to be less intense. In the selected projects, the city government always acts as the main project coordinator, determining the degree of interaction with the other three actors. Overall, the intensity of collaboration is rather high, which can be explained by the policy goals, which focus more on the collaborative dimension of smart cities than on the technology dimension. For Apps For Ghent, GLL and MDIVG, the main reason for a medium rating on collaboration is the lower interaction with research partners, which are either only using the generated data for academic purposes (MDIVG), only involved for the promotion of the research group (Apps For Ghent) or, as is the case for GLL, have not yet had the chance to collaborate in one of the projects.

6.3 Reuse of Knowledge

This observation brings us to another interesting dimension: the reuse of knowledge. While an increasing amount of smart city projects are being set up, all focusing on efficiency and sustainability, the question rises whether each of these projects generates new knowledge. From this perspective it is important to build upon previous projects and related knowledge. Reuse processes are considered increasingly important for developing high-quality software and ICT projects. As explained by [49], reuse processes can play a crucial role in the success of private entrepreneurial initiatives as well public projects.

Reuse is critical, as it allows working on existing artifacts instead of starting from scratch, thereby enabling the development and deployment of software and services with greater ease. Consequently, time and human effort required to develop software product and pilots can also be effectively reduced. Given the financial crisis across Europe, reuse of ICT-based pilots and products can effectively add to the cost-cutting measures proposed by the public and private bodies. In addition to this, iterative reuse can also have a relevant, verifiable impact on product productivity and quality, as reusing existing artifacts can iteratively improve the quality of the software or pilot. Nevertheless, our analysis shows that only two of the selected smart city projects incorporate reuse of knowledge. Citadel and Zwerm are both part of collaborative European projects in which the reuse of the infrastructure and system logics in other cities is one of the main goals.

6.4 Importance of Big Data

As our society becomes more digital, with key drivers such as social media, mobile devices and sensor networks, we notice a tremendous growth of generated data. This trend is often defined with the phrase ‘Big Data’. There are numerous definitions for the term ‘Big Data’. However, most authors agree that Big Data is a loosely defined term to describe data that has become so large and so complex that they are difficult to process using standard (statistical) software and databases [50]. The analysis of Big Data can help people interact in a more flexible and adaptive way with their environment [51, 52]. Big Data can be a source of competitive advantage presenting new opportunities to create new business models to monetize data or to customize services to individuals. However, Mantelero [53] also points out that these huge amounts of data represent a strategic and economically relevant asset resulting in a centralized power held only by a few subjects. In the context of smart cities, Big Data can be approached as a valuable resource connecting the dimension 'reuse of knowledge' and 'Open Data'. Smart cities often produce huge amounts of data, be it by opening up (governmental) datasets, sharing research results or capturing data by sensors placed throughout the city. In order to optimally tap into this source of raw information, smart city projects must find a way to cope with Big Data. In our analysis, only two out of six smart city projects take this challenge more or less into account (Citadel and Apps For Ghent). Both projects focus on transforming raw data into actionable services and understandable visualizations. Given the increasing importance of this dimension, there are various opportunities for future smart city projects to focus on harnessing this largely untapped potential.

6.5 Importance of Open Data

Open Data is related to the idea that certain data should be freely available to everyone to use and republish as they wish, without restrictions from copyright, patents or other mechanisms of control. The goals of the Open Data movement are similar to those of other 'Open' movements such as Open Source, Open Content, or Open Access. The term 'Open Data' itself is recently gaining popularity with the rise of the Internet and World Wide Web and, especially, with the launch of open-data government initiatives such as Data.gov. In order to become more innovative and transparent, Public Administrations worldwide are starting up Open Data Portals stimulated by the idea that open government data (OGD) can open up economic opportunities, can promote transparency and accountability or can support the reform of public services and innovation [54]. Similarly, the EU's 'Open Data Strategy for Europe' emphasizes the fact that public administrations are sitting on a goldmine of unrealized economic potential. Therefore, it is not surprising that Open Data is a central dimension in two out of six smart city projects (Citadel and Apps For Ghent). Open Data is increasingly becoming important for smart cities. The market value of the reuse of public governmental data in the European Union is estimated at €27 billion, each year [55]. Similar to Big Data, this potential is nevertheless largely untapped and the actual economic valorization of this estimation still remains to be proven. We should also be vigilant of privacy and security issues concerning open data since these data sources can also be used for malicious purposes. More specifically, triangulating different data sources can pose a threat for the privacy of the individual and revealing governmental data might help to find weak spots in security systems.

6.6 Importance of Technology

A lot of smart city projects have a technological-deterministic nature. They build upon the belief that (new) media and ICT solutions can improve life in the city and that technology is the main driver to solve the complex societal challenges we face in contemporary cities. New technologies allow for rapid, distributed, contextual and personalized information exchange. It connects information from public organizations and becomes remixed, annotated and redistributed by the citizens (an informal network of people). These socio-technological evolutions fostered a strong belief in the possibilities for smart cities. The central position of technology is also present in all selected smart city projects except one (Future legends). Whereas technology certainly enables a lot of new opportunities, it is dangerous to believe that technology as such is sufficient to create a smarter city. This potential can only be harnessed if it is embedded in a social context. Technology can support city innovations, but to think of it as the main driver of social change is only a one-dimensional point of view. In order to overcome the short-term nature of smart city projects and have impact over a longer period of time, the social context should be central in smart city projects. Of our selected cases, Future Legends is the only project which became autonomous after the project ended. Not surprisingly, this project was the only one which used technology merely to serve social innovation.

6.7 Economic Value

In the end, smart city projects aim to generate economic and/or public value. While this is often part of the project legitimations when applying for funding, especially for the European Union, none of the selected cases was so far able to generate any substantial economic value. Although the value of Open Data and open collaborative innovation ecosystems is often put forward as a huge source of untapped potential, reality has not yet provided any substantial proof for this. This is one of the biggest challenges for smart city projects. If these projects are not able to boost economy or even be economically successful to be able to become autonomous, smart city projects will always have to rely on governmental support and funding.

6.8 Public Value

Besides monetary value, the generated value can have a public nature as well. Especially when supported by public resources, this might also be a valid project legitimation. Although the concept of public value is much harder to assess, the selected smart cities projects tend to generate at least some public value. For Zwerm, this value was validated trough academic research, confirming that the project had improved social cohesion in both neighborhoods [56]. The Future

Legends project resulted in both policy advise on the stimulation of culture participation for urban youngsters as well as a community driven crowd sourced radio station [57]. For the other smart city projects, the generated public value is more 'fuzzy' or still needs to be proven. Although the promises and project goals contain the creation of public value for all of the selected cases, it is unclear whether the creation of public value was actually achieved or not. In order to legitimize smart city projects, it is important for these projects to validate the creation of public value by measuring its impact.

6.9 Potential for Civic Engagement

Civic or community engagement is typically defined along a continuum of participation but it goes further than participation and involvement. It also involves capturing people's attention and focusing their efforts [58, p. 5]. Thus, one can distinguish many forms of community engagement, with varying levels of communication, such as providing knowledge to the public, consulting the public, involving the community, collaborating with the community or empowering the community to make decisions and to implement and manage change [59, p. 8]. Scearce [60] distinguishes five dimensions or processes in engagement:

- Listening to and consulting the crowds: e.g. online conversations and openly asking for advice
- Designing for serendipity: Creating collaborative environments, in person and online
- Bridging differences: Connecting people with different perspectives
- Catalyzing mutual support: Helping people help each other
- Providing handrails for collective action: Giving enough direction for individuals to take effective and coordinated action.

Based on these dimensions, she formulates best-practices related to the social potential of ICT on (a) a 'macro-level', creating a 'public sphere' that enables people in a society to communicate with each other about their positions as citizens and that helps them to act as a political entity; (b) an 'intermediate-level', creating more or less institutionalized and sustainable, but not necessarily formalized, interaction networks of individuals having the same or a similar social position, interests or desires; and (c) a 'micro-level' where ICT has become an important source for the development and acquisition of social capital [61–63].

Because smart cities aim to stimulate 'smart citizenship', they often focus on the empowerment of citizens and improving civic participation, interaction and engagement. All six smart city projects have a high potential for civic engagement. This proves that the above dimensions play a central role in smart cities and that these projects are fully incorporating the stimulation of civic engagement.

6.10 Knowledge Valorization

This dimension assesses the overall valorization of knowledge and surrounding affordances. Although the goals of smart city projects are often very promising, for most of the cases, evidence of solid, sustainable and meaningful valorization of knowledge and enabling processes within the smarty city ecosystem, is sparse. For the selected smart city projects, valorization is mostly of an academic nature (publishing) or serves the purpose of branding a city as an innovative city. Nevertheless, there certainly is ambition to overcome this problem and to stimulate an increased valorization of smart city projects. Through the European projects for example, local developments will be able to be applied in other European cities as well and the Gent Living Lab project aims at bringing together different smart city initiatives in order to optimally make use of the generated knowledge from different projects.

6.11 Sustainability

Sustainability is the main bottleneck of all selected smart city initiatives, with the exception of Future Legends. Smart city projects are often instigated and fuelled by (European) project funding. Once these projects finish, the generated technology, service and/or knowledge disappears. A second threat for the sustainability of smart city projects is technological-determinism. When technology has a central position in the project, the social dimension and the supporting context surrounding the technology are of often neglected. Therefore, most smart city projects have a hard time crossing the chasm from demonstrator towards an autonomous, sustainable product or service which can service without funding.

6.12 Potential for Economic Growth

In the analysis, a distinction is made between the actual generated economic value and the potential for economic growth. This assessment is hypothetical and analyses the potential value of the generated knowledge within the project over a longer period of time, if challenges such as sustainability would be overcome. This allows a comparison between the potential of the project and the actual valorization. In the selected smart city projects two distinct project goals can be distinguished: (a) projects aimed at the creation of public and economic value (Citadel, GLL, Apps For Ghent) and (b) projects aimed exclusively at the creation of public value (Zwerm, MDIVG, Future Legends). Notably, none of the cases merely has economic objectives. The potential for economic growth can be found in the use of Open Data for the development of innovative services (Apps For Ghent, Citadel) or the collaboration between different stakeholders to co-develop innovative services (GLL). The cases that do have potential for economic growth, however, still have to find a way to realize that potential.

6.13 Importance of Funding

All of the cases with the exception of Apps For Ghent, relied on funding for the kick-start of the project. For the European projects (Citadel and Zwerm) this dependency remains very strong even after the project launched. Without funding these projects (would) seize to exist. The local projects on the other hand rely less on European funding, but the downside of this is that this makes it hard for them to realize their full potential. These projects are governed by the city government, but the officials that are working on these projects have only little or no resources (especially time) to do so. In the case of Apps For Ghent, and especially GLL, promises and opportunities are very high but both projects lack the resources to harness these opportunities to their full potential. The Future Legends project is somehow exceptional in the sense that this project is fully supported by the community and no longer needs external support.

7 Conclusion and Discussion

The concept of a 'smart city' is a container of promises. It holds the belief that cities can and should act as smart collaborative ecosystems, enabled by state-of-the art technology. It envisions cities as laboratories and drivers for social change. In reality, however, a lot of the promises and the potential of a smart city still remain to be proven on multiple levels. In this chapter, a conceptual framework is proposed which enables the analysis of the architecture, collaboration and different dimensions of smart city projects. When this framework is applied to a set of smart city projects in one local ecosystem, different lessons concerning the current state of smart cities can be learned. By making an overarching analysis of six smart city projects in the city of Ghent, the analysis affords an assessment of the overall 'smartness' of a city.

Although smart cities claim to go beyond technology and to have a citizen centric nature, reality shows that a lot of smart city projects still have a rather techno-centric nature (e.g. placing sensors). While collaboration is central in smart cities, not all projects involve all the actors, policy, research, citizens and private partners, in the city. Especially the lack of involvement of private partners and possible business models forecloses the long-term sustainability and economic value creation of smart city projects. Smart cities do have the potential to enable multi-stakeholder collaborative value creation, but therefore they need central governance which stimulates this collaboration, serves as a container for the reuse of knowledge, potentially through Open Data and thus enhancing the sustainability of the generated knowledge. In this context, [64] put forward the concept of *knowledge retention* as an important process in the context of open innovation, indicating the storage and maintenance of knowledge over time. For the city of Ghent, the goals of GLL are most in line with this governance role. This platform, governed by the city government should act as a central actor in the smart city, allowing for an optimal valorization of public and economic value. But for this, sufficient resources are needed, which is the main bottleneck of current smart city initiatives. Most smart city projects rely heavily on public funding, but this funding only has a temporary nature and therefore forecloses long-term planning and strategies, beyond the projects themselves. So far, smart cities have not (or only little) been able to produce long-term creation of value. Most projects are showcases that prove what might be possible, without actual implementation or long-term integration in the everyday life of the city.

In order to move beyond promises and demonstrators, it is important to keep measuring the actual impact of smart city projects. The proposed framework in this chapter highlights and analyses some smart city dimensions, but actual impact measuring remains challenging. Nevertheless, lots of public funding is being consumed by smart city projects, so continuous monitoring and critical analysis is needed in order to force smart cities to prove their added value.

References

1. Eurostat. (2012). Eurostat regional yearbook 2012, Luxembourg.
2. Bloomberg, M. R. (2012). While nations talk, cities act. The @C40Cities mayors summit will advance urban solutions to combat climate change: http://bit.ly/ZGdC3x. March 8, 2012, 7:40 PM. Tweet (MikeBloomberg).
3. Caragliu, A., Del Bo, C., & Nijkamp, P. (2009) Smart cities in Europe. Paper presented at the 3rd Central European Conference on Regional Science (CERS), Košice, Slovak Republic.
4. Dolente, C., Galea, J., & Leporelli, C. (2010). Next generation access and digital divide: opposite sides of the same coin? Paper presented at the European Regional ITS Conference, Copenhagen, Denmark.
5. Verdegem, P. (2009). De digitale kloof en/in e-government: Uitdagingen voor de overheid in de informatiemaatschappij.
6. O'Reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Commun. Strateg., 65*, 17–37.
7. Van Audenhove, L., Lievens, B., & Cammaerts, B. (2005). E-democratie voor Vlaanderen: Stand van zaken., Brussels, Belgium.
8. Poiesz, T. B. C., & Van Raaij, W. F. (2002). *Synergetische Marketing. Een visie op oorzaken en gevolg van veranderend consumentengedrag*. Amsterdam: Prentice Hall.
9. Frissen, V., & van Lieshout, M. (2006). ICT and everyday life: The role of the user. In P. Verbeek & A. Slob (Eds.), *Technology, behavior and the environment, a multidisciplinary approach*. Dordrecht: Kluwer.
10. ITU. (2005). The internet of things: Executive summary, Geneva, Switzerland.
11. Kwon, O., & Kim, J. (2007). A methodology of identifying ubiquitous smart services for U-city development. In J. Indulska, L. T. Yang, J. Cao, J. Ma, E. Loukis, Y. Charalabidis, & J. Scholl (Eds.), *Ubiquitous intelligence and computing*. Berlin: Springer.

12. Shin, D. (2009). Ubiquitous city: Urban technologies, urban infrastructure and urban informatics. *Journal of Information Science, 35*, 515–526.
13. Choi, J. (2010). The city is connections: Seoul as an urban network. *Multimedia Systems, 16*, 75–84.
14. Loukis, E., Charalabidis, Y., & Scholl, J. (2011). Editorial of the special issue on digital cities. *Telematics and Informatics, 28*, 144–147.
15. Ergazakis, E., & Ergazakis, K. (2011). Digital cities: Towards an integrated decision support methodology. *Telematics and Informatics, 28*, 148–162.
16. Middleton, C., & Bryne, A. (2011). An exploration of user-generated wireless broadband infrastructures in digital cities. *Telematics and Informatics, 28*, 163–175.
17. Komninos, N. (2008). *Intelligent cities and globalisation of innovation networks*. London: Routledge.
18. Ojala, T., Valkama, V., Kukka, H., Heikkinen, T., Lindén, T., Jurmu, M., et al. (2010). UBI-hotspots: Sustainable ecosystem infrastructure for real world urban computing research and business. Presented at the 2nd International Conference on Management of Emergent Digital EcoSystems (MEDES 2010), Bangkok, Thailand.
19. Arnkil, R., Järvensivu, A., Koski, P., & Piirainen, T. (2010). Exploring the quadruple helix. Report of Quadruple Helix Research for the CLIQ Project., Tampere.
20. Etzkowitz, H. (2008). The triple helix: University–industry–government. Implications for Policy and Evaluation.
21. Schuurman, D., De Moor, K., De Marez, L., & Evens, T. (2011). A living lab research approach for mobile TV. *Telematics and Informatics, 28*, 271–282.
22. Westerlund, M., & Leminen, S. (2011). Managing the challenges of becoming an open innovation company: Experiences from Living Labs. *Technology Innovation Management Review, 15*, 223–231.
23. Feurstein, K., Hesmer, A., Hribernik, K., Thoben, T., & Schumacher, J. (2008). Living labs: A new development strategy. In J. Schumacher & V. P. Niitamo (Eds.), *European living labs—A new approach for human centric regional innovation*. Berlin: Wissenschaftlicher.
24. Buitendag, A. A. K., van der Walt, J. S., Malebane, T., & de Jager, L. (2012). Addressing knowledge support services as part of a living lab environment. *Issues in Informing Science and Information Technology, 9*, 221–241.
25. Cosgrave, E., Arbuthnot, K., & Tryfonas, T. (2013). Living labs, innovation districts and information marketplaces: A systems approach for smart cities. *Procedia Computer Science, 16*, 668–677.
26. Paskaleva, K. (2011). The smart city: A nexus for open innovation? *Intell. Buildings International, 3*, 153–171.
27. European Commission. (2011). Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Digital Agenda for Europe., Brussels, Belgium.
28. OECD. (2007). Guidelines for access to research data from public funding, Paris, France.
29. Swan, A. (2012). Policy guidelines for the development and promotion of open access. Paris: United Nations Educational, Scientific and Cultural Organization.
30. Von Hippel, E. (2005). *Democratizing innovation*. Cambridge: MIT Press.
31. Bogers, M., Afuah, A., & Bastian, B. (2010). Users as innovators: A review, critique, and future research directions. *Journal of Management, 36*, 857–875.
32. Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York: New York University Press.
33. Cosgrave, E., & Tryfonas, T. (2012). Exploring the relationship between smart city policy and implementation. In The First International Conference on Smart Systems, Devices and Technologies, pp. 79–82.
34. Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.
35. Hargadon, A. B., & Bechky, B. A. (2006). When collections of creatives become creative collectives: A field study of problem solving at work. *Organization Science, 17*, 484–500.

36. Fransman, M. (2010). *The new ICT ecosystem: Implications for policy and regulation*. Cambridge: Cambridge University Press.
37. Stocker, A., Dösinger, G., Saed, A., & Wagner, C. (2007). The three pillars of "corporate web 2.0": A model for definition. In Proceedings of the I-MEDIA '07 and I-SEMANTICS '07 Conference, Graz, Austria.
38. Leminen, S., Westerlund, M., & Nyström, A. (2012). Living labs as open-innovation networks. TIM Rev. September, 6–11 2012.
39. Perkmann, M., & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews, 9*, 259–280.
40. Brem, A., & Viardot, E. (2013). *Evolution of innovation management: Trends in an international context*. Hampshire: Palgrave Macmillan.
41. Bogers, M., & West, J. (2012). Managing distributed innovation: Strategic utilization of open and user innovation. *Creativity and Innovation Management, 21*, 61–75.
42. Hargadon, A. (1998). Firms as knowledge brokers: Lessons in pursuing continuous innovation. *California Management Review, 40*, 209–227.
43. Norman, D. (2002). *The design of everyday things*. New York: Basic Books.
44. Ballon, P. (2007). Business modelling revisited: The configuration of control and value. *Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media, 9*, 6–19.
45. Yin, R. (1984). *Case study research*. Beverly Hills: Sage Publications.
46. Eisenhardt, K. (1989). Building theories from case study research. *Academy of Management Review, 14*, 532–550.
47. Stad Gent. (2007). Strategische nota van het meerjarenplan 2007–2012. Available at http://www.gent.be
48. Schenk, E., & Guittard, C. (2009). Towards a characterization of crowdsourcing practices. Available online at: http://halshs.archives-ouvertes.fr/halshs-00439256/fr/
49. Basili, V. R., Briand, L. C., & Melo, W. L. (1996). How reuse influences productivity in object-oriented systems. *Communications of the ACM, 39*, 104–116.
50. Snijders, C., Matzat, U., & Reips, U. D. (2012). "Big data": Big gaps of knowledge in the field of internet science. *International Journal of Internet Science, 7*, 1–5.
51. Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). Big data: The next frontier for innovation, competition, and productivity. McKinsey Global Institute, Retrived May 21, 2014 from http://www.mckinsey.com/Insights/MGI/Research/Technology_and_Innovation/Big_data_The_next_frontier_for_innovation
52. Anderson, J. Q., & Rainie, L. (2012). Big data: Experts say new forms of information analysis will help people be more nimble and adaptive, but worry over humans' capacity to understand and use these new tools well, Washington, DC.
53. Mantelero, A. (2012). Masters of big data: Concentration of power over digital information. Available SSRN http://ssrn.com/abstract=2048236
54. Davies, T. (2010). Open data, democracy and public sector reform. A look at open government data use from http://www.data.gov.uk. Retrived May 21, 2014 from http://www.opendataimpacts.net/report/wp-content/uploads/2010/08/How-is-open-government-data-being-used-in-practice.pdf
55. Lippert. (2010). Public sector information reuse in Denmark: European public sector information platform, Topic Report No. 20. European Public Sector Information (PSI) Platform, funded by the European Commission.
56. Coenen, T., Mechant, P., Laureyssens, T., Claeys, L., & Criel, J. (2013). ZWERM: Stimulating urban neighborhood self-organization through gamification. Presented at the International Conference Using ICT, Social Media and Mobile Technologies to Foster Self-Organisation in Urban and Neighbourhood Governance, Delft, Netherlands.
57. All, A., Coorevits, L., & Schuurman, D. (2013). Bottom-up radio: Creating a new media format using living lab research. Paper presented at Breaking the Media Value Chain: VII International Conference on Communication and Reality, Barcelona, Spain.
58. Aslin, H. J. & Brown, V. A. (2004). Towards whole of community engagement: A practical toolkit. Canberra: Murray-Darling Basin Commission.

59. Thompson, L., Stenekes, N., Kruger, H. & Carr, A. (2009). Engaging in biosecurity: Literature review of community engagement approaches. Canberra: Bureau of Rural Sciences.
60. Scearce, D. (2011). Connected Citizens: The Power, Peril and Potential of Networks. Knight Foundation and Monitor Institute, Retrived May 21, 2014 from https://knight.app.box.com/shared/ng70lqn9hb
61. Friedman, T. L. (2005). *The world is flat: A brief history of the twenty-first century*. New York: Farrar Straus and Giroux.
62. Stern, M., & Dillman, D. (2006). Community participation, social ties, and use of the internet. *City Community, 5*, 409–424.
63. Wellman, B., Quan-Haase, A., Boase, J., Chen, W., Hampton, K., Díaz, I. and Miyata, K. (2003). The Social Affordances of the Internet for Networked Individualism. *Journal of Computer-Mediated Communication, 8*, 0. doi:10.1111/j.1083-6101.2003.tb00216.x
64. Lichtenthaler, U., & Lichtenthaler, E. (2009). A capability-based framework for open innovation: Complementing absorptive capacity. *Journal of Management Studies, 48*, 1315–1338.
65. Mechant, P., Stevens, I., Evens, T., & Verdegem, P. (2012). E–deliberation 2.0 for smart cities: A critical assessment of two “idea generation” cases. *International Journal of Electronic Governance, 5*, 82–98.
66. Schuurman, D., Baccarne, B., Mechant, P., & De Marez, L. (2012). Smart ideas for smart cities: Investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. *Journal of Theoretical and Applied Electronic Commerce Research, 7*, 11–12.

Environmental Sustainable Fleet Planning in B2C e-Commerce Urban Distribution Networks

Francesco Carrabs, Raffaele Cerulli and Anna Sciomachen

Abstract Sustainable distribution is one of the topics concerning the smart city concept. In this chapter we face the problem of delivering a given amount of goods in urban areas arising from e-channel department stores, with the aim of minimizing the overall distribution costs; costs take into account traveling components, loading and other operative aspects, and environmental issues. More precisely, in the present business to consumer distribution problem, we have to determine the fleet of not homogeneous vehicles (trucks, wagons, vans and picks-up) to be used for satisfying the demands of clients coming from e-channels, and their related itineraries, given the traveling limits imposed by the urban government; in particular, we have to respect the maximum route length constraints and use the appropriate vehicles for each kind of street. We propose a mathematical programming model to solve this computationally difficult problem, which is strategic for being able to implement sustainable distribution plans in a smart city context. Preliminary results of test bed cases related to different sized urban distribution networks are reported and analyzed.

Keywords City logistics • Sustainable distribution • e-Channel • Network models • Vehicle routing problem

---

F. Carrabs · R. Cerulli
Department of Mathematics, University of Salerno, Via Giovanni Paolo II, nr. 132, 84084 Fisciano, SA, Italy
e-mail: fcarrabs@unisa.it

R. Cerulli
e-mail: raffaele@unisa.it

A. Sciomachen (✉)
Department of Economics and Business Studies, University of Genoa, Via Vivaldi 5, 16125 Genoa, Italy
e-mail: sciomach@economia.unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_9,

1 Introduction

Nowadays, both large and small cities are proposing a new model, called "the smart city", which represents high technological, sustainable, comfortable and secure living environment. Following this idea, a number of models have been developed and deployed with the help of technological advances in computer and communication, such as Information and Communication Technology (ICT) and Intelligent Transport Systems (ITS), which constitute precisely the basis of the smart city model [2, 12].

Sustainable distribution is one of the topics concerning the smart city concept. Recently, increasing attention has been particularly devoted to sustainable development of urban areas as well as mobility of goods for ensuring the wellbeing of community. The aim of a sustainable urban distribution network is to analyze how society intends to provide the means to properly meet economic, environmental and social needs efficiently and equitably, while minimizing negative impacts and their associated costs, including environmental issues, such as congestion, noise and air pollution. In this sense, the idea of city logistics has been proposed to establish efficient and environmentally friendly urban logistics systems [5, 11].

A difficulty in modeling city logistics comes from the complex interactions between private and public stakeholders involved in urban freight transport: shippers, freight carriers, administrators and residents (consumers). In fact, city logistics requires advanced optimization and simulation modeling approaches and tools to assist in the design, implementation and evaluation of schemes that satisfy the needs of all the above stakeholders, who hold different concerns and objectives. While the recent growth of research into urban distribution and city logistics is encouraging (see e.g. [6, 13]), only few works have been concerned with examining the likely impact of policy measures on distribution operations. A review of emerging techniques for enhancing the practical application of city logistics models is presented in [7, 12]; focuses on the evaluation of urban tours traveled by different types of commercial vehicles and their related costs. In Anderson et al. [1] a project is presented having the aim of investigating the ways in which alternative policy measures, such as weight and access time restrictions, can result in changes in the vehicle activities involved in urban distribution operations. New challenges have been observed for distribution systems designed within smart city frameworks. In particular, models of vehicle routing problems (VRP) are considered basic tools for implementing sustainable good distribution channels in urban areas. In this direction, a number of chapters on VRP have been published by operations researchers and practitioners (see, e.g. [9, 10]) with the aim of providing advances for the development of ITS within smart city models. In the present chapter we consider a particular case of VRP, originating from the need of delivering goods in an urban context arising from e-channel department stores. More precisely, in this urban business to consumer (B2C) distribution problem we have to determine the fleet of not homogeneous vehicles (trucks, wagons, vans and pick-up) to be used for the delivery of a given amount of goods in urban areas. Note that the management of the fleet and the global routing of vehicles in the urban network are key elements for sustainable goods distribution plans. Our problem is strongly connected to the design of city logistics systems for medium–large cities, where it provides the means to efficiently keep large trucks out of the city center, with small and environment-friendly vehicles providing the last leg of distribution activities [5]. Following this direction, in this chapter, each vehicle involved in the distribution process is characterized by two parameters: (1) the size (which allows it to cross only some types of roads) and (2) the maximum load capacity. Starting from a depot (to be determined) each vehicle must pass through the streets of the city (compatible with its size) to deliver the required goods along that road and go back to the chosen depot. The considered cost components, to be minimized, take into account traveling, loading and environmental issues.

We present a mathematical formulation of this novel urban B2C distribution problem for solving it. The referring urban B2C network problem (UB2CNP) is presented in more details in the next section. Section 3 reports the proposed network model and the related Mixed Integer Programming (MIP) formulation. Finally, some preliminary results and outlines for future works are given.

2 Problem Definition

The proposed urban logistic network problem (UB2CNP) can be seen as an extension of the classical vehicle routing problem VRP, encountered very frequently in making decisions about the distribution of goods and services. Given a number of customers with known demands and a fleet of not identical vehicles with known capacities, the problem consists in finding a set of routes originating and terminating at a central depot and serving all the customers exactly once. The routes cannot violate the capacity constraints on the vehicles. Differently from the classical VRP formulation, in addition, we must meet the size constraints on the streets, which specify which kind of vehicle can cross the street. All problem parameters, such as customer demand and typologies of streets, are assumed to be known with certainty. The standard objective of the UB2CNP problem consists of minimizing the total travel cost.

The UB2CNP is a basic distribution-management problem that can be used to model many real world problems. Some of the most useful applications of the UB2CNP include bank deliveries, postal deliveries, industrial refuse collection, national franchise restaurant services, school bus routing, security patrol services, and vendor deliveries for just-in-time manufacturing.

Here, the UB2CNP applies to deliver groceries ordered from e-channel department stores to customers who reside at their homes. The management of the department stores has hence to collect the orders and group them according to the allowable vehicles. Further, customers are identified according to their address with reference to the corresponding kind of street, for being able to define the routes necessary to satisfy the overall demand and choose the best vehicle to use for the delivery which minimizes costs and the environmental impact. The problem, as particular case of the classical VRP problem, is NP-complete [8] that is computational difficult to be solved, and instances involving more than 100 customers are very hard to solve optimally. For this reason it makes sense to focus on the development of efficient mixed integer programming formulation models, possibly accomplished by the creation of heuristics approach to solve the problem. For recent surveys on the state of the art in VRP research we recommend the survey by Cordeau et al. [4] that describes both exact and heuristic methods, and the survey by Bräysy and Gendreau [3] that focuses on metaheuristics.

3 The Urban Logistic Problem

Formally the UB2CNP is defined as follow. Let $G = (V \cup \{0\}, E, L)$ be a connected digraph where V is the set of locations, 0 is a special vertex representing the depot, L is the set of different typologies (label) of streets, A is a set of arcs to which two values are associated: (1) a nonnegative weight t_{ij}, denoting the travel time (or the edge length) and (2) a label indicating the edge (street) type. Let n, m and l be the cardinality of V, E and L, respectively. A service requirement q_i, which can be delivery from the depot, associated with each customer. Vehicles of different type and different capacity must be routed to serve all the customers. A feasible vehicle route $\rho = \{0, v_1, v_2, \ldots, v_{\ell-1}, v_\ell, 0\}$ of length l is an ordered sequence of different customers to be served such that the total capacity of the vehicle is not exceeded and, the streets constraints are satisfied. A feasible solution $S = \{\rho_1, \rho_2, \ldots, \rho_k\}$ of the problem is a collection of feasible routes. We denote by $c(\rho)$ the total length of route ρ and by $c(S) = \sum_{\rho_i \in S} c(\rho_i)$ the total length of the feasible solution S. The UB2CNP problem consists in computing the minimum cardinality set $S = \{\rho_1, \rho_2, \ldots, \rho_k\}$ of feasible routes such that all the customers are served and each customer is visited by a single vehicle. Note that this objective implies the minimization of the number of vehicles used for delivering the required goods, thus in turn reducing both the congestion and the pollution in the city tours as well as the final cost.

3.1 The Urban Logistic Network Model

To model this problem we use an edge labeled graph. The nodes represent intersections and the arcs the streets of the city. The nodes are classified as: depot nodes (where goods are stored), costumer nodes (where goods have to be delivered) and the transshipment nodes. We assign a different label to each type of street according to its width. Moreover, each label will be associated to a particular type of vehicle. Without loss of generality, we assume that the labels are ordered according to the width of the street. For example, if there are three types of roads there are three different labels: A, B and C. The vehicles associated to label A can travel along the streets of type A, B and C, labeled B vehicles can travel along streets B and C, while vehicles with label C are allowed to pass only through streets of type C. Each vehicle is characterized by two parameters: (1) the size (which allows it to cross only some types of roads) and (2) the maximum load capacity. Starting from a depot each

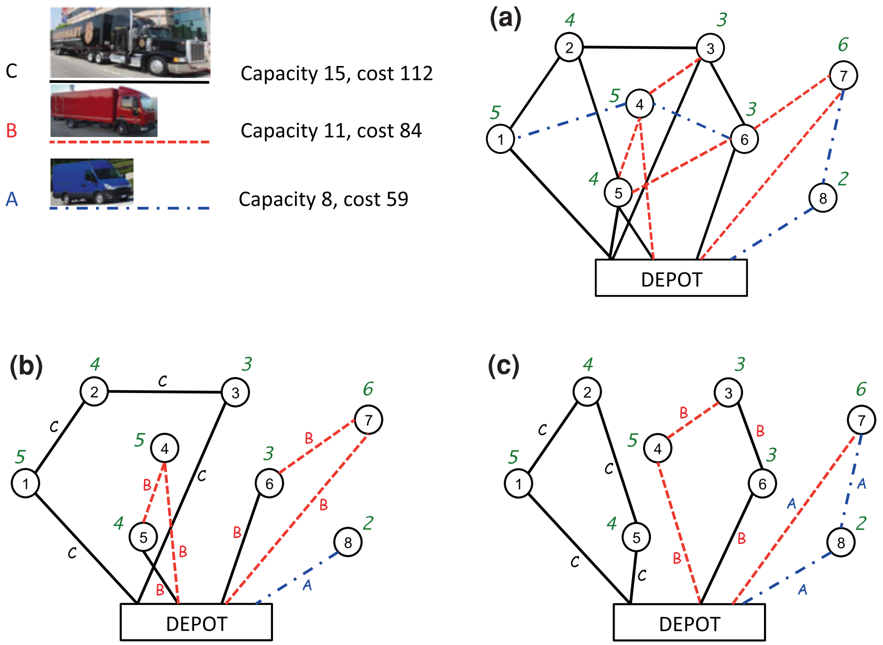


Fig. 1 A simple example of the problem where no cost are associated to the edge of the graph. **a** The labeled graph G. **b** A feasible solution with value 112 + 84 + 84 + 59 = 339 and **c** a better solution with value 112 + 84 + 59 = 255

vehicle must pass through the streets of the city (compatible with its size) to deliver the required goods along that road and go back to the depot. A cost c_k is associated to each type of vehicle. The length of each route cannot exceed a fixed value. A simple example of our referring urban B2C network model is reported in Fig. 1a, which shows a small urban center in which eight customers must be supplied from a single depot by using three type of vehicles. To each vehicle is associated a capacity 8, 11, 15 and a fixed cost 59, 84, 112, respectively. To each edge is associated a label representing the type of vehicle that can cross this edge. In this particular case, the cost of the edges is neglected. The numbers outside the nodes represent the associated goods' demand. In Fig. 1b and c are reported two feasible solutions with cost 339 and 255, respectively. Readers can easily note how the number of the used vehicles impacts on the final cost.

3.2 Mixed Integer Programming Mathematical Formulation

In this section we present a integer programming formulation for the UB2CNP. Before presenting the whole model let us summarize the required notations. Consider customers at various locations in the city which must be served by vehicles hosted at a central depot. Denote the central depot by 0 and the locations by $i = 1 \ldots n$. We can represent the input information using a directed network $G = (V \cup \{0\}, E, L)$, where V denotes the set of n vertices, E the set of m arcs (the streets) and L the set of labels associated to the arcs (the streets characteristic).

The following inputs are assumed to be available:

- T = number of vehicle types;
- Q_t = capacity of vehicle type $t (Q_1 < Q_2 < \cdots < Q_T)$;
- f_t = fixed activation cost of vehicle type $t (f_l < f_2 < \cdots < f_T)$;
- d_j = demand of customer j;
- c^t_{ij} cost to pay for each vehicle of type t that crosses the arc (i, j);
- a^t_{ij} that assumes value equal to 1 if the edge (i, j) can be traversed by the vehicles of type t;
- V_d set of demand nodes;
- V_p set of transhipment nodes ($V = V_d \cup V_p \cup \{0\}$ and $V' = V_d \cup V_p$).
- mk = number of vehicles of type k available

In addition, the following decision variables are used:

- binary variable x^k_{ij} that assumes value equal to 1 if a vehicle of type k travels from i to j, and 0 otherwise;
- continuous variable y_{ij} that represents the flow of goods from i to j.

Then, the (MIP) formulation of UB2CNP is the following:

$$\min \sum_{k\in T} f_k \sum_{j\in V'} x^k_{0j} + \sum_{k\in T} \sum_{\substack{i,j\in V \\ i\neq j}} c^k_{ij} x^k_{ij} \tag{1}$$

$$s.t. \sum_{k\in T} \sum_{i\in V} x^k_{ij} = 1 \qquad \forall j \in V_d \tag{2}$$

$$\sum_{i\in V} x^k_{ip} - \sum_{j\in V} x^k_{pj} = 0 \qquad \forall p \in V', \forall k \in T \tag{3}$$

$$x^k_{ij} \leq a^k_{ij} \qquad \forall i,j \in V,\ i \neq j,\ \forall k \in T \tag{4}$$

$$\sum_{j\in V'} x^k_{0j} \leq m_k \qquad \forall k \in T \tag{5}$$

$$\sum_{i\in V} y_{ij} - \sum_{i\in V} y_{ji} = q_j \qquad \forall j \in V_d \tag{6}$$

$$\sum_{i\in V} y_{ij} - \sum_{i\in V} y_{ji} = 0 \qquad \forall j \in V_p \tag{7}$$

$$y_{0j} \leq \sum_{k=1}^{T} (Q_k) x^k_{0j} \qquad j \in V' \tag{8}$$

$$y_{ij} \leq M \sum_{k=1}^{T} x_{ij}^{k} \qquad \forall (i, j) \in E \tag{9}$$

$$x_{ij}^{k} \in \{0, 1\} \qquad \forall i, j \in V, \ i \neq j, \ \forall k \in T \tag{10}$$

$$y_{i,j} \geq 0 \qquad \forall (i,j) \in E \tag{11}$$

where M is chosen to be a large number so that (9) becomes redundant if $\sum_{k \in T} \sum_{i \in V} x_{ij}^{k} = 1$. For our problem is easy to see that a correct value for M is $\max_{k \in T}\{Q_k\}$. However, due to the constraints (4) we can associate different value M_{ij} to each arc (i, j) of the graph considering the maximum capacity of the vehicle among those that can traverse the arc (i, j).

In the above formulation, the objective function (1) requires the minimization of the total cost to serve all customers. Note that the cost coefficients depend on the type of the vehicles; in this way we are able to take into a proper account a sort of pollution charge depending on the environmental impact of the vehicle. Moreover we consider a fix cost f_k required to use the vehicle k. Constraints (2) and (3) impose that a customer is visited exactly once and that if a vehicle visits a customer, it must also depart from it. Constraints (4) guarantees that each vehicle can traverse only appropriate streets. The maximum number of vehicles available for each vehicle type is imposed by constraints (5). Constraints (6) and (7) are the commodity flow constraints: they specify that the difference between the quantity of goods a vehicle carries before and after visiting a customer is equal to the demand of that customer (this demand is equal to 0 for the transhipment nodes). The constraints (8) ensure that the vehicle capacity is never exceeded whenever the constraints (9) guarantee that the value y_{ij} can be greater than 0 only if exists at least a vehicle that crosses the arc (i, j). Finally, constraints (10) and (11) are the variables constraints.

4 Computational Tests

The model were coded in C++ and solved by CPLEX 12 on a 2.33 GHz Intel Core2 processor. We carried out the computational tests on a set of scenarios composed by three instances having the same number of vertices, edges and vehicles. In the randomly generated instances, the number of vertices ranges from 10 to 40 and the density ranges from 0.3 to 0.5. We used small instances because, how we will see in the following, the UB2CNP problem appears very hard to solve in particular when the density of the graph increases. Moreover, we generated instances with 2 and 3 different type of vehicles in order to evaluate also the impact of this parameter on the performance of the model; in particular, in our instances we consider two types of urban routes where vans and wagons, and vans, wagons and trucks are allowed, respectively.

Table 1 Test results carried out on the small instances with (a) 2 type of vehicles and (b) 3 type of vehicles

id	n	m	v	MIP		
				Obj	#Routes	Time
(*a*)						
1	10	13	2	483.33	1	0.02
2	10	18	2	417.66	1	0.02
3	10	21	2	1006.33	3.33	0.07
4	20	54	2	1880.66	5.66	1.06
5	20	73	2	1469.33	5	4.96
6	20	94	2	1983	5.33	20.33
7	30	127	2	3297	8.66	7.91
8	30	170	2	*2938.66**	*8.33**	434.35
9	30	216	2	2879.33	6	1593.98
10	40	233	2	*2735.33**	*8**	2480.98
11	40	307	2	*2545.33**	*7.66**	3142.33
12	40	385	2	*2229**	*7.33**	3748.88
(*b*)						
1	10	13	3	544.66	1	0.02
2	10	18	3	507.33	1	0.02
3	10	21	3	1789.33	4.66	0.18
4	20	54	3	4186	7.33	3.94
5	20	73	3	2909.33	5.33	10.74
6	20	94	3	3515.33	5.66	719.27
7	30	127	3	5324	8	324.07
8	30	170	3	*5078.66**	*8**	2627.9
9	30	216	3	*5174**	*7.33**	3763
10	40	233	3	*5122**	*9**	3971.91
11	40	307	3	*3461**	*7.33**	7210.03
12	40	385	3	N.D.	N.D.	N.D.

* is associated to the computational time if the optimal solution is not found within the fixed time limit.

In Table 1a are reported the results of the model with a number of vehicles equal to 2. The first four columns list the id (*id*), the number of vertices (n), the number of edges (m) and the number of different vehicles ($|T|$), respectively. The column MIP is divided in three subcolumns (*Obj*, *Routes* and *Time*) reporting the objective function value, the number of the routes found and the CPU time (in seconds) spent. A threshold of 2 h and of 3 GB of memory were imposed for the solution of each instance. The results reported in each line of the table are the average values computed on the three instances of the same scenario. Finally, if for at least an instance of a scenario the model finds a feasible (but not optimal) solution, within the time limit or the memory limit, the marker "*" is reported on the column *Obj* and *Routes* of that scenario. Moreover, if for at least an instance of a scenario the model does not find a feasible solution, within the thresholds, the term N.D. (Not Determined) is reported for this scenario.

From the results of Table 1a we can see that the model is able to solve all the instances up to 30 vertices except for the scenario n°8. On the scenarios up to 20 vertices, the model is very fast while on the instances with 30 vertices the computational time increases meaningfully. Obviously, as the density of the graph grows the computational time increases. However, it is interesting to notice that, in some cases, instances with more vertices and low density require less computational time than instances with less vertices but higher density (see scenarios 6 and 7). On the greatest instances with 40 vertices, the model never finds the optimal solution but, within the thresholds, a feasible solution is always found.

In Table 1b are shown the results of the model with a number of vehicles equal to 3. Comparing the Time columns of the two tables it is evident that the complexity of the instances meaningfully increases when the number of vehicles grows. Indeed, the model finds the optimal solution on the scenarios up to 7. On the remaining five scenarios, the model finds in four cases a feasible solution while on the scenario n°12 it fails to find a feasible solutions. Also in this table, the scenario n°6 required more computational time than the scenario n°7 and this enforces our conjecture that the performance of the model are more affected by the density than by the number of vertices of the graph.

It should be noted that the value of the solution is closely related to the environmental impact of the solution: the smaller the value of the solution (smaller the cost of the objective function), the lower is the congestion of city streets and, therefore, the lower is the emissions of greenhouse gases and air polluting compounds and noise congestion.

5 Conclusion and Outlines for Future Works

In this chapter we propose a variant of the classical vehicle routing problem (VRP). We called "Urban logistic network problem" (UB2CNP) this new variant. For this new problem we propose an integer mathematical formulation; the problem originated from the need of determining a sustainable fleet of vehicles to be used for delivering goods in a urban B2C distribution problem.

We execute some preliminary tests of our mathematical programming model on random generated graph instances, representing urban transportation networks.

In the future experimentation we will highlight the importance of the type of vehicles and how this type affects the optimal solution of the problem; in particular we deeply analyze the environmental impact in the objective function cost component. Moreover one of the aims we want to achieve is to study the relationship between the reduction of the emissions of greenhouse gases and the increased costs of the distribution service. To do this we will use the methodology of sensitivity analysis. From applicative point of view we strongly believe that the proposed novel variant of the classical VRP goes in the direction of the development of ITS which is one of the necessary tools for efficient smart city models.

References

1. Anderson, S., Allen, J., & Browne, M. (2005). Urban logistics—how can it meet policy makers—sustainability objectives? *Journal of Transport Geography, 13*, 71–81.
2. Anttiroiko, A. V., Valkama, P., & Bailey, S. J. (2013). Smart cities in the new service economy: Building platforms for smart services. *AI & Society,*. doi:10.1007/s00146-013-0464-0.
3. Bräysy, O., & Gendreau, M. (2005). Vehicle routing problem with time windows, part ii: Metaheuristics. *Transportation Science, 39*(1), 119–139.
4. Cordeau, J-F., Desaulniers, G., Desrosiers, J., Solomon, M. M., & Soumis, F. (2002). The vehicle routing problem. In P. Toth & D. Vigo (Eds.), volume 9 of SIAM monographs on discrete mathematics and applications, Chap. 7, 157193. SIAM, Philidelphia.
5. Crainic, T. G., Ricciardi, N., & Storchi, G. (2004). Advanced freight transportation systems for congested urban areas. *Transportation Research Part C, 12*, 119–137.
6. Crainic, T. G., Ricciardi, N., & Storchi, G. (2009). Models for evaluating and planning city logistics systems. *Transportation Science, 43*(4), 432–454.
7. Figliozzi, M. A. (2010). The impacts of congestion of commercial vehicle tour characteristics and costs. *Transportation Research Part E, 46*, 496–506.
8. Lenstra, J. K., & Rinnooy Kan, A. H. G. (1981). Complexity of vehicle routing and scheduling problems. *Networks, 11*, 221–227.
9. Li, J. Q., Borenstein, D., & Mirchandani, P. B. (2007). A decision support system for the single-depot vehicle rescheduling problem. *Computers & Operations Research, 34*, 1008–1032.
10. Qureshi, A. G., Taniguchi, E., & Yamada, T. (2009). An exact solution approach for vehicle routing and scheduling problems with soft time windows. *Transportation Research E, 45*(6), 960–977.
11. Taniguchi, E., Thompson, R. G., Yamada, T., & Van Duin, R. (2001). *City logistics—network modeling and Intelligent transport systems*. Oxford: Elsevier.
12. Taniguchi, E., Thompson, R. G., & Yamada, T. (2012). Emerging techniques for enhancing the practical application of city logistics models. *Procedia—Social and Behavioral Sciences, 39*, 3–18.
13. Teo, J. S. E., Taniguchi, E., & Qureshi, A. G. (2012). Evaluating city logistics measure in e-commerce with multiagent systems. *Procedia—Social and Behavioral Sciences, 39*, 349–359.

Smart Security: Integrated Systems for Security Policies in Urban Environments

Enrico di Bella, Francesca Odone, Matteo Corsi, Alberto Sillitti and Ruth Breu

Abstract Smart Security systems are applications of the Smart City paradigm for local crime prevention. Like most Smart City tools, they consist of informational and technological components that support decision-making processes. A pre-requisite for such tools is that they are supposed to be means of ongoing management and policy innovations: we therefore review some of the crucial components of a Smart Security system from the viewpoint of a local government or a local branch of the public administration, in order to analyze the high-level requisites, characteristics and potentials of such a system. The objective is to help Public officials in identifying both what defines a useful technical tool but also what is required on the part of the public administration to actually make it useful. We therefore discuss the following problems. First, we address the issue of indicators, data and the use of statistical analysis to infer the likely determinants of crime and to define risk parameters for urban spaces. In doing that, we suggest innovative tools to introduce spatial information in crime count models. Second,

---

E. di Bella (✉) · M. Corsi
Department of Economics and Business Studies, University of Genoa, Genoa, Italy
e-mail: enrico.dibella@economia.unige.it

M. Corsi
e-mail: matteo.corsi@edu.unige.it

F. Odone
Department of Informatics Bioengineering Robotics and Systems Engineering, University of Genoa, Genoa, Italy
e-mail: francesca.odone@unige.it

A. Sillitti
Center for Applied Software Engineering, Free University of Bozen, Bolzano, Italy
e-mail: alberto.sillitti@unibz.it

R. Breu
Institut für Informatik, University of Innsbruck, Innsbruck, Austria
e-mail: ruth.breu@uibk.ac.at

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_10,

we discuss sensors and sensor output analysis, trying to define the circumstances that make it useful and the new possibilities offered by current technology. Then we discuss about integration of different information both from a conceptual and a technical point of view, stressing the importance of closing the gap between cold and hot data in order to realize an integrated early warning system. Finally, we discuss the problem of creating a scalable Smart Security system in a local government, indicating a list of significant international experiences.

Keywords Crime mapping • Urban security policies • Security dashboard • Smart security • Intelligent video surveillance

1 Introduction

Smartness for urban environments is supposed to imply a commitment to innovation in technology, management and policy, but the first element of this triad has been researched within the "smart" framework more extensively than the other two [1]. This is the case as well with the specific dimension of urban smartness that is security [2]. Systems for crime visualization, analysis and street surveillance have already been proposed and researched theoretically and applied in practice (e.g., [3, 4]). From an IT standpoint, the gradual innovation regarding these tools has been mostly confined to the integration of different technologies and the development of new technical tools. In a few cases, authentically smart projects have aimed at innovating the management and the policies of urban security "together with" instead of "as a consequence of" the technology of urban security, but they have been few and far between [5–7]. Our intent is, therefore, to illustrate the structure, the logic, the objectives and the requirements of a "Smart Security" system from a management and policy point of view. The issues that we will cover are, of course, just as technical, but each single technical tool or methodology is going to be discussed from a problem-solving point of view, with greater focus on directing public administrations towards promising fields and less on suggesting hardware or software solutions for IT experts.

The foundational assumption of Smart Security is that to improve quality of life, city governance and management should be based on an exhaustive amount of information on a wide range of activities occurring in public spaces [8]. When collected consistently and in the correct format, such information may constitute the input of analytical tools allowing local governments to anticipate and understand economic and social processes and to respond effectively to issues, crises and environmental changes (e.g., [9, 10]). In the specific field of crime prevention, local governments are not always and not only the main actors of public security (depending on national systems) but also decision-makers for a number of social, economic and urban planning policies that can have huge effects on crime. Because of this, a Smart City approach dealing with urban security should be focused on translating theoretical knowledge about crime and deviancy into indicators, early warning systems, models and analytical frameworks. Such a toolbox should then come into play when and where decision making takes place, supporting well informed, precisely targeted and correctly monitored policies.

In recent years, a number of large western cities have started massive investments aimed at innovating in the field of urban security and at building a better informational background to policy decisions about crime prevention, fear of crime and support to the more vulnerable components of the community (e.g., [7, 11]). There are, however, significant challenges to those efforts:

1. criminology offers a wide range of indicators concerning urban security, but most of them are disputed; different criminological theories suggest different ways of measuring crime, of measuring its determinants and defining the correct scale at which determinants should be identified;
2. behaviors and situations may be more accurate at defining crime then any indicator, but sensors meant to capture behaviors and situations either deliver information *post facto* or they are affected by a severe trade-off between accuracy and earliness;
3. indicators and sensors could theoretically work complementarily, both with the idea of extending the ability of a system to identify different and evolving threats and that of allowing triangulation [12]; however, integration of data sources of such different kinds is far from trivial and requires a consistent amount of planning and the cooperation of experts coming from different disciplines: criminologists, economists, statisticians, urban planners, video image analysts, and computer scientists;
4. even when information is available and reasonably accurate and timely, preventive action requires a lot on the part of the public administration; part of that is about technological innovation but a significant part is about management and policy innovation [1].

Smart Security should approach these challenges in two different ways: on one hand, it has to assume as relevant to its domain every technical solution that provides useful information and support to action for the Public Administration; on the other hand, it has to provide a constant evaluation of the consistency of each innovative tool with preexisting and preordained high level goals of innovative security policy and management. Conceptually, a Smart Security system consists of three logical units: the first one is the module for the analysis of “Place and Population”, where crime is analyzed in conjunction with its macro determinants; the second one is the “Individuals and Behavior” module where it is analyzed at micro level and where the actions and movements of the individuals are relevant; the last module is the “Integrated System” software infrastructure which coordinates all the information flows inside the system and includes the user’s frontend where most of the informative elements for the policy actions are shown. Compared to technologically-driven smart programs, Smart Security adds a virtual fourth element in the intense feedback between technological innovation and management and policy innovation. The new frontier in the field of Smart Security Systems consists of the integration of these partial elements in a single framework as the one described in Fig. 1.

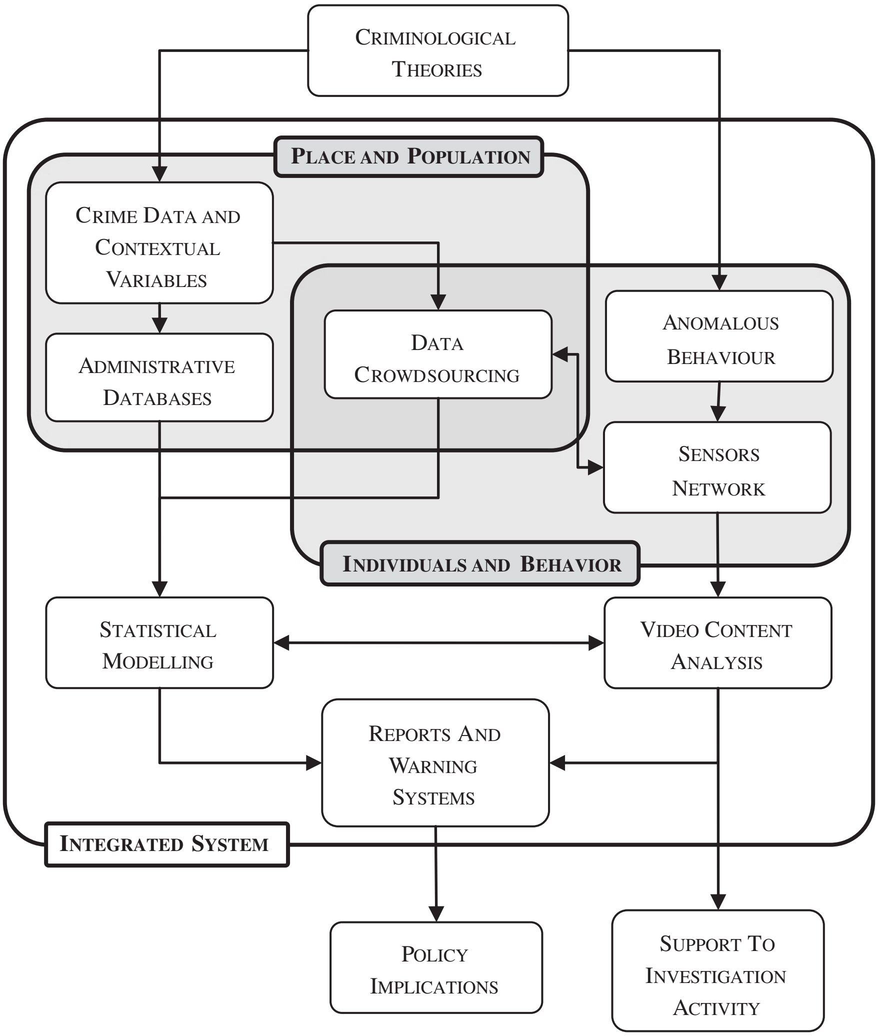


Fig. 1 Logical structure of a Smart Security Integrated System

2 Measuring Crime and Its Determinants in Urban Environments

Information concerning crime that is relevant to Smart Security includes measures of crime and measures of risk or mitigating factors. Such information may not be sufficient to create Smart Security systems, but it is all but necessary.

Like all measures, those concerning crime and its determinants are spatially and temporally located: they matter precisely because they provide intelligence about specific times and places. Since crime is not a constant over time and it is not distributed uniformly in space, it is common practice to draw crime trends and crime maps [13]; these are two relatively trivial building blocks of any informative system (including Smart Security systems) designed to support decision making on urban security and both have a history that's at least a century old. However, as obvious as crime trends and maps are these days, they imply a concept that should be key to any innovative Smart Security system. The concept is that temporal and spatial clusters of crime are the "footprints" of local risk factors and local mitigating factors. It goes without saying that local determinants may change not only in size/intensity, but also in quality. So a Smart system is increasingly informative the more it is capable of mapping crime and its determinants at high resolution.

Measuring crimes is a less trivial activity than one might think: a crime is a legal (abstract) entity consisting of complex behaviors and multiple acts which are hardly numerable in most cases; a simple count of crimes requires therefore, a first level abstraction/elaboration that consists in identifying a reasonable proxy indicator for crimes (like calls for service, police incident reports, victimization self-reports, complaints, sentences, etc.). The raw number of crimes is rarely of use in support of management and policy decisions, as it is inadequate for cross-sectional and inter-temporal comparisons [14]; other indicators have been used in criminology and for official data and statistics, usually as an elaboration of a raw count of crimes, like population-based rates, risk-based rates, densities and location quotients. However, decision makers and public officials should be advised that different indicators actually indicate different things, that is, each proxy and each elaboration of the simple count of crimes carries with itself more or less sophisticated assumptions and meaning differences [15–23]. As for the indicators of risk factors and mitigating factors, a long and intricate debate has been discussing the determinants of crime since the early years of the discipline of criminology. The Department of Sociology of the University of Chicago is the source of the Social Disorganization Theory [24]. By studying the vast growth of the city of Chicago between 1860 and 1910, they noticed that urban areas were more crime-prone than rural ones. Moreover, they identified a connection between crime and several urban issues like poverty, racial heterogeneity, and residential mobility, all leading to the weakening of social control and the disintegration of formal social organizations [13].

The interest in geographic criminology began during the 19th century in France and in Belgium after the publication of the first geographical map of crime. In 1829, Michel Andrè Guerry and Adriano Balbi [25] published a map representing the distribution of crime over the Departments of France between 1825 and 1827. This preliminary study was followed by that of the Belgian statistician and astronomer Quetelet in 1842 and by a number of studies in the Netherlands, England and Wales and in Italy [13].

Between the 60s and the 70s several authors (e.g., [26–28]) developed analytical frameworks of crime and insecurity in the urban environments focused on spatial and functional features of the built environment. Their work, which is globally labeled as the Ecological Theory of Crime, is the combination of very different approaches (Crime Prevention Through Environmental Design—CPTED, defensible space, eyes on the street, etc.).

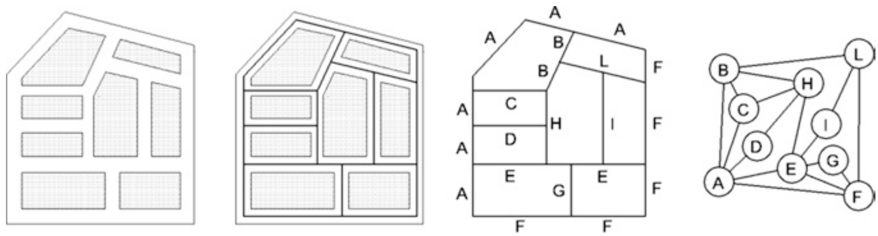


Fig. 2 Dual representation of the urban map. From the *left* to the *right* a simple urban space made of buildings (*shaded shapes*) and roads; the median lines network of the streets among the buildings; the roads network (letters stand for the street names); the graph corresponding to the original urban layout based on the street crossings

These ideas paved the way, during the 80s, to the development of situational crime prevention [29–32]. According to the followers of the situational crime prevention, to reduce the number of crimes, it is necessary to reduce the opportunities of committing a crime because "opportunity makes the thief" [33]. These ideas led crime analysts to increase the attention for urban design details (such as street furniture, street lighting, pedestrian pathways, housing design, visibility from the street and of the street) and to a deep study of the spatial configuration of the streets conducted through the Space Syntax Analysis (SSA) [34]. SSA was initially conceived as a theory to analyze small environments and their configurational features. This discipline studies the configurational properties of urban space [35] through quantitative measures. Thus, it allows the identification of patterns and structures which influence the development of activities in space, in particular movement and land use [36]. Figure 2 exemplifies for a simplified urban structure how it is possible to convert an urban layout (first figure on the left) into a graph (last figure on the right), a mathematical object whose characteristics can be measured in many different ways (e.g., [37]). Since movement and land use are thought to be linked to crime, SSA was used in the development of the CPTED proposed by Jeffery [28]. Thanks to the increasing number of measures used in the Space Syntax Analysis, it soon became possible to compute the relative degree of accessibility, connection, and integration of each street in its urban network, and to index numerically a large number of properties of the urban environment [36]. Among the others, [38] analyzed the street structure and its dependence with crime volumes: they found that streets with many twist and turns have higher crime rates.

During the last thirty years, a new theory on the spread of crime through urban spaces emerged. According to the Routine Activity Theory (e.g., [39]), the number of crimes increases if the number of opportunities for criminals rise and if society lacks an adequate surveillance against crime. Indeed, crimes are often committed in places where victims and offenders hold their routine activities, for example work, leisure, or social interaction, and where they satisfy their basic needs [40]. This theory focuses on space because it is considered an explicit determinant of human actions, including committing offences. Some empirical studies are in favor of this theory [39]. Used Routine Activity Theory to explain the increase in the number of crimes in American cities. For instance, they pointed out that, with more women working, a larger number of houses were empty during daytime and this fact led to the rise in the number of robberies increasing the vulnerability of suburbs [41]. Found out that, in Cleveland, streets with schools and bars are highly crime dense, while [42] identified the places near commercial stores as particularly risky. In this context, some studies on the relationship between crime and transports have been developed by [43]: they conclude that the structure of the public transport system can influence the number of crimes committed: higher numbers of crimes are recorded near stations and bus stops.

In recent years, a new interest for a combined study of socio-demographic and spatial factors in the analysis of crime has emerged. In fact, although crime mapping is certainly the most immediate way to obtain quick information on the criminal incidence in an area, it is interesting to study the relationship between urban crimes and the economic, socio-demographic and spatial features of the study region. Indeed, the study of crime in the context in which it happens could bring to the identification of both global and local risk factors, helping local governments in drawing up policies for Urban Security [44]. Provides empirical evidence for skepticism on the idea of "territoriality" and "defensible space" put forward by Newman [27]: he suggests that, other things being equal, property crimes tend to cluster in those globally or locally segregated areas. In detail, particularly risky areas can be found in cul-de-sac footpaths and rear dead end alleys, but also in those segregated short cul-de-sac carriageways which Newman considered to be the key places where local surveillance should be increased and casual intrusion by non-residents excluded. Hillier [45], discussing the work by Chih-Feng Shu [44], concludes that in Space Syntax Crime Analysis, spatial factors are relevant and that they operate both at a global and local level. More recently, [46] discuss the relationship between crime and urban planning presenting also the results of an empirical research conducted in the city of Vilnius: the aim of this study is to identify, with the use of ASA, the most vulnerable open public spaces of the city.

3 The Role of Statistical Analysis in Integrated Systems for Smart Security

Information of the kind presented in the previous paragraph becomes relevant to Smart Security systems when it allows local governments and the public administration to monitor the development of the situation, to infer plausible causal relationships between some theoretical determinant of crime and a certain measure of crime and when it allows either to identify promising actions that can be taken or situations that cannot be explained under the available information and require additional investigation. From a statistical standpoint, it means being able to produce basic descriptive statistics of crime and being able to produce statistical models. The basic statistics of crime are little more than the conceptualization of crime trends and crime maps: means, rates, standard deviations, spatial and temporal clusters, etc. These are the most commonly and widely used tools for the statistical analysis of crime and they let public administrator monitor the evolution of crime over time or compare crime rates in different areas, they do not include any interpretation of the counted events, neither suggest possible policies or actions that may be appropriate or useful. The availability of microdata that contain georeferenced information on relevant risk factors at street level of detail, allows a second, more effective level of analysis. The database of reported crimes, made of records containing a full set of the available information relating each crime (e.g., date and time of the event; gender, age, and nationality of the victim; place of the event; etc.), can be combined with all the other information that Municipalities possess for their administrative purposes.[1] Therefore, criminal events recorded by law enforcement agencies and risk factors suggested by criminological theory can be analyzed conjointly (e.g., [47]). Statistical models identify which contextual variables actually work as risk factors or mitigating factors and can be considered as explanatory variables with crime being the dependant variable. The interpretation of the model starts with the estimation of a set of coefficients, one per explanatory variable, which mediate their effect on the criminal occurrences over the whole city; the coefficients may be positive or negative depending on their role of increasing or decreasing crime risk. Thanks to the model, it is possible to compute for each spatial unit (street, street segment, block, etc.) a number of expected events based on the values of the contextual variables and to compare these expected events to the actual number of recorded crimes. In principle, even with important objections that, for the sake of simplicity, it is unnecessary to delve here, this difference among these quantities is a measure of goodness of fit of the model. As a general rule, if the criminological hypotheses fit well to the specific study area, most of the roads should have an expected number of criminal events that is close to the actual number of occurrences. On the contrary, high discrepancies among these values may identify situations with far fewer events, or too many events than the ones expected on the pure basis of the context variables values. The first situation suggests the presence of unspecified favorable conditions unaccounted for by the model: some relevant

[1] Possible examples are demographic elements (e.g., number of residents per age interval, gender, and nationality), socio-economic indicators (e.g., house values acquired from the Land Registry, aggregate tax return values, number of shops, number of gambling halls, number of bars and pubs, etc.), or configurational dimensions of urban spaces as they result, for instance, from the Space Syntax analysis (centrality of the street in the urban network, pedestrian movement, number of intersections of the street with other streets, etc.) or from the CCTV measurements.

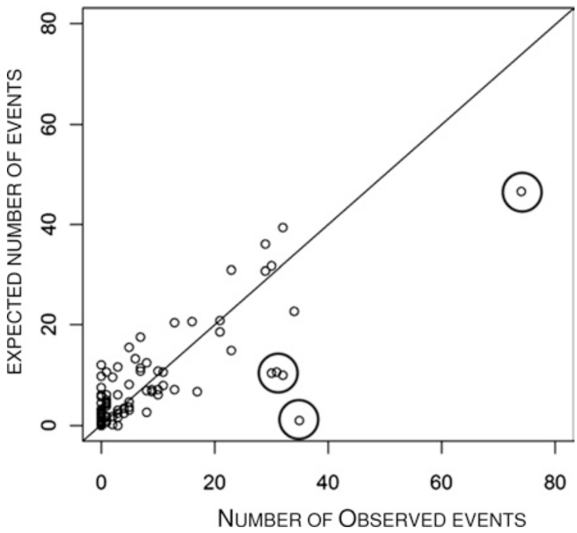


Fig. 3 Expected versus Observed arson and criminal damage occurrences on parked vehicles in a neighborhood of an Italian city in a 24 months period. Circled are the "soccer stadium effect" roads

factors that are omitted from it seem to actually mitigate crime. The area, in this case, is worth a specific investigation as its crime-mitigating characteristics might be be reproducible elsewhere in the city and used as positive experiences, as long as a later on-the-field analysis is able to identify the positive factors at play. In the second situation, we have a number of events that is much higher than expected and there are some elements, unspecified in the model, increasing the actual risk of the road. Figure 3 shows an example of a comparison between observed and expected values for the number of damage recorded for each street in a neighborhood of a city in northern Italy. The more the points (representing the single streets of the neighborhood) are positioned along the diagonal, the better the matching of the expected versus observed values. On the contrary, the more they move away from the diagonal, the stronger the effect of the contextual elements not included in the statistical model. In a Smart Security System, a statistical module with the characteristics herein described and whose skeleton structure is given in Fig. 4 allows local administrations to identify critical situations for which customized solutions are needed.

In addition to this, the literature of statistical methods for the analysis of crime is very vast and may be helpful to investigate the effect on crime of intervention policies, of new technologies, of social change or urban planning. For a recent review of these techniques, refer to [48]. The statistical tools can be properly customized to answer the needs of any municipality. However, it is relevant that when a Smart Security system is implemented, the key points that the Public Administrators need to check and monitor are clear and well defined in the system design phase: statistical analysis does not make sense by itself; it should be shaped around the information needs of law enforcement agencies.

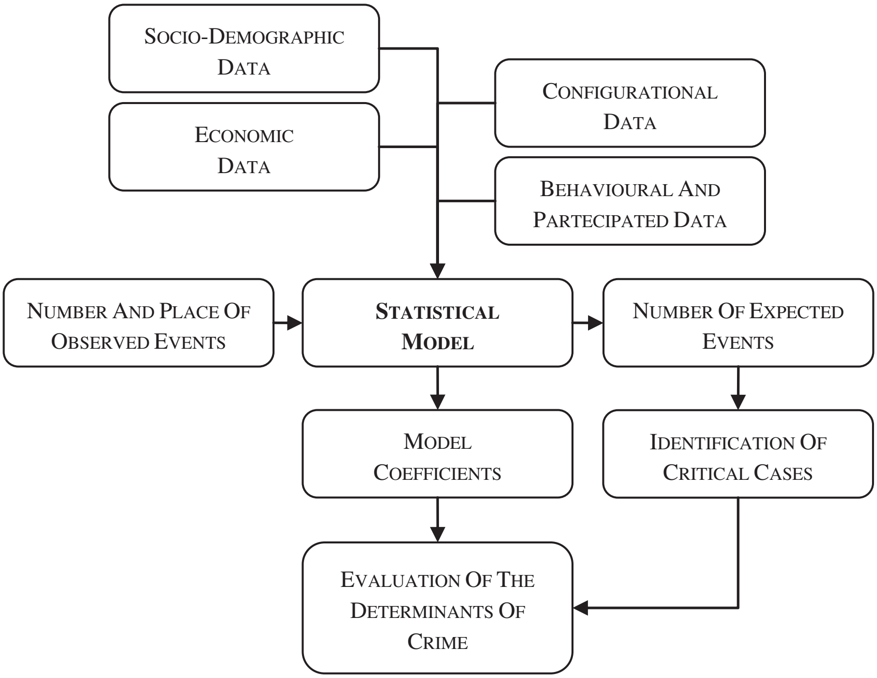


Fig. 4 The role of statistical modeling in the analysis of crime

4 Individual Behavior and Sensors

Sensors are supposed to have a crucial role in Smart City [49, 50] and the domain of Smart Security benefits from theories and practices concerning the use of sensors for crime control that predate the concept itself of Smart City by a few decades. Optical sensors are the most obvious example: the first experiments of video surveillance systems for crime prevention date back to the 80s. However, motion detectors, acoustic detectors (like gunfire locators) and even biological and chemical sensors all have been considered for their potential in crime prevention and repression strategies. The rationale behind the use of sensors in a crime prevention environment has usually been that of detecting individual behaviors, with the purpose of collecting evidence (in a forensic perspective), directing prevention or repression efforts against crime acts or deterring crime altogether by virtue of the mere possibility of collection of evidence and activation of preventive and repressive actions. In a Smart Security environment, the value of evidence collected through sensors is assumed as a given in the same way crime maps and trends are. Smart Security begins where the benefits of preventing crime, instead of repressing it, come into play. The evolution of video surveillance is paradigmatic with respect to the problem of deterrence, repression and prevention. For many years CCTV systems have been very controversial and their effectiveness for crime prevention has been questioned. While law enforcement agencies worldwide have been investing for years in CCTV as a crime-fighting technology and the technology behind CCTV rapidly developed and cameras proliferated, supporters of CCTV have typically argued that cameras make cities safer but recent studies have called into question this claim. According to some, their effectiveness might be limited and their impact on citizens' sense of security might be the opposite of what governments intend [51–56]. Surveillance systems have been welcomed by public administrations for monitoring purposes (parking lots, public transports), for access control (automatic car plate reading, etc.) or transport security [55]. In July 2005, during the attack to the London subway system the public video surveillance system installed allowed the authorities to identify the bombers and trace their paths. The system did not prevent the attacks but its help in subsequent investigations was priceless. This event encouraged public administrations to invest on video surveillance systems to prevent crimes and terrorist attacks. Since then, the scale of video surveillance networks has increased in scale [57] and today installations of 50,000 camera networks have been reported. The Singapore transport network is monitored by a 6,000 cameras network and, in general, most urban centres can count on camera networks of dozens of cameras.

These large systems are usually connected to centralized control centres, where a human operator interacts with dozens (or hundreds) of sensor sources using several separate monitors/windows for visualizing and analyzing the video or data streams. Although each separate source produces useful data, the human operator is easily overwhelmed with the task of integrating these varied forms of data into a complete global view and understanding of a scene.

This scenario will soon become obsolete thanks to the technological progress of intelligent systems and algorithms [57]. Indeed, the proliferation of surveillance cameras throughout public places stimulates the development of software able to monitor automatically the large amount of video footage produced. Human operators cannot monitor such a vast volume of data. This means that today most large installations have a limited effectiveness because of the lack of means to interrogate the content of the data generated. Once a camera network is installed, it is important to estimate the topology of the network to learn the relative positions of the cameras and the possible intersections between fields of view. This simplifies various tasks, among all an effective tracking of people within the space monitored by the network. The topology cannot be estimated manually if the network is large. Automatic procedures may also be applied to facilitate the design of the network: locate optimal positions of the camera for a maximum coverage [58].

Such networks are often heterogeneous as they often include cameras installed by the public administration specifically for the purpose of public security, plus private camera networks that may usefully complement the available information, such as cameras installed by ATMs, banks, stores, etc. This heterogeneity on the sensors, the transmission, and compression protocols, causes additional problems, producing asynchronous videos (e.g., [59]) and variable resolution signals.

Modern camera systems are able to control large areas, to zoom in (with optical zooms as in PTZ cameras or digitally, with mega or giga-pixel cameras), but also to detect moving objects and track them along the scene [60]. These systems perform real time analysis and, more importantly, record video footage for later use.

Information acquired by multiple cameras may be merged with the purpose of tracking moving objects across the views [61, 62]. If cameras have a field of view overlap one may associate corresponding view simultaneously. If the cameras have no field of view overlap moving objects may be associated along time based on an analysis of their similarity and on prior knowledge on the cameras mutual positions [63, 64].

In crime prevention, video surveillance is closely connected to biometry, since the ultimate goal is often to associate a face to the person who perpetrated the felony. Face biometry (i.e., the ability to associate automatically an identity to a face portrayed in an image or image frame) is particularly attractive, since it does not need any specific sensor but can be applied to the output of a high resolution video stream. The research community has been very active on this respect, addressing face recognition from different perspectives (e.g., [65]). Although the achievements on face biometry in the last decades are impressive, satisfactory results can be obtained mainly in constrained scenarios or with a relatively small set of enrolled identities and, for this reason, the use of face recognition in urban environments is still limited [66, 67].

Early intelligent video surveillance systems were able to detect the presence of people in forbidden zones. This was the extent of the forbidden/dangerous action taken into consideration. Nowadays, we are concentrating instead on dangerous behaviors of people and crowds [68–70]. More recently, the interest of the research community has been directed towards intelligent systems able to learn models of normal activities from long time observations and to apply them to detect anomalies in an adaptive way [71–74].

5 Where All That Is Observational Converges: Smart Security as a Preventive and Early Warning System

A Smart Security system should be designed to work at the point of convergence of multiple information sources. From what has been discussed so far, it is clear that some sources are "cold" data collected by various structures of the Public Administration; others are hot and consist of live raw or processed information coming from sensors situated in specific locations in the urban area.

An additional and very important source is a hybrid of the two: crowdsourcing[2] allows local governments to receive massive amounts of data, reports and contents generated via smartphones and the internet in general [76, 77]. Crowdsourcing can

[2] From a terminology standpoint, this entire field is still lacking consistency. We make use of the term "crowdsourcing" in its more general meaning of an organization outsourcing specific tasks (like producing goods, services or information) to vast crowds of unrelated individuals instead of using traditional employees or suppliers. As a matter of fact, the term is frequently associated with the generation of web contents because that was the first practical application of crowdsourcing [75], but a broader meaning should be acceptable as well. Specific forms of crowdsourcing that are particularly significant for Smart Security systems have specific names, like Crowdsensing or Smartsensing, that imply the use of ubiquitous sensors (mostly smartphones) to collect data.

integrate, in a vast number of fields, the traditional information used by the Public Administration [78–81] and it surely can mitigate the cost of building large networks of sensors while producing information that, being collected on the end user-side of the public services supply system, can be much more contextual (i.e., rich with information about what is being sensed, where and when, beyond what a single sensor is normally expected to capture).

A much debated issue concerning data from smart sensing tools is that of privacy. While this is a very serious and relevant problem, it is not substantially different from that of privacy with all the rest of geo-localized or remotely-sensed information that local governments already use (e.g., in G.I.S. systems). So, while the specificities of smart sensing have to be considered also under a privacy perspective and while privacy is obviously an issue when a smart system uses data concerning individual citizens, the hypothesis of using such systems seems to mostly require specifications and not innovations of existing privacy rules. Privacy and anonymity issues influenced the spread of public video surveillance systems [82, 83]. In most countries, current legislations do not prevent abuse or misuse of video footage. Misuse can be perpetrated by individuals with an access to the video stream or by organizations. While the debate is still open, to some extent, technology is offering different ways of protecting the privacy of citizens: face detection or text detection can be used to anonymize video footage [84], video encryption technologies allow us to protect video sources [85]. If these filters are implemented within the sensors, thanks to the use of embedded systems, then the video stream is protected from the source and can be transmitted safely.

Crowdsourcing is a significant addition not only because of the scope of its reach but also because it shows that a rigid distinction between hot and cold information limits the smartness of a system. Live sensors should be used to generate cold data as well [86]. Statistical analyses over time periods should help decoding the meaning of what a live sensor is capturing. In broader terms, in a Smart Security system there is relative continuity and exchange of information between the analytical environments of what has happened in weeks, months or even years and what is happening now or is going to happen in a few minutes. From the point of view of a Local Government or that of any local branch of the Public Administration, Smart Security is, in fact, an early warning system (or the premise of it) precisely by virtue of this integration of information relative to different timeframes. Early warning systems (EWS) are "The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss".[3] EWSs have been implemented in many fields, from disaster management and prevention to epidemiology, drug control, poverty reduction, drought and famine prevention, armed conflict prevention and so on. In the field of crime prevention, EWSs have been used to organize

[3] United Nations, Office for Disaster Reduction (UNISDR).

policing [87–90] and to predict individual behaviors [91]; while the concept is popular, however, its application in complex governance problems is only becoming feasible in current Smart City environments.[4]

In a Smart Security system, statistical tools, sensors and crowdsourcing information, integrated with each other, produce an output that consists of the synthetic results of the analysis performed by each, and of a system of flags that appear in front of the system managers when certain trigger conditions are met. For example, it may happen that the recent history of a place shows a particularly intense spatiotemporal concentration of crimes, or that the trend of its socio-economic and demographic characteristics that are likely determinants of crime may hint at a probable increase of the risk of crime. The objective of the smart tool is to communicate what the flag is about in simple, unambiguous, and exhaustive fashion, adopting output representations that can be easily interpreted by city officials that are responsible of the decision making process. More precisely, flags should be designed to be the first element of the decision making process at the end of which the Public Administration produces a policy change or an action of some sort to improve urban security conditions. Given these requirements, a smart tool for urban security adds to the units of analysis an interface for the management and the representation of data that is built around three distinct elements: a crime map, a dashboard, and a warning system. The crime map is the most basic level of the entire system; it is meant to allow the spatial representation of crime but can as easily be used to map relevant context variables, in particular when they show some correlation with the presence of crime or to illustrate composite indicators. Since one of the objectives of the unit performing the statistical analyses is modeling urban crime and then showing the difference between estimated and observed values, such estimated values and difference of values are two particularly significant examples of composite indicators. The crime map can have any sort of definition level, from that of large administrative subdivisions to that of a single street or street segment. Since the main objective of the map is to make apparent any geographic effect at play, it has to show how the concentration of each relevant variable changes from place to place, making the dislocation of high and low values more important than the values themselves. This usually means that the value of a variable in each geographical unit is synthesized through one out of a finite palette of colors (four to ten in most cases) and the overall chromatic patchwork created by the map should give, in a glance, the idea of dispersion and concentration. Dashboards represent the second level of the interface. They provide a different method to read the values synthesized on the map with less emphasis on the spatial effects and greater emphasis on ranking and prioritization, discrimination, and detailed comparison. Dashboards are intended to quantify the measure of significant variables, usually within a graphical representation that

[4] See [92] for a current commercial example. Similar examples can be found concerning predictive policing and disaster management.

helps interpreting the value, for example by adding a scale of colors ranging from green to red depending on the measured value. While apparently simple, dashboards imply some intricacies: the top and the bottom of the scale may be fixed or depend on historical longitudinal observations or on current cross-sectional values, with the average and the thresholds between low and average and average and high that change accordingly. Obviously, the difference is not only the different outcome but also the different meaning: measuring a value against its historical highs and lows is different than measuring it against the values of the same variable in different places. A dashboard can also help visualizing the difference between the current value and the value recorded in the previous time unit, from a few hours or days to months before, giving an immediate representation of change. The numerical values of a variable, of its change over time or its difference with the values in other places, allows decision makers to set priorities for their actions on one issue or to balance the effort between different issues. Dashboards allow to easily identify and list places where the value of a variable is above or beyond a certain level and to disentangle the effects of different explanatory variables on a dependent variable. This makes possible to understand which risk factor is high where actual crime is high or which risk factor is responsible for making expected crime high. Dashboards should be contextualized as much as possible: since they are an extremely synthetic tool, the user should be given as much information as possible on the characteristics of the place that the dashboard refers to, so that the reading is not left as an abstract and inexplicable value. Usually, maps and dashboards contain quantitative information on places and population. However, smart sensors and cameras, while primarily oriented to analyze individual behavior, are also a source of cumulated individual behaviors. Therefore, if a smart tool for urban security is built around them, a considerable number of variables that can be represented in maps and dashboards can actually come from a database of what was captured by smart sensors. The last element of a smart tool is a warning system. It can exist as a specific element of the tool or it can be integrated within the map and the dashboard. Its function is to help the user at noticing critical situations even when they are hidden in a large amount of information, indicating it with a flag, i.e., a specific and visible signal of some sorts. Flags may be the consequence of slow, gradual processes that progressively increase risk at a certain place beyond a given level. They may come from sudden increases, from cyclical peaks and they may as well depend on individual behaviors that are excessively distant from the average or from an accumulation of many concurrent and slightly anomalous behaviors of different people. Flags are not particularly sophisticated instruments; they are based on threshold values that trigger them when the reading goes above or below. The sophisticated part of a warning system is the balancing of the thresholds, of the sensitivity of the triggers, and the ability of the system to react to changes by updating its thresholds over time. Obviously, the objective is minimizing false positives as well as false negatives, keeping in mind that a smart tool is not a substitute of decision makers but just a support system and, consequently, whenever it is possible, flags and warnings should stimulate a cross-checking of results and an on-the-spot investigation before any actions are taken.

6 Handling Complex Systems: The Integrated Network System

Integrating information from different sources is a very complex activity, especially if the data sources are very different from each other (e.g., text, video, audio, etc.). To simplify the integration processes, sources other than text often need to be enhanced through the manual or automatic generation of meta-data that is a textual description of the content of the data source (e.g., the name of the people in a video, the date of the data collection, a transcript of the conversations from the audio, etc.) [93]. However, even in the simplest case in which we need to integrate only text-based information, the activity can present several challenges.

Moreover, there are several kind of information coming from different sources that can be integrated and used to improve the situation awareness (e.g., weather, air quality, light, etc.) that can provide a constant (and frequently large) stream of data. The amount and the heterogeneity of such data is extremely difficult to manage with the traditional approaches based on OLAP (On-Line Analytical Processing) and data warehouses [94]. To this end, new approaches have emerged and classified under the label *big data* and implemented through the so-called NoSQL databases [95].

On-line analysis of data is also required to ensure the reliability of sensors used for the data collection to identify immediately problems that may prevent useful subsequent analysis and integrations with other sources. Such analyses include simple statistical evaluations of the quality of the data and complex ad-hoc analyses based on the information coming from different sources that are related to each other and can be used to crosscheck their validity. The quality of the data collected is the starting point for implementing an effective integration reducing false positives and false negatives, therefore an alerting system based on on-line analysis can help in such activity.

To have complete information integration on which it is possible to develop reliable applications, it is required that the integration is implemented at different levels: communication, syntactic, and semantic [96]. The communication level deals with the technical aspects of the data transfer among the different systems involved in the integration; the syntactic level deals with the data formats and the transformations required to create a common representation of the information; finally, the semantic levels deals with the meaning of the different pieces of data and how to relate each other.

At each level, there are several challenges including the followings:

Communication level	size of the information and technical implementation
Syntactic level	kind of information and storage
Semantic level	organization of the information

The organization of the information deals with the ability to define high-level (and generally abstract) concepts and connect all pieces of information related to that concept. For instance, considering a robbery, there are several pieces of

<Agenda>	<List>
<Person>	<Contact>
<Name>John</Name>	<Name>John Smith </Name>
<Surname>Smith</Surname>	<email>smith@ent.com</email>
<email>smith@ent.com</email>	</Contact>
</Person>	<Contact>
<Person>	<Name>Tom Brown </Name>
<Name>Tom</Name>	<email>tb@brown.com</email>
<Surname>Brown</Surname>	</Contact>
<email>tb@brown.com</email>	</List>
</Person>	
</Agenda>	

Fig. 5 Incompatible structured information providing the same content through different structures

information from different sources that can be related including: the timeframe from the police reports, the suspected invited people from the investigation records of the police, the video of the surveillance cameras, etc. Such integration is very difficult to perform automatically and requires an extensive amount of research to be implemented in a general context even if in some very restricted domains it is feasible with the current technologies that are part of the so-called *semantic web* (even if the term includes the world "web", the technology is not used only for the web but it is the domain where it comes from) [97].

The kind of information refers to its structure. We can classify information in two large sets: unstructured and structured. Unstructured information is any kind of text designed with human beings in mind (e.g., this book). On the contrary, structured information designed to be processed and stored easily by a machine through a database and exchanged using a semi-structured form that includes special markers (called *tags* in many languages used for this purpose) that makes processing possible. Languages like HTML (HyperText Markup Language) and XML (eXtensible Markup Language) are very popular in any kind of document-based representations (not just on the web for which they were conceived at first) and are based on such a concept to make the interpretation, the visualization, and the storage of information easier. However, even with structured and semi-structured information, the integration of different data sources is not straightforward since each source may use a different set of tags and organize the information in different ways. In Fig. 5 an example of two incompatible structures of the same information is given. Moreover, it happens very frequently that the differences among data sources are not just syntactic differences (Fig. 5) but also semantic ones (e.g., the same tags used to identify different content in different documents, different in information sets provided, etc.). Therefore, integrating different data sources requires a deep knowledge of the data representations and requires a considerable effort. However, given the importance of the applications that are based on information integration, there is an enormous amount of research in the area aiming at automating the integration as much as possible [98, 99]. One of the current trends in research about information integration is based on the development of ontologies that allow automatic conversion mechanisms and highlight incompatibilities [100].

How the information is stored and its size are additional aspects that need to be considered when dealing with different sources of information. Currently, every activity (human-based or machine-based) produces a large set of digital information stored in several databases. Such databases are huge, therefore transferring or copying the entire data sets to perform complex operations is often unfeasible. Beyond such problems, we also have to consider the sensitivity of some kind of data and/or the privacy aspects related to them. In such cases, a sanitization procedure is often required before allowing other kind of operations and analysis on such data removing the sensitive part of the data and/or aggregating at a higher level with no privacy or sensitivity concerns.

Therefore, it is required to develop on-line analysis techniques that are able to process and integrate information on the fly (whenever such information becomes available) and exchange only the relevant data without overloading the communication infrastructure. Moreover, relational databases that are often used to store information struggle in managing such large amount of data if there is not an adequate investment in the hardware infrastructure. As stated before, traditional approaches through data warehouses are not able to address properly this kind of problems, therefore NoSQL databases are emerging offering better performances and scalability at a much lower cost at expenses of some properties of the relational databases that can be relaxed in some application contexts. These technologies have been designed to address problems related to the storage of large data sets but their correct usage is linked to the specific problems the application has to address.The technical implementation is basically related to the usage of specific technologies. In the well-known world of relational databases, there are standards that are accepted by almost any implementation such as the SQL language to perform interrogations and insert/modify data. However, in the NoSQL world, there are no common standards for even basic operations and each implementation has its own approach producing two main effects: 1) it is difficult to switch from one technology to another and 2) every technology requires a complete set of new skills. For this reasons, the use of NoSQL technologies need to be considered only in specific cases since it may be difficult to fix some mistakes in the selection of the right technology to use.

There are plenty of open source technologies that can be used to implement such systems (databases, analysis and visualization tools, sensors, etc.) producing a set of advantages such as the absence of a license fee, the ability to adapt the tools to the specific needs, no vendor lock-in, etc. Moreover, when dealing with problems related to integration, security, and privacy, the usage of open data formats, protocols, and tools help in identifying bugs, assuring the absence of malicious code and enhance the overall interoperability and the level of integration of different systems.

From the architectural point of view, integrating several data sources at the same time is extremely complex due to the main problems described earlier. However, the technologies available today allow developers to split the problems in several smaller problems that are easier to address and integrate them only later on. In this way, it is possible to create a more scalable architecture able to integrate an arbitrary number of data sources limiting the complexity of their integration. In any case, even with just two data sources, the three level of integration (communication, syntactic, and semantic) should be taken into consideration to provide a meaningful integrated system.

A specific issue related to the integration of video sources requires a reference to interfaces, in particular when IP video cameras are concerned. Over the years the main producers developed various standards, currently the main one is ONVIF, founded by Axis, Bosch and Sony. ONVIF is about (1) standardization of communication between IP-based physical security devices and (2) interoperability between IP-based physical security products regardless of manufacturer. It is also worth mentioning HD-Serial Digital Interfaces (SDI), a family of digital video interfaces used for transmitting uncompressed, unencrypted digital video signals within analog television facilities. This technology has been conceived with the goal of bridging the gap between analog systems and digital installations over IP.

7 A Good Start: Roadmaps Towards a Smart Security

With all the different issues now on the table, we can conclude our work with an attempt at drawing guidelines for the implementation of a Smart Security system in a Public Administration context. Smart Security tools may have different levels of complexity, having to comply with different technical, administrative, and economic limitations (see Table 1 for a few documented examples), but some elements in their infrastructure and implementation are going to define if and how much they can actually be considered smart.

The first and crucial element that defines the smartness of a crime prevention system is that it should be built around the management and policy needs of the Public Administration and not as a retrofitting of them. "Technological performance is not to be taken for granted as a logical progression from technological advancement, but rather performance depends on effective management of technological systems and infrastructure" [1]. The bottom-up process of influential projects like COMPSTAT [101, 102], GeoArchive [87] and the general effort to introduce GIS as a crime prevention tool [4, 103] constitute very good examples.

Being an early warning approach, Smart Security requires an "early response" organizational framework as well. This means that, regardless of the source of the information that generates the warning (be it a statistical analysis, a live sensor, a crowdsensing tool or a triangulation combining any of them) the organizational goal must be that of having the resources required to prevent the issue and the determination and ability deploy them in a timely fashion.

Table 1 Existing projects and software containing significant smart elements

Notable examples	Smart elements
Compstat [101, 102, 104, 105]	Organizational focus, bottom-up development, data collection, mapping, statistical analysis, early warning philosophy, results evaluation
GeoArchive [4, 87]	Organizational focus, bottom-up development, data collection, mapping, statistical analysis, early warning philosophy
SACSI [106–108]	Data collection, mapping, statistical analysis, results evaluation
COMPASS [109]	Data collection and data sharing, mapping, statistical analysis, decision support, results evaluation
Operation virtual shield [100, 110]	CCTV, early warning philosophy
G.I.S.-based free and commercial software [103]	Mapping crime and context (with elements of statistical analysis)
Urban crime simulator [111]	Crime modeling based on criminological theory
Desurbs [7]	Organizational focus, data collection, urban planning and design focus, mapping, statistical analysis, decision support, integration
Commercial software (PredPol, IBM Spss and BlueCrush, Esri, …)	Mapping, statistical analysis, predictive policing

In terms of components, a Smart Security system is scalable according to evolving needs and consists of part or all of the following key elements:

1. Relevant administrative databases (e.g., crime records, socio demographic and economic data, urban graph);
2. Sensor network(s);
3. Crowdsourcing applications and websites;
4. Crime maps and trends visualization;
5. Security dashboard;
6. Intelligence module (Data integration and analysis).

The entire system, in order for the early warning mechanism to work, has to be integrated inside a single user interface with coordinated warning flags. However, of all these elements, some may already be in use in many local governments and just need to be integrated in the new system, while others require a greater deal of work. In spite of this, incremental developments are possible and, in many ways, superior to the "all-or-nothing" approach. Another crucial point is that Smart Systems are, by definition, tailored locally and, consequently, they do not necessarily need every element of this list. Some smaller settlements may never have enough data to justify a complex statistical tool. Some may have little need for having both a crime map and the dashboard. Sensor networks are a useful addition where and when their effectiveness is documented and sensors are worthwhile if there is a precise idea of what use to make of the data collected through them.

With respect to point 1, the main problem which may arise is technical, due to the existence of databases which are not normalized and which make difficult their querying or joining. Classical examples are different geographical boundaries of the statistical units, different levels of aggregation of data, different definitions of the same variable, coding errors caused by fields that are sensitive to spelling mistakes or different forms of abbreviation. Concerning point 2, most of the Municipalities interested into the implementation of a Smart Security system already have a CCTV system of cameras installed and it is usually reasonable to integrate an existing infrastructure into the framework of a smart system whenever possible. However, there is no guarantee that the technological standards and the aims of such an infrastructure are ultimately compatible with a smart system. Crowdsourcing and smartsensing projects (point 3) are currently being developed in some of the most advanced and innovative municipalities around the world, but compared to other elements of the system, here the emphasis should be on designing them with compatibility with a Smart Security environment in mind from the beginning. Whether they ask users to produce content, ideas, information or else, in a proactive creative process or they just ask them permission for capturing opportunistic information in a passive, "authorize and forget" manner, they make sense as an element of the system if they fill significant information areas with reliable data that can be confronted and integrated with data already available.

The Crime Mapping System (point 4), the Security Dashboard (point 5) use the administrative data and offer different kinds of graphical and numerical representation. They can occasionally be developed starting from existing municipal Geographic Information Systems (GIS) and/or linked to databases and other tools that already provide synthetic tables of information. There is a multiplicity of possible software combinations that answer the needs of each specific context, including open source solutions. The same holds for statistical software packages and, ultimately, decisions should be based on compatibility with pre-existing infrastructures and instruments and with the specific characteristics and requirements of each local government.

The Software interface (point 6) is a technical need for the setting up of the system. As a matter of fact, it can be intended into two ways. On one hand, it is the container inside which all the queries are executed, the datasets connected, and the computations done using the dedicated tools and packages. On the other hand, it is the tool which gives the output to the final user in an interactive and easy to use interface. In fact, the final goal of a Smart Security system is to assist the Public Administrators and law enforcement agencies to understand a fast changing world and to implement the most effective security policies. The software system is the environment inside which the automated procedures defined by the experts are repeated automatically without the need of the final users to possess advance competences of statistics, video analysis, or software engineering. Obviously, given the sensitive nature of the data, security and control over the system and the information in it is crucial.

Table 2 gives a general overview of what we discussed in this final section and outlines what is needed for each component of a Smart Security. Starting from what we indicate in Table 2, any Municipality or Law enforcement agency can find its own roadmap towards a Smart Security System. Note that the Warning

Table 2 Requirements table for the key elements of a Smart Security System

Element of the Smart Security System	Requirements						
	Administrative database	Sensor network	Crime mapping	Security dashboard	Intelligence module: statistical analysis	Intelligence module: sensors analysis	Intelligence module: data integration
Crime mapping	Yes	No		No	No	No	Yes
Security dashboard	Yes	No	No		No	No	Yes
Statistical analysis module	Yes	No	Yes	Yes		No	Yes
Sensor analysis module	No	Yes	No	No	No		Yes

System is not listed in Table 2, being a very advanced feature of the system has various requirement as it must be tailored on the specific needs of the users.

Finally, intelligent solutions are ways to optimize the capacity, efficiency, and sustainability of a system. Typically, by means of ICT-based information processing. Smart technology is not, in itself, enough for a smart solution if users and operators are not involved in a learning process and the institutions that will use the system need to be changed as well. The system design should not focus on the smart infrastructure alone and not only on the final goal, but rather the transition phase itself should be designed carefully, with much attention for intermediate and hybrid stages where sometimes the flexibility gained from the intelligent solution can already be put to use [11].

References

1. Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation: Focusing on management, policy, and context. In *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance* (pp. 185–194).
2. Harrison, C., & Donnelly, I. (2011). A theory of smart cities. In: *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences (ISSS)*, *Hull* (Vol. 55, pp. 1–15).
3. Van den Berg, L., Pol, P. M. J, Mingardo, G., & Speller, C. J. M. (Eds.) (2006). *The safe city: Safety and urban development in European cities*. Farnham: Ashgate Publishing.
4. Weisburd, D., & McEwen, T. (1998). *Crime mapping and crime prevention*. New York: Criminal Justice Press.
5. Weisburd, D., Mastrofski, S. D., Greenspan, R., & Willis, J. J. (2004). *Growth of Compstat in American policing*. US Department of Justice: National Institute of Justice.
6. Steden, R., Boutellier, H., Scholte, R. D., & Heijnen, M. (2012). Beyond crime statistics: The construction and application of a criminogenity monitor in Amsterdam. *European Journal on Criminal Policy and Research, 19*, 47–62.
7. Bonatsos, A., Middleton, L., Melas, P., & Sabeur, Z. (2013). Crime open data aggregation and management for the design of safer spaces in urban environments. In *Environmental Software Systems. Fotering information Sharing* (pp. 311–320). Berlin, Heidelberg: Springer.
8. Bettencourt, L. (2013). The uses of big data in cities. Santa Fe Institute Working Paper 29.
9. Batty, M., Axhausen, K. W., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., et al. (2012). Smart cities of the future. *European Physical Journal: Special Topics, 214*(1), 481–518.
10. Paskaleva, K. A. (2011). The smart city: A nexus for open innovation? *Intelligent Buildings International, 3*(3), 153–171.
11. De Haan, J., Vrancken, J. L. M., & Lukszo, Z. (2011). Why is intelligent technology alone not an intelligent solution? *Futures, 43*(9), 970–978.
12. Denzin, N. K. (2006). *Sociological methods: A sourcebook*. Piscataway: Aldine Transactions.
13. Paulsen, D. J., & Robinson, M. B. (2009). *Crime mapping and spatial aspects of crime*. Boston: Allyn & Bacon.
14. Chamlin, M. B., & Cochran, J. K. (2004). An excursus on the population size-crime relationship. *Western Criminology Review, 5*(2), 119–130.
15. Andresen, M. A. (2007). Location quotients, ambient populations, and the spatial analysis of crime in Vancouver, Canada. *Environment and Planning A, 39*(10), 2423–2444.

16. Andresen, M. A. (2006). Crime measures and the spatial analysis of criminal activity. *British Journal of Criminology, 46*(2), 258–285.
17. Boggs, S. L. (1965). Urban crime patterns. *American Sociological Review, 30*(6), 899–908.
18. Cohen, L. E., Kaufman, R. L., & Gottfredson, M. R. (1985). Risk-based crime statistics: A forecasting comparison for burglary and auto theft. *Journal of Criminal Justice, 13*(5), 445–457.
19. Harries, K. D. (1991). Alternative denominators in conventional crime rates. In: P. Brantingham & P. Brantingham (Eds.), *Environmental criminology* (2nd ed., pp. 147–165). USA: Waveland Press.
20. Harries, K. D. (2006). Property crimes and violence in United States: an analysis of the influence of population density. *International Journal of Criminal Justice Sciences, 1*(2), 24–34.
21. Sparks, R. F. (1981). Measuring crime rates and opportunities for crime. In: R.G. Lehnen & W. G. Skogan (Eds.), *The national crime survey: Working papers volume I: current and historical perspectives* (Vol. 1, pp. 52–58). Washington, DC: U.S. Department of Justice.
22. Stipak, B. (1988). Alternatives to population-based crime rates. *International Journal of Comparative and Applied Criminal Justice, 12*(2), 247–260.
23. Zhang, H., & Peterson, M. (2007). A spatial analysis of neighborhood crime in Omaha, Nebraska using alternative measures of crime rates. Internet Journal of Criminology. http://www.internetjournalofcriminology.com/Zhang%20Peterson%20-%20A%20SPATIAL%20ANALYSIS%20OF%20NEIGHBOURHOOD%20CRIME.pdf.
24. Thomas, W. I. (1966). Social disorganization and social reorganization. In M. Janovitz (Ed.), *On social organization and social personality: Selected papers* (pp. 3–11). Chicago: The University of Chicago Press.
25. Guerry, A. M. (1833). *Essai sur la statistique morale de la France*. Cochard.
26. Jacobs, J. (1961). *The death and life of great american cities*. New York: Vintage.
27. Newman, O. (1972). *Defensible space: Crime prevention trough urban design*. New York: MacMillan.
28. Jeffery, C. (1971). *Crime prevention through environmental design*. Thousand Oaks: Sage Publishing.
29. Clarke, R. V. G. (1997). *Situational crime prevention*. New York: Criminal Justice Press.
30. Clarke, R. V. (1983). Situational crime prevention: Its theoretical basis and practical scope. In M. Tonry & N. Morris (Eds.), *Crime and justice: an annual review of research* (pp. Vol. 14, pp. 225–256). Chicago: The Chicago University Press.
31. Clarke, R. V. G. (1992). *Situational crime prevention: Successful case studies*. New York: Harrow and Heston.
32. Clarke, R. V. (1995). Situational crime prevention. In M. Tonry & D. Farrington (Eds.), *Building a safer society: Strategic approaches to crime prevention. Crime and justice: A review of research* (Vol. 19, pp. 91–150). Chicago: The Chicago University Press.
33. Felson, M., & Clarke, R. V. (1998). *Opportunity makes the thief: Practical theory for crime prevention*. London: Police and Reducing Crime Unit; Research, Development and Statistics Directorate. Police Research Series Paper 98.
34. Hillier, B. (1988). Against enclosure. In N. Teymur, T. A. Markus, & T. Woolley (Eds.), *Rehumanizing housing* (pp. 63–88). London: Butterworths.
35. Hillier, B., & Hanson, J. (1984). *The social logic of space*. Cambridge: Cambridge University Press.
36. Hillier, B., & Sahbaz, O. (2008). An evidence based approach to crime and urban design. In: R. Cooper, C. Boyko, G. Evans, & M. Adams (Eds.), *Designing sustainable cities: Decision-making tools and resources for design* (pp. 163–186). London: Wiley-Blackwell.
37. Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge: Cambridge University Press.
38. Beavon, D. J. K., Brantingham, P. L., & Brantingham, P. J. (1994). The influence of street networks on the patterning of property offences. In R. V. Clarke (Ed.), *Crime prevention studies* (Vol. 2). New York: Willow Tree Press.
39. Cohen, L., & Felson, M. (1979). Social change and crime rates. *American Sociological Review, 44*, 588–608.

40. Eck, J. E., & Weisburd, D. (1995). Crime places in crime theory. In J. E. Eck & D. Weisburd (Eds.), *Crime and place*. Monsey.
41. Roncek, D. W. (1981). Dangerous places: Crime and residential environment. *Social Forces, 60*, 74–96.
42. Rice, K. J., & Smith, W. R. (2002). Socioecological models of automotive theft: Integrating routine activity and social disorganization approaches. *Journal of Research in Crime and Delinquency, 39*, 304–336.
43. Block, R., & Davis, S. (1996). The environs of rapid transit stations: A focus for street crime or just another risky place? In R. Clarke (Ed.), *Preventing mass transit crime*. New York: Criminal Justice Press.
44. Chih-Feng Shu, S. (2000). Housing layout and crime vulnerability. *Urban Design International, 5*(3–4), 177–188.
45. Hillier, B. (2004). Can streets be made safe? *Urban Design International, 9*(1), 31–45.
46. Sinkiene, J., Stankeviče, I., & Navickaite, K. (2012). Creating safer cities through urban planning and development. *Public Policy and Administration, 11*(3), 390–403.
47. di Bella, E., Persico, L., & Corsi, M. (2011). A multivariate analysis of the space syntax out-put for the definition of strata in street security surveys. In *DISEFIN Series of Economic Working Papers 5*.
48. Piquero, A. R., & Weisburd, D. (Eds.). (2010). *Handbook of quantitative criminology*. Berlin: Springer.
49. Schaffers, H., Komninos, N., & Pallot, M. (2012). Smart cities as innovation ecosystems sustained by the future internet. In *FIREBALL Project White Paper. EU* (pp. 1–65).
50. Yovanof, G. S., & Hazapis, G. N. (2009). An architectural framework and enabling wireless technologies for digital cities & intelligent urban environments. *Wireless Personal Communications, 49*, 445–463.
51. Farrington, D. P., Gill, M., Waples, S. J., & Argomaniz, J. (2007). The effects of closed-circuit television on crime: Meta-analysis of an English national quasi-experimental multi-site evaluation. *Journal of Experimental Criminology, 3*(1), 21–38.
52. Ratcliffe, J. H., Taniguchi, T., & Taylor, R. B. (2009). The crime reduction effects of public CCTV cameras: A multi-method spatial approach. *Justice Quarterly, 26*(4), 746–770.
53. Welsh, B. C., & Farrington, D. P. (2003). Effects of closed-circuit television on crime. *Annals of the American Academy of Political and Social Science, 587*, 110–135.
54. Welsh, B. C., & Farrington, D. P. (2005). Evidence-based crime prevention: Conclusions and directions for a safer society. *Canadian Journal of Criminology and Criminal Justice, 47*(2), 337–354.
55. Welsh, B. C., & Farrington, D. P. (2009). Public area CCTV and crime prevention: An updated systematic review and meta-analysis. *Justice Quarterly, 26*(4), 716–745.
56. Welsh, B. C., Mudge, M. E., & Farrington, D. P. (2010). Reconceptualizing public area surveillance and crime prevention: Security guards, place managers and defensible space. *Security Journal, 23*(4), 299–319.
57. Remagnino, P., Monekosso, D. N., & Jain, L. C. (2011). *Innovations in defence support systems—3: Intelligent paradigms in security*. Berlin: Springer.
58. van den Hengel, A., Hill, R., Wart, B., Cichowski, A., Detmold, H., Madden, C., Dick, A., & Bastian, J. (2009). Automatic camera placement for large scale surveillance networks. In *Workshop on Applications of Computer Vision*.
59. Zini, L., Cavallaro, A., & Odone, F. (2013). Action-based multi-camera synchronization. *IEEE Journal on Emerging and Selected Topics in Circuits and Systems, 3*(2), 165–174.
60. Haritaoglu, I., Harwood, D., & Davis, L. (2000). W4: real-time surveillance of people and their activities. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 22*(8), 809–830.
61. Khan, B. S., & Shah, M. (2003). Consistent labeling of tracked objects in multiple cameras with overlapping fields of view. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 25*(10), 1355–1360.
62. Taj, M., & Cavallaro, A. (2011). Distributed and decentralized multi-camera tracking: A survey. *IEEE Signal Processing Magazine, 28*(3), 46–58.

63. Gheissari, N., Sebastian, T., & Hartley, R. (2006). Person re-identification using spatiotemporal appearance. In *IEEE Conference on Computer Vision and Pattern Recognition* (pp. 1528–1535).
64. Zheng, W., Gong, S., & Xiang, T. (2011). Person re-identification by probabilistic relative distance comparison. In *IEEE Conference on Computer Vision and Pattern Recognition* (pp. 649–656).
65. Stan, L., & Jain, A. (2011). *Handbook of face recognition*. Berlin: Springer.
66. Shachtman, N. (2006, January 25). The new security: cameras that never forget your face. *The New York Times*, Published.
67. Viola, P., & Jones, M. (2004). Robust real-time face detection. *International Journal of Computer Vision, 57*(2), 137–154.
68. Poppe, R. (2010). A survey on vision-based action recognition. *Image and Vision Computing, 28*(6), 976–990.
69. Bird, N., Masoud, O., Papanikolopoulos, N., & Isaacs, A. (2005). Detection of loitering individuals in public transport areas. *IEEE Transactions on Intelligent Transportation Systems, 6*(2), 167–177.
70. Krausz, B., & Bauckhage, C. (2011). Automatic detection of dangerous motion behavior in human crowds. In *IEEE International Conference on Advanced Video and Signal-based Surveillance, AVSS*.
71. Stauffer, C., Eric, W., & Grimson, L. (2000). Learning patterns of activity using real-time tracking. *IEEE Transactions on Pattern Analysis and Machine Intelligence, 22*(8), 747–757.
72. Atev, S., Masoud, O., & Papanikolopoulos, N. (2006). Learning traffic patterns at intersections by spectral clustering of motion trajectories. In *IROS Intelligent Robots and Systems* (pp. 4851–4856).
73. Morris, B. T., & Trivedi, M. M. (2008). A survey of vision-based trajectory learning and analysis for surveillance. *IEEE Transactions on Circuits and Systems for Video Technology, 18*(8), 1114–1127.
74. Noceti, N., & Odone, F. (2012). Learning common behaviors from large sets of unlabeled temporal series. *Image and Vision Computing, 30*(11), 875–895.
75. Estellés-Arolas, E., & González-Ladrón-De-Guevara, F. (2012). Towards an integrated crowdsourcing definition. *Journal of Information Science, 38*, 189–200.
76. Cuff, D., Hansen, M., & Kang, J. (2008). Urban sensing: Out of the woods. In *Communications of the ACM*, Vol. 51.
77. Ganti, R. K., Ye, F., & Lei, H. (2011). Mobile crowdsensing: Current state and future challenges. In *IEEE Communications Magazine* (pp. 32–39).
78. Cardone, G., & Foschini, L. (2013). Fostering participation in smart cities: A geo-social crowdsensing platform. *IEEE Communications Magazine, 51*(6), 112–119.
79. Coric, V. & Gruteser, M. (2013). Crowdsensing maps of on-street parking spaces. In *2013 IEEE International Conference on Distributed Computing in Sensor Systems (DCOSS)* (pp. 115–122).
80. Ghose, A., Bhaumik, C., & Chakravarty, T. (2013). BlueEye: A system for proximity detection using bluetooth on mobile phones. In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication* (pp. 1135–1142).
81. Heipke, C. (2010). Crowdsourcing geospatial data. *ISPRS Journal of Photogrammetry and Remote Sensing, 65*, 550–557.
82. Kumagai, J., & Cherry, S. (2004). Sensors and sensibility. *IEEE Spectrum, 41*(7), 22–28.
83. The Constitution Project. (2006). Guidelines for public video surveillance, a guide to protecting communities and preserving civil liberties.
84. Newton, E. M., Sweeney, L., & Malin, B. (2005). Preserving privacy by de-identifying face images. *IEEE Transactions on Knowledge and Data Engineering, 17*(2), 232–243.
85. Cavallaro, A. (2004). Adding privacy constraints to video-based applications. In *European Workshop on the Integration of Knowledge, Semantics and Digital Media Technology*.
86. Dufour, J. Y. (Ed.) (2012). *Intelligent video surveillance systems*. London: Wiley.
87. Block, C. (1998). The geoArchive: An information foundation for community policing. In *Crime Mapping and Crime Prevention* (pp. 27–81).

88. Buslik, M., & Maltz, M. (1998). Power to the people: Mapping and information sharing in the Chicago Police Department. In *Crime Mapping and Crime Prevention, Crime Prevention Studies* (Vol. 8).
89. Cohen, J., Gorr, W., & Olligschlaeger, A. (2007). Leading indicators and spatial interactions: A crime forecasting model for proactive police deployment. *Geographical Analysis, 39*(1), 105–127.
90. Cohen, J., & Gorr, W. (2005). *Development of crime forecasting and mapping systems for use by police*. Pittsburgh: H. John Heinz III School of Public Policy and Management, Carnegie Mellon University.
91. Cocx, T. K., Kosters, W. A., & Laros, J. F. J. (2008). *An Early Warning System for the Prediction of Criminal Careers. MICAI 2008: Advances in Artificial Intelligence* (pp. 77–89). Berlin, Heidelberg: Springer.
92. Andersen, J. J. (2013). Assess the urban surveillance infrastructure: Develop a framework. In *IBM Development* (pp. 1–11).
93. Rezaei, A., Rossi, B., Sillitti, A., & Succi, G. (2012). Knowledge extraction from events flows. In G. Anastasi, E. Bellini, E. Di Nitto, C. Ghezzi, L. Tanca, & E. Zimeo (Eds.), *Methodologies and technologies for networked enterprises*. Berlin: Springer.
94. Kimball, R., & Ross, M. (2013). *The data warehouse toolkit: The definitive guide to dimensional modeling*. London: Wiley.
95. NoSQL Archive. http://nosql-database.org/.
96. Predonzani, P., Sillitti, A., & Vernazza, T. (2001). Components and data-flow applied to the integration of web services. In *IEEE Conference on Industrial Electronics Society* (Vol. 3, pp. 2204–2207).
97. Semantic Web. http://semanticweb.org/.
98. Scotto, M., Sillitti, A., Vernazza, T., & Succi, G. (2001). Managing web-based information. In *5th International Conference on Enterprise Information Systems* (Vol. 1, pp. 575–578).
99. Sillitti, A., Scotto, M., Succi, G., & Vernazza, T. (2003). News miner: A tool for information retrieval. In *7th International Conference on Intelligent Engineering Systems*.
100. W3C Standards Semantic Web. http://www.w3.org/standards/semanticweb/ontology.
101. Moore, M. H., & Aa, Braga. (2003). Measuring and improving police performance: The lessons of Compstat and its progeny. *Policing: An International Journal of Police Strategies & Management, 26*, 439–453.
102. Weisburd, D., Mastrofski, S. D., Greenspan, R., & Willis, J. J. (2004). *The growth of compstat in American policing*. Washington, DC: Police Foundation.
103. Chainey, S., & Ratcliffe, J. (2008). *GIS and crime mapping*. London: Wiley.
104. Harris, K. D. (1999). *Mapping crime: principles and practice*. Washington, DC: U.S. Department of Justice.
105. Kennedy, L. W., Caplan, J. M., & Piza, E. (2010). Risk clusters, hotspots, and spatial intelligence: Risk terrain modeling as an algorithm for police resource allocation strategies. *Journal of Quantitate Criminology, 27*, 339–362.
106. Groff, E., Fleury, J., & Stoe, D. (2001). *Strategic approaches to community safety initiative (SACSI): Enhancing the analytic capacity of a local problem-solving effort*. Washington, DC: National Institute of Justice.
107. Pattavina, A., Pierce, G., & Saiz, A. (2002). Urban neighborhood information systems: crime prevention and control applications. *Journal of Urban Technology, 9*, 37–41.
108. Roehl, J., Rosenbaum, D. P., Costello, S. K., Coldren, J. R, Jr, Schuck, A. M., Kunard, L., et al. (2008). *Brief paving the way for project safe neighborhoods: SACSI in 10 US cities*. Washington, DC: U.S Department of Justice.
109. Boba, R. (2009). *Crime analysis with crime mapping*. Beverley Hills: Sage Publications.
110. Monahan, T., & Mokos, T. J. (2013). Crowdsourcing urban surveillance: The development of homeland security markets for environmental sensor networks. *Geoforum, 49*, 279–288.
111. Lee, J., & Yu, C. (2010). The development of Urban Crime Simulator. In *Proceedings of the 1st International Conference and Exhibition on Computing for Geospatial Research & Application—COM.Geo'10* (p. 1). New York, USA: ACM Press.

The Co-production of Social Innovation: The Case of Living Lab

Anna Cossetta and Mauro Palumbo

Abstract Our article aims to reflect on some key concepts that have emerged in the recent literature on innovation. In particular, it will seek convergence between social and open innovation within the framework of Smart Cities. The Smart cities are embedded in the last 20 years processes of change that have altered conditions and modalities of innovation and knowledge generation. The city is still, like Robert Park in 1915, the "social laboratory" par excellence for the study of human behavior in a modern urban environment. If we consider recent debate on Smart city definition, we can find that ICT can be a powerful tool for building the collaborative digital environment that enhances the intelligent capacity of localities [30]. In that sense we can consider use the most used definition: "a city may be called smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance". Early as at this definition we can find the pillars of our reflection: the innovation as social innovation, the new role of the 2.0 citizen–public, the issue of governance.

Keywords Innovation • Open innovation • Triple helix • Quadruple helix • Living labs

A. Cossetta (✉) · M. Palumbo
Department of Education, University of Genoa, Genoa, Italy
e-mail: anna.cossetta@gmail.com

M. Palumbo
e-mail: palumbo@unige.it

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3_11,

1 Innovation

Innovation seems to be the most urgent need of our society. Innovation, said recently Edmund Phelps is the only antidote to the crisis but also to inequality. A true elixir to satisfy the changing needs of an ever more personalized (and wounded) world.

The post Fordism, the rise of knowledge and creativity economy, the radical change in factors of production (raw material, labor, capital) support an additional power of knowledge creativity.

"In an essential sense, innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organizational set-ups" [16]. This neoschumpeterian definition suggests us to consider innovation as a result of productivity efficiency and adaptive efficiency. Innovation is a social fact driven by individuals as well as large institutions, associations, online or offline community and so on.

Innovation, in polanyian word, is embedded in society: this is the starting point of the large recent literature on social innovation.

2 Social Innovation

If we read some definition of social innovation, we can find, for example: A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals [29]. We define social innovations as new ideas (products, services and models) that simultaneously meet social needs and create new relationships or collaborations. In other words, they are innovations that are both good for society and enhance society's capacity to act [27]. Social innovation can be defined as the development and implementation of new ideas (products, services and models) to meet social needs and create new social relationships or collaborations. It represents new responses to pressing social demand, which affect the process of social interactions. It is aimed at improving human well-being. Social innovations are innovations that are social in both their ends and their means. They are innovations that are not only good for society but also enhance individuals' capacity to act [21].

These are dense definitions, that should be analyzed word for word, but here it is important that we underline the connection between the concept of social innovation and the stakeholder ecosystem [17]. The social dimension of innovation engages local systems, close-knit territorial networks full of tacit, atypical knowledge and hence of particular relevance. From this point of view every economic, institutional and social actor is able to innovate: the crucial element is that we have to recognize the role of hybridization and the meeting of diverse realities and organizational culture. On the contrary, the incapability to innovate is tied to an ineffectiveness to adopt different perspective when analyzing problems or to risk collectively not kindly recognized by the majority. If we consider the social innovation as one of the pillars of our theoretical approach, we have to underline that innovation starts when there is a social request that a social need is met. The first step is the recognition of an unmet need, and then the necessity to find one or more solutions. Social innovation approach leads us to a emphatic model: institutions and companies can no longer study the user's profile, but they have to enter in the user's world, sharing opinions and narrations, sharing, we can say, all the process of innovation.

3 Helix of Innovation

We can also say that the contemporary social construction of innovation is very comparable to Triple and Quadruple Helix approach proposed by Etzkowitz and Leydesorff [19] and by Carayannis and Campbell [6]. Starting from a "Mode 1", characterized by a "linear model of innovation", according to which university and research centres are the starting points of innovation process and the role of end users was confined to the "passive consumer one", 20 years ago we passed to a "Mode 2" [22, pp. 3–4], characterized by five principles: (1) knowledge produced in context of application; (2) transdisciplinarity; (3) heterogeneity and organizational diversity; (4) social accountability and reflexivity; (5) quality control. As Carayannis et al. [8, pp. 3–4] pointed out, this Mode paved the way to the Triple Helix model, that stressed on the importance for innovation of university-industry-government relations [19]. But at the same time stimulated the passage to the Mode 3, "that is more inclined to emphasize the coexistence and coevolution of different knowledge and innovation modes (…) accentuates pluralism and diversity of innovation modes as being necessary for advancing societies and economies" [8]. This is an important step because it stressed the importance of cross-fertilization that in any case seems to let into the circle of researchers and firms although with the help of the government. Citizens, consumers, end users, do not come into play yet, in this model, except through the guarantee that the government should ensure their interests. A substantial change occurs with Quadruple Helix model [6, p. 218, 206], that adds a fourth helix: the public, defined bay these authors as "the media based and culture based public" and "the civil society" and associated with the "creative class". In the meantime, social studies about science and innovation proposed the Social Construction of Technology [31] and the Actor Network Theory [24], to underline that innovation is social context dependent and can't be limited to the closed network university-industry, also if this circle is heterogeneous and transdisciplinary.

These theories consider not only the social character of innovation, but also the necessity for a new territorialization. Innovation need to a place-based strategy linked to territorial specificities. Governance must be responsive to a self-potential discovery: the legitimacy, however, requires the involvement of end users. Social innovation, we can say, can be possible, only if we move from triple helix to

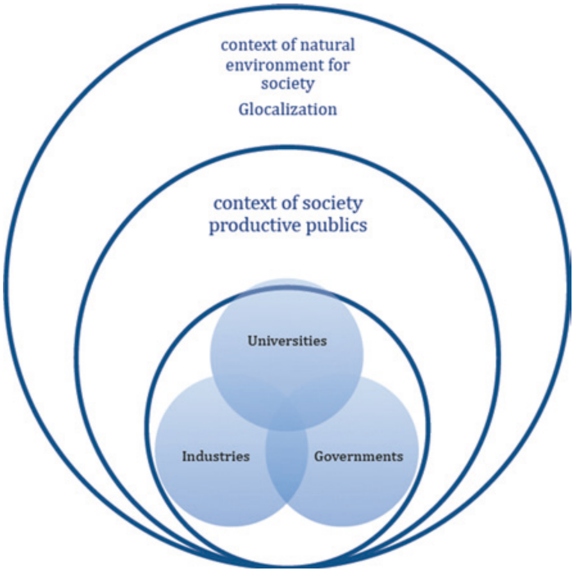


Fig. 1 Our elaboration from Carayannis et al. [8]

quadruple helix, adding "the General public" to the "classical" three actors, University, Industries and Government. More recently Carayannis [7] introduce quintuple helix, adding context of natural environments for society (Fig. 1).

4 Open Innovation

During last two decades companies have realized the progressive loss of importance about control of innovation according to close traditional model. In traditional closed innovation, a company generates, develops and commercialized its own ideas. The approach of self-reliance dominated the R&D operations of many industrial corporation for most of the 20th century. Chesbrough [10] coined the term "open innovation" a concept based on the observed fact that useful knowledge today is widely distributed, and no company, no matter how capable or how big, could innovate effectively on its own [12]. The official definition (2006) said that Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology [11].

Open innovation, we can say with Joel West, is using the market rather internal hierarchies to source and commercialize innovation. Firms start with capturing ideas from a larger group (and often from web community), using the new forms of collaborating with external actors, creating the environment and the trust, then managing ideas and interactions and turns ideas into innovation. In open innovation model there are also institutional ways to support the role of the network (business services, company, government), as well as bottom up channels (company, individuals, clients), and together they create an interconnected system. R&D, production, financing, creation, business incubators, marketing, consumption, enduser platform, services providers and customer care become the gears of a complex mechanism.

If we considered public policy it is clear that many measures have their roots in the closed innovation era. They shoot from a logic focused on developing large national or regional markets, defending local firms, restricting foreign workers and students, and subsiding large local firms to keep them innovating. If we consider open innovation approach policy have to change into a strong support to knowledge diffusion: government have to facilitate mobility of workforce and the educational system must systematically create highly qualified labor and new intellectual property norms.

5 Changing Actors in a Changing System

In order to explain the relationship between social and open innovation and the Helix system, we need to focus directly on the dynamic relationships that underlie contemporary innovation systems. Not enough of the traditional dyadic relationships, impromptu and extemporized, between an individual researcher and an individual entrepreneur, or even formal agreements university-government, government-enterprises, universities and enterprises. Today the paradigm of innovation demands joint learning between the three actors in the chain: the activism of a pivot organization is important, but the structural nature of innovation processes assumed synergies and strategic shifts, changes and adjustments for each other. More than specific knowledge, distinguishing the individual actors, it is central the potential collective and place-based knowledge.

In that sense it becomes very important to focus on the players of the fourth helix: the end users, public production, smart cities consumers-citizens who actively participate on the innovation process.

Until a few decades ago, the world of production was describable by actors and roles defined. Economic sociology had its certainties, its patterns. A complex frame inhabited by recognizable subjects: the entrepreneurs, the workers, the employees, the managers, the supervisors, etc. The relationship between public and private was complex, but with recognizable and often governed boundaries.

Economic production was always been a private matter, in private place, often fenced, sometimes secret, mostly closed (cf. [3]).

In 1990s, but its possible to recognize also earlier warning signs, technological innovations and diversification of capitalisms, led to radical changes. From the birth of the Web, in particular, it was possible to put into practice, many desires of the hacker culture, as well as theorization of Prosumer Movement according to "The third wave" of Alvin Toffler.

The collaborative production was possible to a few, but become a reality. In last decade this process was stepped up and economical, and sociological literature coined terms as "co-production" and "co-creation" [23], "the public productive" [3], "societing" [4], "wikinomics" [35], etc.

On its turn, the *digitalization or the democratization of production* not only allowed automatization of existing manufacturing techniques but also brought in life new manufacturing processes such as the additive manufacturing process, well known as 3d printing, F/OSS systems, Wiki platforms and so on. In his seminal 2006 work 'The Wealth of Networks', Yochai Benkler presents a new era in the production of information, the 'networked information economy', facilitating action by decentralized individual users, and in particular 'commons-based peer production' initiatives which provided a feasible, nonproprietary alternative to information production by corporate (or State) entities. Important and revolutionary features of this new kind of production compared to previous forms were the non-hierarchical decentralized organization of the initiatives, their 'non-market' nature i.e. the fact that production took place altruistically and communally without remuneration or proprietary rights for participants and the fact that the information produced could be disseminated worldwide for very little cost.

There is no doubt that some of these systems are contributing to the development of the sharing economy or even of the gift economy, (we talked about it in [2]) but it is necessary to avoid falling in naive optimism. Recent history of New Economy and ICT Giants as Amazon, Apple and Google show how crowd collaboration can be exploited to make profits.

It is useful to recall here that the possibilities of web platforms, and in particular the activation of collaborative processes of participation and co production, are the result of changes, which occurred in the post Fordism. Commenting on the literature on the end of the standard enterprise and mass production, Gary B. Herrigel in 2000 argued that the various forms of vertical disintegration, the flexible specialization, the production of diversified quality, systematic rationalization, were waiting for a new model of practice. Actually it was not a unique model, but rather a set of places and platforms habitable in the Web.

The fragmentation of mass markets had taken place for years. The so-called Original Equipment Manufacturers (OEM) began to realize more and more customized goods [1] to meet in increasingly sophisticated consumers [9], but the personalized production need new technologies. Global markets open up new opportunities, but at the same time, new risks and difficulties to understand the needs of customers. OEMs are under increasing pressure to a strong outsourcing not only to control costs, but also to a request for specialization which fail to support.[1]

The post-Fordism had shown that it was increasingly difficult and expensive to predict and anticipate consumer tastes.

Consumer trends and modalities of the individualistic consumer stressed enterprises facing a situation of increasing complexity: not only is there more of a

[1] There is a vast literature on this phenomenon: see for example Sako and Helper [33].

consumer-typology to which standardize the production, but the same segmentation appears more difficult. As a result, the similarities between consumers being increasingly temporary and not affecting the totality of the individual's behavior but just specific consumption activities: firms therefore, instead of focusing on the product or consumers are increasingly brought to prioritize the criteria that guide, from time to time, consumers' choices.

Consumers are becoming more eclectic, they make contradictory choices, they move away from old hierarchical prestige symbols by goods acquisition. At the same time they are enchanting [32] by an hypertrophic development of the possibility to choose so many goods on the market, which increases both the variety and the renewal rate and also the growth of communicative and expressive factors of the products. Markets, in that sense, are no longer defined by a set of products that perform the same use function, but by everything that can compete symbolically to satisfy its intangible needs.

Firms are enchanted as their consumers; they are disoriented in a cloud of outsourcing and in a sea of no longer understood consumers. In this climate of uncertainty, companies have started to change their strategies. They began to open up, to look for new ways to interact with suppliers, consumers, consultants, other firms, etc. The new production framework has profoundly converted industrial relations up to risemantization of the notion of competition.

The meaning of competition—from the Latin *cum-pete*—do not in fact refer to a kind of natural selection that rewards the strongest at the expense of others, but rather to the ability to converge towards a common goal while moving from different starting points. If this is the goal that drives cross-cutting subjects of the production of social value through business initiative, the principle of co-ordination that is shown most effective is that of cooperation.

According to Richard Sennett [34] cooperate is very different from simple collaboration: in the first case, in addition to the objectives, it has to be shared also the means and the goals of the action. Networks of relationships increase their importance not only for connection among people and organizations, but through a variety of methods and forms of regulation. Relational systems are not only the output, the result of initiatives that aim to increase the level of coordination, but the input to create complex and more effective systems, in order to generate social value. A value that, to be true, it needs to be shared and so you need to rest on a network able to give voice to the needs and attract resources and availability of a wide area.

A parallel process intervened in the domain of public participation to public choices. For a long period the representative democracy and its decision making process was based on three pillars: the public institution, to which people delegated decisional power by means of the electoral competition; the experts (or the technicians-bureaucrats), whose power was due to scientific or organizational knowledge and, finally, the representatives of the main social economic people's interests, i.e. social or economic organizations (e.g. Trade Unions). For a long time, these three kind of actors represented citizens enough to discourage the direct commitment in decision making processes, according also to the *free rider* Olson's model. But in the last decades, and particularly thanks to the mobilizing power of ICT, people asked for a direct participation to public choices, especially to the micro or meso level ones. The evolution of ICT interacts with the raising of an “adulthood of citizens” [13] and allows forms of direct and real time involvement of citizens that both integrate or (try to) substitute the “traditional” forms of democratic decision making.

An Italian scholar [25], points out that the social production of knowledge is maximized when you add to the enhancement of knowledge (tacit or explicit) the creation OD organizational structures that allow relationships and cooperation among social actors.

There notations paving the way to further developments, detected by contemporary scholars, that we will find in Living Labs in the next section. The connection between processes of development of individual skills (micro level), and the creation of meso structures where skills can grow with continuity and stability lead to the territorialization of the triple or Quadruple helix. In Smart Cities this is a key phenomenon: what are optimum conditions for innovation? What are the essential networks and nodes for Smart Cities?

Socialization and cultural guide to innovation become crucial: a highly socialized innovation means an innovation perceived and experienced as a collective target priority and a vibrant part of the society (organized actors and individuals). The socialization process, in that sense, transforms innovations, from technical issue into a widespread social action object, while the political and cultural leadership refers to all regulations, policies and initiatives of different institutional levels (International, European, national and local) in order to the same, clear and sharing elements that come into play in the innovation process [25].

For some author [15], the key elements of orchestration are quality of Research, socialization of innovation and governance, while others [14] say that are knowledge mobility, innovation appropriability and network stability. Relations among the player are characterized, necessarily, by *coopetition*, combining competition and cooperation in the value net [28] which is represented as a diamond shape, with four defined player designations at the corners: customers, suppliers, competitors and *complementors*. E.G. Carayannis insists on *coopetition:* already in 1999, in an article written with Jeffrey Alexander, put the attention to the relationships linking the firm to its environment at the market, political and ecosystems levels. The introduction of the ecosystem level, that Carayannis proposes in a number of works, paves the way to the direct intervention of end user in innovation processes, that is one of the key features of Living Labs.

6 The Living Labs

A Living Lab, according to a EC [20, p. 7] document, is “a user driven open innovation ecosystem based on business-citizens-government partnership which enables users to take active part in the research, development and innovation process” or “a user driven, open innovation environment in real-life settings in which users test and experiment new products or services, in a framework integrating companies, people, research and innovation actors and public sector (the so called Public-Private-People Partnership, PPPP)." Recently also Wikipedia proposes a similar definition: "A living lab is a user-centred, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region), integrating concurrent research and innovation processes a public-private-people partnership. The concept is based on a systematic user co-creation approach integrating research and innovation processes. These are integrated through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artifacts in real life use cases. Such use cases involve user communities, not only as observed subjects but also as a source of creation."

The concept of Living Labs was born in Boston, where professor William Mitchell was used to observe the living patterns of users in smart homes. The idea was to involving city dwellers more actively in urban planning and city design [26], but suddenly Living Lab was traduced in Europe in wider use to "Enhance innovation, inclusion, usefulness and usability of ICT and its application in society" [18].

The main and more innovative dimensions of a LL are:

(a) The first one is for sure the involvement of end users at the early stages of innovation process. This involvement, however, has different motivations which co-exist in different types of LL submitting different logic. These motivations can be arranged along a continuum, which has at one end a "corporate oriented", in which the early involvement of end users ensures a better compliance of the products to the need of the consumer, reducing time from conception to commercialization: this means a better competitiveness of enterprises. At the other extreme the "need oriented", that is the attempt of putting before the need and the problems instead of solutions and products.
In this case the role of end users is not only limited to an active part in a process driven by firms (or research institutions), but is a guiding role, allowed (we think) by the public governance (and sometimes by public funding) of the Living Lab. Is matter of fact that the first experiences of LLs derives from "enlighten" firms or research centers, that opened their doors to end users, but during their evolution LLs recognized to end users a role of growing importance. Some Authors underline that the methodology and the methods used to build and to conduct the Living Lab play an important role in its future and that the concept design phase is crucial for its success [5, p. 1]. The crucial role of end user is obtained if "we can shift the perspective from problems to opportunities and from requirements to needs" (Ibid.); in this way, from the point of view of users, we have the best insurance that their needs will be put on the center (and on the beginning) of the innovation process and, from the point of view of firms, they'll be sure about the success of the products that will derive from the LL. So empowerment of citizens walk hand in hand with competitiveness of economic sector and an "user driven innovation" will really took place.

(b) Open and social innovation. Living Labs has the function of open innovation intermediaries that aims to provide structure and governance to user involvement. In this sense, Living Lab is home of user contribution, identifying and codifying tacit and practice based knowledge and diffusing into ad hoc innovation network. Living Lab is also a place of social innovation, because it is a real life environment, where is possible to generate new socially negotiated meanings for products and services. If we consider the methodological point of view, the "social" aspect of the innovation process derives not only by the end user's involvement, but also from the "social" character of the process by which a Living Lab works: real or virtual meetings, direct involvement of end users in ideation phase, use of methodologies that can maximize the participation and the interaction (also with other actors, not only end users, but also public, experts, researchers and social representatives). From the substantial point of view, first of all innovative can be the process or the product and the "social" aspect derives from the shared benefits in a bigger community; this is also linked to the main area in which LLs usually works: although quite every matter can be the subject of a LL, a great part of its refers to [20] e-Wellbeing, e-Services in Rural or Developing Areas, e-Democracy and e-Governance, ICT for Energy Efficiency. Also in the Ligurian case of Alcotra the concerned sectors are closely linked to primary needs of citizens (health, energy, mobility). Social innovation is in our opinion closely linked also to the principle of co-creation, that means that all stakeholders must cooperate to the final outcome of the Living Lab and that cooperative way of work are a key feature of a Living Lab.

(c) The (public) governance of the Living Lab. This aspect is not usually quoted, because Living labs can also arise "from the scratch", or thanks to the solicitation of firms or research centers (less probably, by end users' associations). Anyway, we think that a minimum set of rules warrantied by a public body are necessary to give to the participants the starting trust to share knowledge (and to devote time) with other people and to commit in a common effort for common objectives. There is no doubt that in contemporary society there is an increasingly availability to cooperate and collaborate, in particular through new technologies. Phenomenon as Wikipedia, but also open source communities, crowdfunding, peer to peer networks and so on demonstrate [2] that people tend to participate to imagined community sharing knowledge and intelligence: a new and old way to exchange and build relationships. In case of Living Lab the aim is not giving economy but competitiveness: it is very likely and desirable that LL products provide profits to firms and development for territories. The presence of local public organizations should ensure that LL innovation stimulates both companies and research system putting at the center social needs. Local government support the idea that "needs are opportunities waiting to be exploited" [5: 3] albeit in a logic of competitiveness. Public institution, as we see in Alcotra Innovation experience, is an irreplaceable actor because of ensuring costs and organizations of the startup phase of LL with a methodological and monitoring and evaluation system that is functional to the inclusion of all primary and secondary stakeholders. For a good governance is required an ICT infrastructure, that allows shared participation, immediate feedback, direct democracy in the governance. ICT infrastructure is closely linked to the governance of the LL. Although public governance is an important requirement, a LL works well if it's spontaneous and if all stakeholders play a role in decision making process and cooperate (as suggested above) to final results. So LL must be democratic and participative, not only to be coherent with its philosophy, but also to give room to all competencies and availabilities.

(d) A real life setting and the goal to produce new goods or services, or to improve in an innovative way actual good or services of public interest. This means that a LL is not an arena in which people only debates new ideas, but an ecosystem in which innovation take place and produce something of new and useful for people, firms and the involved communities. Of course in some case the real life experimentation will be most important than in other cases, in which crowdsourcing of ideas will be privileged, but in any case something of new and useful must be the outcome of LLs. This must be also an important part of evaluation, that can't be limited to the process, but must include results and impacts. The way in which profit oriented actors and socially oriented actors can cooperate is linked also to the way in which each of them can have a gain, because a LL must be a win–win game to be seriously played.

7 Alcotra Innovation Living Lab

The Alcotra Innovation strategic project, funded by the Alcotra Italy–France 2007–2013 territorial cross-border cooperation program, had as partners Rhône-Alpes and Provence-Alpes-Cote d'Azur Regions, in France, and those of Piedmont (acting as Coordinator), Liguria and Aosta Valley, in Italy, as well as the Province of Turin. The project, launched in September 2010 and lasting for 3 years, aimed at experimentally introducing the Living Lab approach into the respective innovation policies and practices, according to a transnational perspective, namely through the building up and operation of cross-border Living Labs in the five participant regions. It was therefore quite natural for the Alcotra Innovation partners during the project design phase (in the year 2009), to be attracted by the potential contribution of the Living Lab approach to existing, and upcoming, regional innovation policies and practices. There was already evidence in that sense in the three Regions: Piedmont—being a member of the ENoLL (European Network of Living Labs) since 2008—PACA—with the success story of "PACALabs", one of the earliest examples of user driven and territorially oriented innovation policy promoted by the public hand—and Rhône-Alpes with 7 Living Labs (most of them created in 2009) is particularly active in the domain of media, design and uses innovation. However, a new perception was emerging that the full potential of Living Labs for innovation policy should be grasped in the broader framework of the Alps-Mediterranean EuroRegion—including Liguria, Piedmont, Provence-Alpes-Côte d'Azur, Rhône-Alpes and Aosta Valley—rather than at single regional level. Therefore, the cross-border dimension was added to the picture.

Four thematic domains were selected for the purpose of Living Lab experimentation, namely:

- Intelligent Mobility, coordinated by Piedmont Region and Liguria Region;
- Smart Energies, alternative sources of power and energy efficiency, coordinated by Aosta Valley Region;
- e-Health, coordinated by PACA Region;
- Creative Industries, coordinated by Rhône-Alpes Region.

In a first phase of the project, each Region organized local workshops with the purpose of raising awareness of the Quadruple Helix stakeholders on the Alcotra Innovation objectives, the cross-border Living Lab's idea and its possible advantages compared to other approaches. With the main exception of PACA Region, where the PACALabs Initiative had been in place since 2008, most regional stakeholders did not know much about user driven open innovation and therefore had to learn about previous successful experiences. In a second phase, having formed the cross-border working groups, which were animated and facilitated by both thematic and methodology experts, participants started to become familiar with the concept and to think about the design of possible pilot actions involving the Living Labs' operational principles in a meaningful and useful way.

The experimentation of Intelligent Mobility was characterized by several starting meetings with interactive methodologies in online and offline contest. The aim of the groups was to develop innovative solutions for tourists and open air travellers and the output of the laboratory was the prototype of an application for mobile device with two different interface. The Living Lab Creative Industries has used a mixed user centered methodology: the aim was create and test innovative solution in museum fruition. After several cross border workshops participants decided to develop two experiments, one in Rhone-Alpes and one in Piedmont, during which artists, software developers, designers, contractors, visitors and museum curators, worked together to prototype interactive museum design. Participants were immersed in the context of the museum: the laboratory where ideas were born, tested, changed, imagined and co created in augmented reality.

8 Conclusions

The experience of cross-border Living Lab Alcotra Innovation show both the potential of this model of open innovation and the need/opportunity to adjust it into local context or in specific issue.

In none of Alcotra Living Lab there is a leadership role of companies, important and articulated are the role of end users, while public institutions were protagonist. Public institutions has in fact some features that, especially in a cross border dimension, can hardly encompassed:

(a) they establish the basic rules of the game, and solve the functions of trust intermediaries;
(b) they tied most important social need with priority for action planning or regional and transnational programming;
(c) cross border dimension show opportunity and difficulties of coopetition among territories. In particular in touristic field, cross border show how territories are complementary but at the same time, they are in a strong competition. Public institutions, in that case, have to select policies to maximize synergies and minimize replacement effects;
(d) they provide some basic services (animation, sharing platform, administration and payment of pocket costs as travel, hospitality etc.),
(e) they are able to steer, especially in the field of public services, both the demand and the offer. This it was evident in e-health, but in tourism and info mobility too.

It was found in all experiment the role of public institution especially at the end of the project, when the need to results perpetuation, found companies and end user associations unable to build a business plan containing living lab costs. The weak point might be considered that an excess of public intervention could alleviate overly the entrepreneurial component of Living Lab. In a Schumpeterian way we can say that innovation arises out of new combinations of existing capabilities and openness is crucial: the famous NIH (Not Invented Here) syndrome is always around the corner, especially in public institutions. Smart Cities need a profound change: from NIH to TFE (Thankfully Founded Elsewhere): it means not reinvent hot water again, but to “use” what has already been invented elsewhere, restarting from there to some new frontiers.

References

1. Addis, M., & Holbrook, M. B. (2001). On the conceptual link between mass customisation and experiential consumption: an explosion of subjectivity. *Journal of Consumer Behaviour, 1*(1), 50–66.
2. Aime, M., & Cossetta, A. (2010). *Il dono al tempo di Internet*. Torino: Einaudi.
3. Arvidsson, A. (2005). Brands a critical perspective. *Journal of Consumer Culture, 5*(2), 235–258.
4. Arvidsson, A., & Giordano, A. (2013). *Societing reloaded*. Milano: Egea.
5. Bergvall-Kåreborn, B., Holst, M., & Ståhlbröst, A. (2009). Concept design with a living lab approach. In Proceedings of the 42nd Hawaii international conference on system sciences. http://originwww.computer.org/portal/web/search/advanced?p_p_id=searchadvanced_WAR_pluginssearch_INSTANCE_eO7R&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1.
6. Carayannis, E. G., & Campbell, D. F. J. (2009). ‘Mode 3’and’Quadruple Helix’: toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management, 46*(3), 201–234.

7. Carayannis, E. G., & Campbell, D. F. J. (2011). Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the Quadruple and Quintuple Helix innovation concepts and the Mode 3 knowledge production system. *Journal of the Knowledge Economy, 2*(3), 327–372.
8. Carayannis, E. G., Barth, T. D., & Campbell, D. F. J. (2012). The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship, 1*(2), 1–12.
9. Carù, A., & Cova, B. (Eds.). (2007). *Consuming experience*. London: Routledge.
10. Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business Press.
11. Chesbrough, H., Vanhaverbeke, W., & West, J. (Eds.). (2006). *Open innovation: Researching a new paradigm*. Oxford university press.
12. Chesbrough, H. (2011). Open services innovation. Rethinking your business to growth.
13. Crozier, M. (1987). *Etat modeste, état moderne, stratégie pour un autre changement*. Paris: Fayard.
14. Dhanaraj, C., & Parkhe, A. (2006). Orchestrating innovation networks. *Academy of Management Review, 31*(3), 659–669.
15. D'Andrea, L. (2006). L'innovazione come processo sociale. Conoscenza & Innovazione. http://conoscenzaeinnovazione.org.
16. Dosi, G. (1988). Sources, procedures, and microeconomic effects of innovation. *Journal of economic literature,* 1120−1171.
17. Fung, A., & Wright, E. O. (2001). Deepening democracy: Innovations in empowered participatory governance. *Politics and Society, 29*(1), 5–42.
18. Eriksson, M., Niitamo, V. P., & Kulkki, S. (2005). *State-of-the-art in utilizing Living Labs approach to user-centric ICT innovation-a European approach*. Lulea: Center for Distance-spanning Technology. Lulea University of Technology Sweden: Lulea. Online under: http://www.cdt.ltu.se/main.php/SOA_LivingLabs.pdf.
19. Etkowitz, H., & Leyedesdorf, f L. (2000). The dynamics of innovation; from National Systems and Mode 2 to a Triple Elix of university-industry-government relations. *Research Policy, 29*, 109–123.
20. European Commission (2009). *Living Labs for user-driven open innovation*. Directorate General for Information Society and Media, Bruxelles.
21. European Commission (2013). *Guide to social innovation*, DG Regional and Urban policy and DG Employment, Social Affairs and Inclusion.
22. Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). The new production of knowledge: The dynamics of science and research in contemporary societies. Sage.
23. Humphreys, A., & Grayson, K. (2008). The intersecting roles of consumer and producer: A critical perspective on co-production, co-creation and prosumption. *Sociology Compass, 2*(3), 963–980.
24. Latour, B. (1987). *Science in action: How to follow scientists and engineers through society*. Cambridge, Mass: Cambridge University Press.
25. Martini, E. (2011). *Socializzare per innovare*. Loffredo Napoli: Il modello della Tripla Elica.
26. Mitchell, W. J. (2005). Constructing complexity. In *Computer aided architectural design futures 2005* (pp. 41–50). Netherlands: Springer.
27. Murray, R., Caulier-Grice, J., & Mulgan, G. (2010). *The open book of social innovation*. National Endowment for Science, Technology and the Art.
28. Nalebuff, B. J., & Brandenburger, A. (1996). *Co-opetition*. London: HarperCollinsBusiness.
29. Phills, J. A., Deiglmeier, K., & Miller, D. T. (2008). Rediscovering social innovation. *Stanford Social Innovation Review, 6*(4), 34–43.
30. Paskaleva K., E-governance ad an enabler of the smart city, in Deakin, M. (2013) *Smart cities: Governing, modelling and analysing the transition*.
31. Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science, 14*, 388–441.

32. Ritzer, G., & Jurgenson, N. (2010). Production, consumption, prosumption the nature of capitalism in the age of the digital prosumer. *Journal of Consumer Culture, 10*(1), 13–36.
33. Sako, M., & Helper, S. (1998). Determinants of trust in supplier relations: Evidence from the automotive industry in Japan and the United States. *Journal of Economic Behavior & Organization, 34*(3), 387–417.
34. Sennett, R. (2012). Together: the rituals, pleasures and politics of cooperation. Yale University Press.
35. Tapscott, D., & Williams, A. D. (2008). Wikinomics: How mass collaboration changes everything. Penguin.com.

Index

R. P. Dameri and C. Rosenthal-Sabroux (eds.), *Smart City*, Progress in IS,
DOI: 10.1007/978-3-319-06160-3,