Progress in IS

Renata Paola Dameri

Smart City Implementation

Creating Economic and Public Value in Innovative Urban Systems

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Preface

Smart cities are a recent phenomenon, but they are spreading quickly all over the world. This vibrant and innovative urban strategy is conceived like an effective instrument to face with the increasing urbanization interesting large and medium cities in the five continents. Despite the topic seems to be well-known and applied by both academicians and practitioners, contents and boundaries of this concept are still confused and jeopardized. It is also the result of a bottom-up trend, as cities are implementing their own smart vision far from the academic theoretical guidelines, following the spontaneous projects issued by local governments, firms, and citizens.

The present book collects a set of essays regarding all the aspects of smart city investigation: from definition to implementation, from theoretical backgrounds to empirical observation. It is a result of a multiyear research activity, putting together both the academic studies about this topic and the political and professional experience of the author. The aim of this work is to deliver an up-to-dated, real-time vision about smart cities all over the world, suggesting a comprehensive definition, a summary of strategic visions and implementations, and some guidelines to develop and implement performance measurements able to evaluate the effectiveness and capability of smart city programs to create economic and public value in urban innovative systems.

Chapter 1 introduces the topic summarizing some key aspects regarding smart cities, to guide the reader in interpreting both the scientific literature and the empirical implementation of smart projects. The global aspect of this urban strategy, on one side represents a unifying point, joining almost all the larger metropolis in pursuing similar goals, on the other side requires to better distinguish standard approaches and distinctive choices. During the latest ten years, several cities all over the world have been starting to develop their own smart strategy, aiming at improving the quality of life of citizens and reducing environmental footprint. However, smart cities show heterogeneous profiles, as they both reflect the history and geographical individuality of each city and implement the political address of their own local and central governments. Moreover, also the scientific researches lack of a shared definition of smart city; and smart city and digital city are often confused each other owing to the large use of ICT in both of them. In this chapter,

the smart city concept is analyzed considering two main aspects: the strategic vision of a smart city and its benefits. A smart city strategic vision is of paramount importance to effectively drive local policies in implementing smart initiatives pursuing shared goals. Smart city benefits are often declared, but not measured; to better define smart city performance is indispensable to realize better outcomes for citizens and other stakeholders.

Also Chap. 2 investigates about the smart city definition, explicitly comparing the strategic vision of its main players, that are academia, industry, and government. To implement a smart city is a complex task, involving different aspects and several actors. As a smart city is especially based on the use of innovative technologies in the urban area, three main actors are involved in its implementation: local government, research institutions, and technology vendors. Local government drives the smart city planning and rules the general aspects; research institutions offer their competences in studying and experimenting innovative technologies and solutions; vendors produce and sell technological platforms and infrastructures for the smart city realization. A linking role is played by consulting companies, offering direction services in complex projects. This chapter analyses the most cited scientific and professional publications to verify the different points of view issued by these different smart city actors and compares their smart city definition.

Chapter 3 addresses the role of ICT in realizing a smarter city. Smart cities use ICT to implement their smart strategies and to collect and deliver information to different users. For this reason, a smart city somewhat joins different aspects of living in the urban area and links several concepts such as wired city, virtual city, intelligent city, information city, digital city, knowledge city, and so on. This deep use of ICT enhances the role of the smart city in collecting and delivering data, information and knowledge affecting the daily life and improving its quality thanks to e_services, a deeper involvement of citizens in the city governance and their proactive role thanks to e_democracy and e_participation. In this chapter the link between smart city and ICT is explored, aiming to outline the pervasive role of ICT in smart projects, but also to highlight smart projects using other technologies or no technologies at all but simply based on the citizens' behaviors or the governance style.

Chapter 4 deals with a capital argument, generally neglected: the evaluation of smart city benefits. A smart city is an urban strategy using technology and promising to improve the quality of life for citizens. However, few practices are known, where cities really measure the impact of smart initiatives on the daily life of their inhabitants. Independent institutions and research centers issue smart city rankings, based on smart projects implementation or technological infrastructures present in cities, but no instruments are applied to really verify if and how much a smart program affects people living in city. This chapter suggests how to develop a Smart City Performance Dashboard to measure and evaluate the capacity of a smart strategy to impact on the quality of life. Based on the most known urban indicators worldwide, this work defines a five-step path for implementing a standard but city-tailored dashboard to both support smart city investments and to evaluate their performance.

As the aim of this book is both to clarify the conceptual aspects of the smart city topic and to investigate about its concrete implementations, Chap. 5 regards one of the pillars of a smarter city, that is smart mobility. Mobility is a critical factor for better living in cities. Transport are crucial for moving from home to work and to access to urban services. However, transport is also one of the most problematic aspects of the urbanization: the enlargement of city dimensions produces traffic congestion, difficulties in delivering public transport services all over the metropolitan area and an increasing of pollution. Smart Mobility is a subset of smart initiatives, especially aiming at planning intelligent transport solutions, concurrently responding to all the smart goals, that are: to reduce pollution, to increase the quality of public services and to better connect city neighborhoods thanks to mobility data collection, processing and delivering. This chapter defines a general framework to analyze characteristics, goals and benefits pursued by smart mobility projects, investigating also the role of ICT in implementing these projects. Several case studies validate the theoretical framework.

Finally, Chap. 6 tells the story of two best smart city experiences in Europe. Meanwhile academic researchers have been studying the theoretical aspects of a smart city, suggesting definitions and models for their understanding, the largest cities all over the world have been starting to realize smart projects to create a smarter living in urban areas. As the smart city movement is spontaneous, each city pursues its own goals prioritizing smart initiatives of different nature: sometimes the use of ICT prevails, some others green energy production is at the core of smart programs; and so on. This chapter studies two smart city best practices: Amsterdam and Genoa. Amsterdam has been the first city all over the world implementing a smart city strategy addressing not only one dimension of living, but with a comprehensive scope. Genoa won the highest number of European calls funding smart city projects and the Genoa Smart City Association aims to compose an integrated smart projects portfolio addressing all the aspects of the metropolitan life. Both these cities are interesting case studies for supporting further implementation in smart cities.

All the chapters are strongly based on the most cited scientific papers defining smart city models and frameworks. Besides the academic basis, a high number of empirical cases are described, supporting the theoretical modeling emerging from the six chapters. At the end of the reading, smart cities all over the world emerge like a promising strategic vision, where technology, political choices and human capital together work to create the best condition for everyone who lives in a large city.

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Chapter 1
Smart City Definition, Goals and Performance

1.1 Introduction

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. The concept smart city has recently been introduced as a strategy to encompass modern urban production factors in a common framework and, in particular, to highlight the importance of Information and Communication Technologies (ICTs) in the latest 20 years for enhancing the competitive profile of a city [1]. To face the increasing problems of urban areas, local public governments, 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, the smart city idea has ancient roots. A paper written in 1993 documents the various telecommunication investments in Singapore and the role of information in the production and distribution processes contributing to the overall growth of GNP, defining Singapore like an "intelligent city" [2]. A large literature survey about both smart city and digital city scientific papers observes that these themes have been studied from twenty years ago [3]. The survey has been applied to both these keywords, as these two concepts have been often considered like synonymous.

Figure 1.1 shows the number of papers about smart city and digital city selected by Google Scholar during the latest twenty years. As the 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 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. The interest about smart city and digital city is quite stable from 1993 to 2010, then it has been increasing exponentially from 2010 to now.

Therefore the idea of a city being 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

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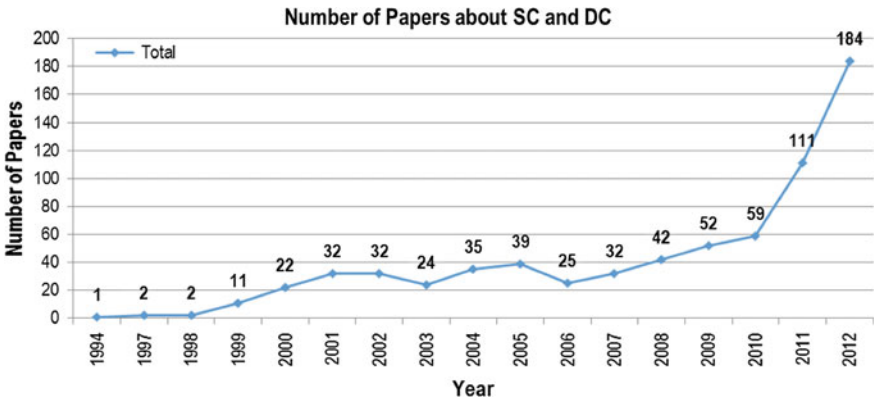

Fig. 1.1 Time analysis: number of papers about smart city (SC) and digital city (DC). *Source* Dameri and Cocchia [3]

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. Globally, one in two people live in cities, megacities are more than twenty, and both figures are expected to increase. In light of this scenario, the major challenge is the ability to grow the urban areas with efficiency and improving the quality of citizens' life. In the city of the future, the environment, the people and the technology have to be devised in an integrated and sustainable way: this is what underlies the concept of the smart city [5].

1.2 Smart City Profile: Some Emerging Facts

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. Figure 1.2 shows the map of cities all over the world awarded for their smartness by the Intelligent Communities Forum (www.intelligentcommunity.org); there are cities in each continent.

However, the panorama is very confused. A deeper analysis of the literature survey [6], 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

Fig. 1.2 Intelligent cities in the world. *Source* Intelligent Communities Forum (www.intelligentcommunity.org)

regarding the smart city enabling technologies, it is difficult to compare definitions written in a time elapse of ten years [7].

In addition, the smart city empirical implementation shows the same heterogeneity. Figure 1.3 shows that a smart city includes all the aspects of the urban life: from tourism to commerce, from industry to agriculture, including logistics, research and education. A smart city program impacts on all the urban infrastructures: public and private buildings, factories and transport facilities. A strong information and communication infrastructure should support knowledge management in the urban context and the sustainability of a smarter city could positively affect water, energy and mobility.

Cities have been starting to implement their own smart projects each in a different way. Generally, especially in the first phases of implementation, smart cities include in their project portfolio only a subset of the topics shown in Fig. 1.3. It contributes to further differentiate smart cities each other. 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, economic crisis and so on. However, these expectations are often supported nor by a clear smart vision of the city, nor by effective smart programs and initiatives [8], and this aspect can explain the heterogeneity of smart city projects.

Indeed, each city has an enormous set of possible actions to be carried out, but… which to choose? Negre and Sabroux [9] face the problem of prioritizing smart initiatives, 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. Without a comprehensive strategy about the mission of a smart city plan, it is very difficult to prioritize the initiatives better answering to a specific city need.

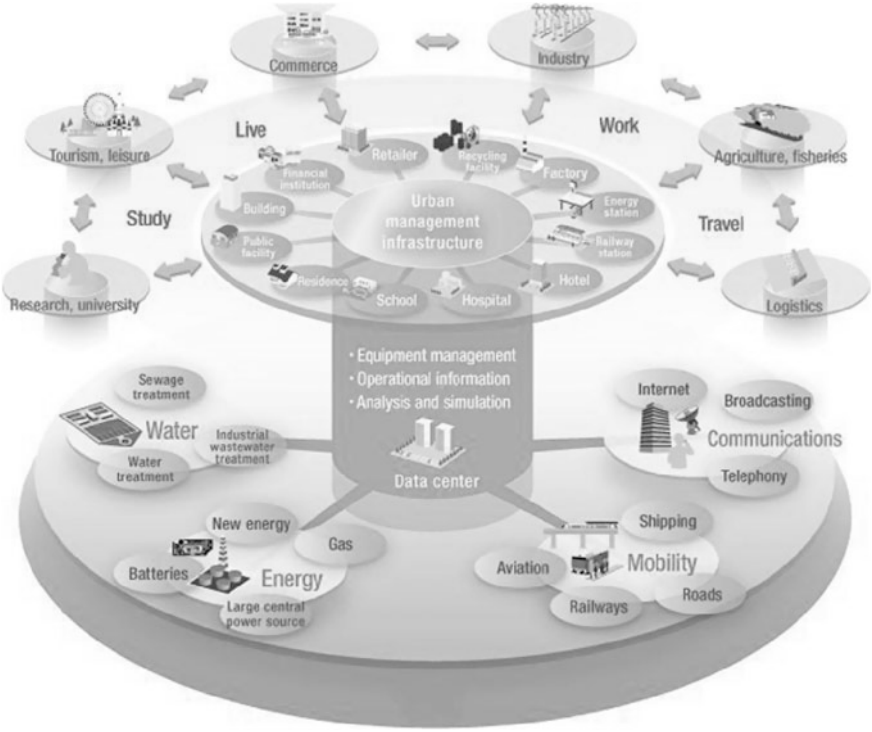

Fig. 1.3 Complexity and heterogeneity in Smart city. *Source* www.khichdionline.com/smart-cities-of-india-100/

The smart city implementation generally rises like a bottom-up phenomenon, that is, several actors independently each other start to realize a smart initiative, using some public infrastructure or technological solutions. For example, a public hospital realizes an online 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 to communicate to the citizens the improved smartness of their city. In Fig. 1.4 we can see an example of a simple framework describing the actors, stakeholders and benefits of a smart city program [10].

Solution vendors, governments and research and education institutions enable the smart city implementation, realizing digital platforms, pursuing environmental preservation and a better quality of life. Several stakeholders enjoy the benefits deriving from the smart city: public administrations, as they gain consensus thanks

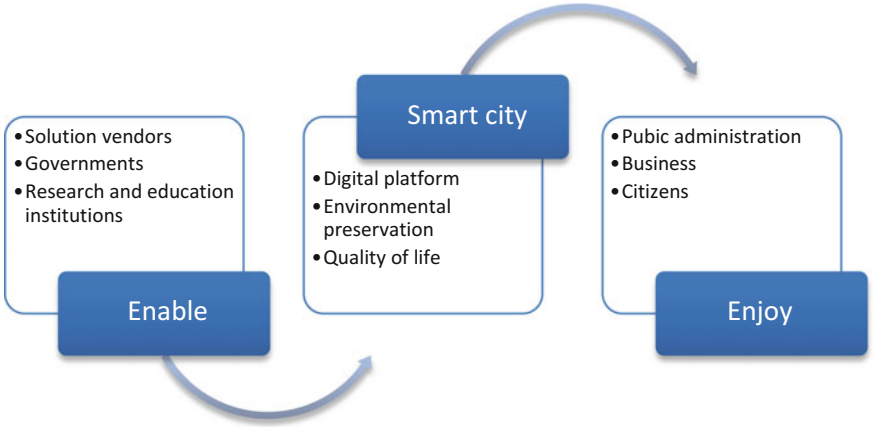

Fig. 1.4 Actors, stakeholders and benefits in smart city. *Source* Dameri [7]

to better public services delivered to citizens and more generally the better life conditions in city; firms and businesses, as they can enjoy a more innovative economic environment and a more attractive city; and citizens, thanks to the better quality of life derived from several aspects: better environment, better public services, better economic and work opportunities. Coordination mechanism is required, to focus the efforts of different actors on the same and shared aims.

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 [11]. Giffinger et al. [15] in their ranking of smart cities in Europe, explicitly include smart people as a fundamental dimension of a smart city. A smart city is a city well performing thanks to a combination of several aspects—not only technical ones, but also or especially human ones—based on self-decisive, independent and aware citizens. Smart people are defined thanks to a set of indicators used to measure and rank this dimension of a smart city. Indicators regard the social and human capital represented by education, level of qualification and affinity to long life learning; but also by creativity, cosmopolitanism and participation in public life (Table 1.1).

Until now, the lack of a smart strategic vision negatively influences the performance obtained by smart projects and initiatives. Nevertheless, no city until now has developed and applied a comprehensive 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

Table 1.1 Smart people dimension in smart city. *Source* Giffinger et al. [15]

Smart people (social and human capital)
• Level of qualification
• Affinity to lifelong learning
• Social and ethnic plurality
• Flexibility
• Creativity
• Cosmopolitanism/open-mindedness
• Participation in public life

sustainable returns to public and private investments [12]. Several frameworks have been suggested, including KPIs to measure the output and outcome of smart city programs. However, few cases are known of cities really using these or other performance measurement frameworks for really understanding the impact of their smart initiatives on the quality of life in city. Also the numerous smart city rankings, even if collecting data and producing indicators about the city smartness, are not able to evaluate the outcome of smart projects for the citizens.

An interesting EU project especially addresses the difficulty to select KPIs for smart cities and to define a standard framework for evaluating their performance (www.citykeys-project.eu). The City Keys project aim is to develop and validate, with the aid of cities, key performance indicators and data collection procedures for the common and transparent monitoring as well as the comparability of smart city solutions across European cities. The project partners cooperate with five cities (Rotterdam, Tampere, Vienna, Zagreb and Zaragoza) and EUROCITIES to define the needs, analyze existing results and develop recommendations for the use of performance indicators. Additional cities will contribute to the project in order to gather as much evidence and feedback as possible about the practical use, benefits and challenges of Key Performance Indicators (KPIs) and smart city project evaluation frameworks.

The project has been started in February 2015 and will run for 2 years. The output will be a set of instruments used by different cities and governments to define and measure smart city performance. The collection will include different instruments

– data sets and data collection regarding the Smart city topics;
– indicators collected in Smart city indexes;
– policy making recommendations;
– project deliverables;
– performance measurement frameworks.

The results will help cities to respond to the needs of their citizens, offer tools for the efficient use of cities' budgets, facilitate and enable stakeholders in projects or cities to learn from each other; it will also create trust in smart city solutions and provide a framework to monitor their long-term results.

The mosaic emerging from the smart city panorama is colourful 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 and 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 adapt 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.

1.3 Smart City Definitions and Core Components

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 Dameri and Cocchia show in their work [3], 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 in Tables 1.2 and 1.3, several elements are the same in both the topics.

Two elements amongst the other are found both in smart and in digital city definitions: the citizens (or people, or community, that is the human aspect) as the main actors and addresser of smarter and digital cities; and the pivotal role of Information and Communication Technology. These words are evidenced in bold in the most cited definitions listed in Tables 1.2 and 1.3.

An important reason to explain the difficult to define the smart city should be found in its the bottom-up nature. Rising from the empirical applications, 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, 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]. The model includes the following topics: Smart living, Smart governance, Smart economy, Smart mobility, Smart environment, and Smart people. Certainly, all these themes are included in smart cities, but not in all of them, and not only these themes are included. Moreover, some of these themes sometimes overlap each other and the clearness of the definition is not satisfying.

His smart city definition 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,

Table 1.2 Most cited definitions of smart city

Definition of Smart city	References
"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 [15]
"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 [36]
"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 [37]
"Smart City is the product of Digital City combined with the Internet of Things"	Su et al. [38]
"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 [39]
"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 [40]
"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 [41]
"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]

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. Moreover, several authors, professionals or companies involved in the smart city implementation include into the perimeter of smart initiatives different aspects; for example, Frost and Sullivan (see Fig. 1.5) consider eight dimensions, instead of six; and they are different in respect to the dimensions included by Giffinger et al. Nam and Pardo [13] include in their smart city framework three factors: technology, institutional and human factors. Other researchers suggest different classifications. Smart city contents are still in progress.

Also examining other smart city definitions, it emerges that there is a large disagreement between the academic view and the empirical view about smart cities.

Table 1.3 Most cited definitions of digital city

Definition of Digital city	References
"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. [42]
"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 [43]
"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"	Hiramatsu and Ishida [44]
"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 [45]
"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 and Hazapis [46]
"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. [47], Dykes et al. [48]

This disagreement regards the main components of a smart city: in the academic debate, smart city is especially based on components such as intellectual and social capital of the city, city governance and smart city strategic planning; in the empirical vision expressed by large companies such as IBM, Cisco and so on, the main component is the technology [16].

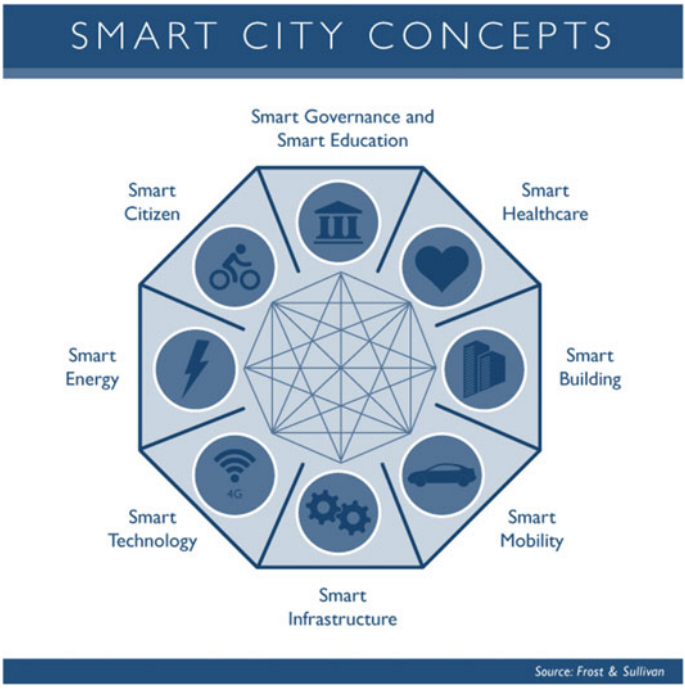

Fig. 1.5 Smart city dimensions. *Source* Frost and Sullivan (www.frost.com)

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

The academic vision considers the intellectual and social capital as one of the most important resources 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, trademarks, 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 [17].

Depending on this vision, the smarter city is the one that has the larger intellectual 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. This idea is supported also by the definition of knowledge city and intelligent city, sometimes overlapped with the definition of smart city and digital city (Table 1.4).

Reading these definitions, it appears that core components of knowledge city and intelligent city are the same of the dimension smart people in the smart city (see Table 1.1) and the ICT (or digital) infrastructure recalls the idea of digital city.

Table 1.4 Knowledge city and intelligent city definitions

Concept	Definition	References
Knowledge city	A knowledge city is a city that aims at 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 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 et al. [49]
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 [45]

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 and more profitable [17, 49].

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 the digital city, and from the need to solve several concrete problems strongly affecting the life in large metropolis, such as traffic, pollution, energy consumption, waste treatment and 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.

For example, the EU Smart city SETIS program [41] explicitly addresses four well-defined goals

- buildings, aiming at designing zero energy buildings for the maximum energy efficiency;
- heating and cooling, aiming at efficient solutions reducing CO_2 emissions;

– electricity, aiming at developing and testing high efficient appliances, lighting and smart metering;
– transport, especially addressing sustainable mobility and alternative fueling vehicles.

The evaluation system applied to this different smart city vision is more tangible and based on physical indicators such as CO_2 emissions, greenhouse gases, waste tonnes, 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—academic ones and business ones—are quite clear in both scientific papers and empirical studies or surveys about smart city, they are scarcely applied when a smart city plan is designed. As Thorne and Griffith explain in their work about the London Smart City development [19], and as it emerges from large literature surveys conducted by several authors, 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 stakeholder 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.

1.4 Smart City Goals and 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 [20].

Dameri [21] tries to put the basis to define the smartness of a city starting from its core components: land, infrastructure, people and government (Fig. 1.6).

Land means the territory, that is, the geographical area upon which the city rises up. Infrastructures is a large element, it includes all the physical, material components of a city such as buildings, streets, transport facilities and so on. People include all the citizens, not only the city inhabitants but also who work, study or

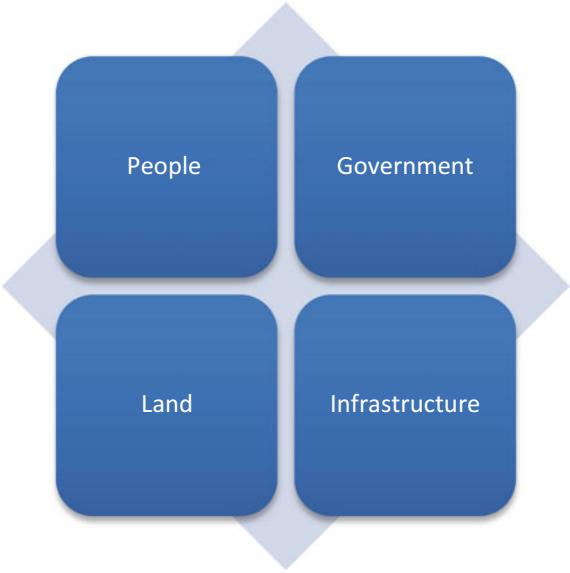

Fig. 1.6 The core components of a city. *Source* Dameri [21]

visit 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? Several authors agree to consider three main aspects of a smart city: effectiveness, environment consideration and innovation [22, 23].

- 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 including 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 for implementing 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. 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 online 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 people satisfaction for the local administration [13].

However, all these activities to improve the smartness of a city are not enough to realize public value enjoyed by all the 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 [24]. Public value is a complex idea, as it includes several different dimensions [25]:

- 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 [26].

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 improvements in the daily life of the citizens, they sometimes 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. Several studies address this topic.

Fontana [27] 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 and 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. To address these difficulties, public authorities state that they want to become "smart", as a smart city is conceived to be actively engaged in improving the quality of life of its citizens and in pursuing sustainable growth. The author not only contributes to the definition of smart city and its role in creating public value, but especially he assesses the real adoption of the smart city model by a significant number of large and medium-size Italian cities, in order to draw recommendations for the best practice adoption. The result of the paper is a smart agenda for local governments allowing the Municipalities to mobilize interests, build consensus, attract resources and produce positive results. These results are defined considering several aspects: strategy implementation, collective learning, higher cohesion, better ownership of new policy initiatives, considered as drivers of local public value.

The importance of citizens is outlined also by Palumbo and Cossetta [28]. In their work regarding social innovation, they introduce the idea that social and open innovation 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 [29]. 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. A successful smart city needs an adequate performance measurement system to collect all the information required to develop an effective involvement of stakeholders. 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; the model includes several dimensions. In a smart city, performance measurement should at least concern the dimensions of production, technological innovation, quality of life and eco-sustainability; measurement should be applied to a set of input, activity, effectiveness, efficiency and outcome indicators.

Baccarne et al. [30] analyze 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. Figure 1.7 explains

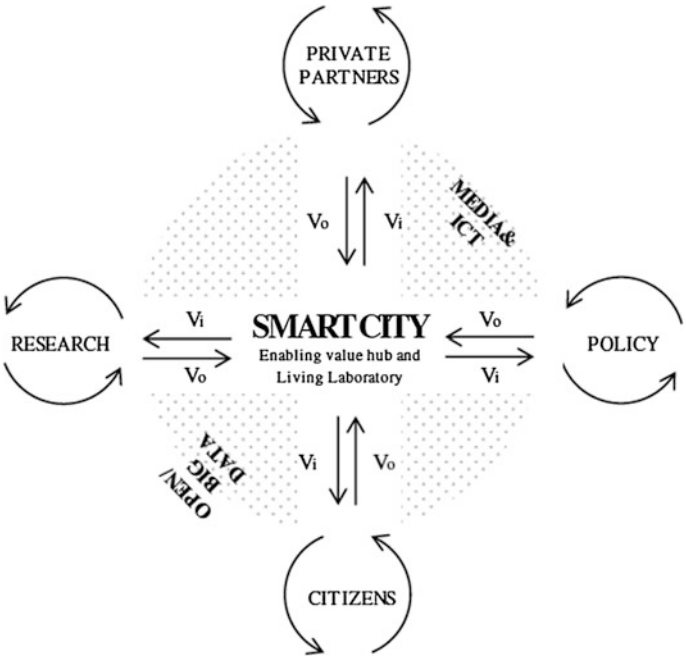

Fig. 1.7 Conceptual model of value creation in a smart city. *Source* Baccarne et al. [30]

how public value in smart city can be created. It requires: research activities to support innovation in urban strategies; policy makers real commitment; citizens actively participating to the smartness of their city with their own smartness; and private partners funding the smart city initiatives and supplying technical solutions.

1.5 Smart City Initiatives and Benefits

It emerges from 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 each other. What especially links these two different ways to understand the smart city benefits are the specific smart projects [31, 32].

The smartness of a city is indeed composed by several dimensions. Giffinger, one of the most cited authors, identifies six different dimensions of Smart city, as showed in Fig. 1.8: Smart mobility, smart environment, smart people, smart living, smart governance and 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

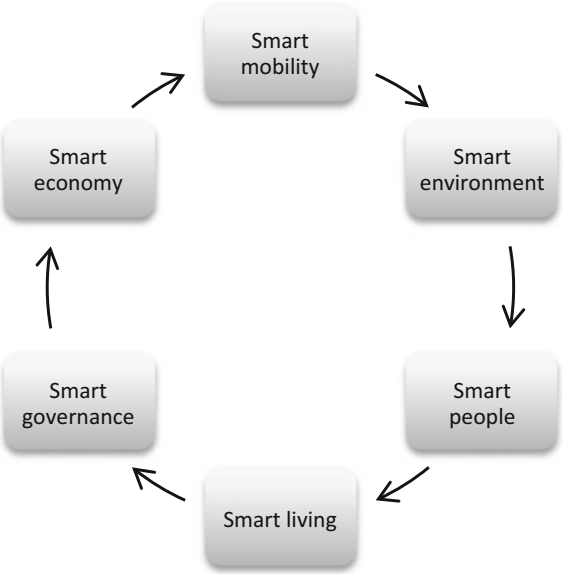

Fig. 1.8 The dimensions of a smart city. *Source* Giffinger et al. [15]

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 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 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 of a city 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 ore more dimensions of the daily life in city [34].

Figure 1.9 shows the direct and indirect impact of smart initiatives on Quality of life in urban areas.

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. Until now, smart projects are mainly focused on some themes such as buildings energy efficiency, greenhouse gases reduction, broadband diffusion, e-services

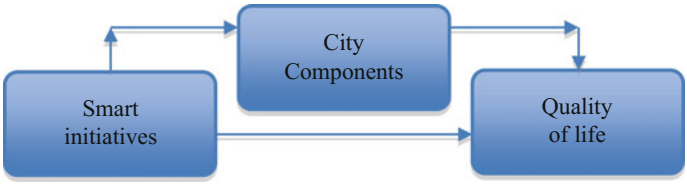

Fig. 1.9 Direct and indirect benefits of smart city initiatives

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].

For example, Dameri (see Chap. 6 further in this book) analyzes Amsterdam and Genoa comparing their smart projects portfolio. The analysis especially addresses the contents of smart projects and the technologies used to realize the expected outcomes. This analysis produces some interesting results about the role that different smart projects play into a smart city portfolio. For the first, it emerges that not all the smart projects included into the smart portfolio have a technological content. For example, the project "E-harbors" in Amsterdam is based on a new negotiation of energy contracts aiming at reducing the energy consumption and to sustain energy produced by renewable sources. The "IRIS" project in Amsterdam is based on a legal framework that offers better opportunities to develop local sustainable energy provisions. These projects use legal instruments to reduce the environmental impact of Amsterdam through the higher use of green energy, accomplishing with the sustainable component of a smart city. In Genoa, we can find several projects not based on technology to improve the smartness of the city. Generally speaking, these projects are mainly addressed to collect and spread best practices, regarding the use and production of energy, transport, and especially the daily behaviour of citizens. For example, the project "Smart Energy at Work" has the aim to write a handbook for implementing best practices for reducing energy waste in workspace. The EU project "Harmonise" has the aim to define EU standards and best practices to support security, resilience and sustainability in urban long-term planning and so on.

Another interesting result emerging from this survey regards the type of technology involved and the effects on the smartness of the city. The survey distinguishes between ICT and engineering technologies. When a smart city project uses ICT, it generally aims at improving the relationship between citizens and public administrations, or at collecting and spreading information improving the knowledge and the awareness about the city. Data are also used to better govern the city or some critical aspects such as traffic, public services, waste management and so on. The impact of these projects is especially linked with an improving of intangible aspects of the life in city, and the citizens' involvement is very high. On the contrary, when engineering technologies are used, the aim of smart projects is especially to reduce the environmental footprint of the city and to produce a higher efficiency of urban infrastructures. Goals are tangible and easier to measure; the

citizens' involvement is low, as the better quality of life in city derives from the environmental and infrastructural quality, instead of from the individual smart behaviours.

Therefore, a smart city and its outcome is the output of specific smart projects; their characteristics are crucial to realize the smartness of a city; but this smartness is not ever the same thing, and the technological and social characteristics of the project portfolio contribute to change the smart city profile [35].

1.6 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, is 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 chapter refers to 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 cannot. 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 multidisciplinary 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.

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Chapter 2
The Conceptual Idea of Smart City: University, Industry, and Government Vision

2.1 Introduction

During the latest twenty years, urbanization has been accelerating all over the world. People move from country to cities to find better opportunities for living, working, studying, developing their entrepreneurial ideas. However, urbanization produces also several diseases such as pollution, traffic, congestion, waste and social exclusion [1, 2].

The smart city movement was born just from these opposite circumstances: the pivotal role of cities and the urban problems deriving from urbanization. A smart city is conceived like an urban strategy using high technology and especially ICT for supporting a participated social and economic development of the urban area, preventing pollution and reducing the environmental footprint.

Until now, smart cities have been implemented especially applying a spontaneous, bottom-up process; municipalities, companies, not-for-profit organizations and the citizens themselves pursue the smartness of their city suggesting or directly implementing smart projects, initiatives, solutions. The final aim of this trend is to improve the citizens' quality of life and the environmental preservation.

Universities all over the world have been the first actor interested in studying and experimenting smart city pilots, starting this wave now interesting a very large set of heterogeneous stakeholders. As technology is the core component of a smart city, solution vendors are also first movers in designing and suggesting smart city solutions. Municipalities are involved as both players and coordinators of smart city plans interesting the city as a whole.

The involvement of universities, industries and (local) governments in the smart city implementation responds to the triple helix idea [3, 4]; where citizens or their representatives are involved too, it becomes a quadruple helix. A smart city emerges therefore like an innovation ecosystem, exploiting social and economic

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development thanks to the hybridization of elements from university, industry and government to generate a creative renewal in the knowledge economy and society.

However, to produce benefits the smart city triple helix should be based on the same idea of smart city shared by all the key actors aiming at the same smart goals. As a sound definition of smart city lacks so far, it is not possible to refer to a shared theoretical concept, but a common smart city idea is the necessary conceptual basis to support a long term, synergic, successful implementation of innovative smart cities thanks to the cooperation of all the involved actors and stakeholders.

This work aims at verifying the conceptual idea of smart city belonging to these different key players: university, industry and government. For pursuing this aim, the author carries out a deep analysis of a large set of documents issued by all these players: the set includes scientific papers, institutional reports and industry surveys focused on the smart city topic and issued by the most representative actors in the international panorama. The content analysis permits to compare not only several smart city definitions, but also aims, components and instruments included in the smart city vision defined by each category of actors. It helps to understand if and how much these visions are similar or different to each other. Implications are derived, regarding public policies and private strategies for a better integration between university, industry and local government in smart city implementation.

2.2 Literature Review

During the latest five years, the smart city topic has been increasing its weight in research activities of universities all over the world. Papers and reports issued about this theme have been exponentially increasing after 2010 so far. Figure 2.1 shows the trend regarding the number of scientific papers about smart city indexed by Scopus and published from 1997 to 2015. The survey includes all the papers with the keywords "smart city" or "smart cities" in title, abstract and keywords. The graphs clearly show that one or few papers have been published from 1997 to 2008. In 2009, papers are 17, in 2011 are 119, in 2014 they reach the number of 731.

An analysis regarding the papers clustered by country or territory shows that all the continents are included: Europe is represented by several countries such as Italy (at the first place), Spain, Germany, France; China and USA are respectively at the second and third place, representing Asia and America. It emerges that smart city is really a global topic.

Clustering papers by subject areas, it emerges like a multidisciplinary field of study; 1443 papers out of 2260 regard Computer science, followed by 773 regarding Engineering; it outlines the technological aspect of a smart city. However, 336 documents are classified in the Social science subject area, remembering that a smart city is not only a technological affair, but also a human and social initiative.

This vibrant topic is until now immature and in progress; indeed, a shared and sound definition of smart city has not been recognized by the scientific community yet. However, some most cited definitions are able to depict the main contents and

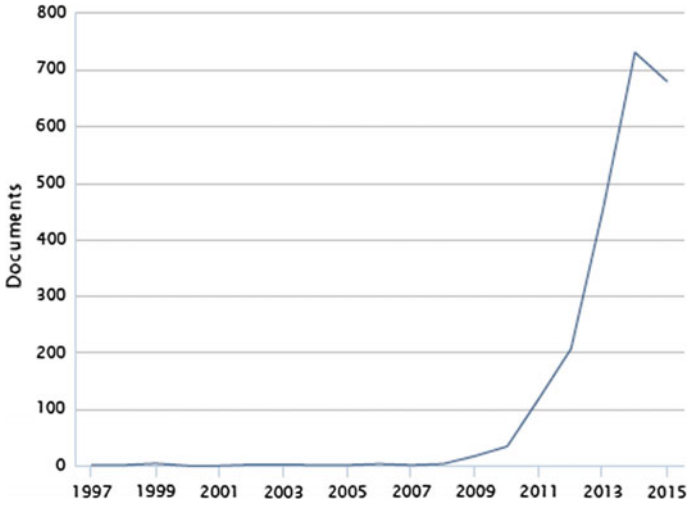

Fig. 2.1 Number of scientific documents indexed by scopus regarding Smart city (years 1997–2015)

aspects characterizing this new urban trend. Table 2.1 contains the definitions issued by researchers, public bodies and solution vendors, to compare their different points of view.

Hall [5] defines a smart city like a place where infrastructures—both traditional and ICT—are the core of an urban system; management, innovation and preservation of these infrastructures are crucial activities to grant to citizens a good quality of life. This pioneer and still immature definition already outlines the role of technology in smart city and the citizens as final addressees of the smart policies.

Also Caragliu et al. [6] define smart city depending on infrastructures and technologies, but they add also two more crucial components: environmental preservation and participation to city governance. The smart city emerges as an integrate subject of both technological and political solutions with a high degree of innovation not only in the physical layer of the city, but also in the human and knowledge component of it.

Similarly, Washburn et al. [7] refer to critical infrastructures, however, they include into the smart city concept also non infrastructural components, that is services, better defined such as city administration, safety, education, healthcare… and more generally all the aspects of a good quality of life when living in city.

Nam and Pardo [8] explicitly include technology, institutions and people in their smart city definition. In their vision, city policies are the core aspect of transforming a city in a smart city, applying technologies and people behaviours to all the aspects of their daily life. Moreover, they outline the importance of creating relationships and participation to enhance the urban smart strategies.

Moving from academic definitions to institutional definitions, we can find sometimes the same contents, some others different points of view. For example,

Table 2.1 Most cited definition of smart city

Definition	Author	Year
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	2000
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, Del Bo, and Nijkamp	2009
The Smart city is the use of Smart Computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient	Washburn et al.	2009
[Smart Cities are about] leveraging interoperability within and across policy domains of the city (e.g. transportation, public safety, energy, education, healthcare and development). Smart City strategies require innovative ways of interacting with stakeholders, managing resources and providing services	Nam and Pardo	2011
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	EU-SETIS	2012
A smart City is a city where social and technological infrastructures and solutions facilitate and accelerate sustainable economic growth. This improves the quality of life in the city for everyone	Amsterdam Smart City	2015
In a smart City, networks are linked together, supporting and positively feeding off each other, so that the technology and data gathering should: be able to constantly gather, analyze and distribute data about the city to optimize efficiency and effectiveness in the pursuit of competitiveness and sustainability; be able to communicate and share such data and information around the city using common definitions and standards so it can be easily reused; be able to act multi-functionally, which means they should provide solutions to multiple problems from a holistic city perspective	Copenhagen Cleantech Cluster	2012
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	2010

the European Commission [9] in its program SETIS defines a smart city especially in order to harmonize technological innovation and economic development with environmental preservation. The environmental component has in the EU vision a central role and EU smart policies are explicitly addressed to use innovative

technologies for reducing the environmental footprint of smart cities. However, in 2014 a more recent smart city definition emerging appears to be more focused on ICT than on environmental issues [10].

Also, Municipalities implementing smart strategies issue their own definition. Amsterdam, generally considered the first smart city in the world, defines a smart city considering both infrastructures and people, and especially the quality of life for every citizen [11]. Copenhagen defines a smart city especially in terms of networks, data and information, ICT and digital services [12].

Also companies working in the smart city sector issue their own definitions, but they try to orient the smart city vision towards the use of their own products and services. IBM focuses on ICT and on facilities needed to use data and information for governing a city in a smarter way. Siemens defines a smart city as an energy efficient and CO_2-neutral city, therefore focusing on environmental aspects. Ericsson especially speaks about a smart connected city; Intel suggests to base a smarter city on ICT and especially on Internet of Things; and the list could continue. Figure 2.2 nicely summarizes the multidimensional aspects of the smart city definition.

Dameri [13] summarizes these and many other definitions putting together both the technological and the institutional aspects, and introduces some other elements, such as: the role of good city governance, the territorial component and the social and inclusive aims of a smart city.

All these definitions outline the innovative role of a smart city; as a city is necessarily a territorial system, a smart city emerges like an innovation ecosystem, that is "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" [14]. However, the condition to realize such an ecosystem is that all players would act in synergy each other.

Fig. 2.2 Smart city definition: a multidimensional approach!

Several papers analyze the smart city like an ecosystem, based on the triple helix model joining all the players and stakeholders involved in the smart city implementation, i.e. local governments, universities and private corporations.

Leydesdorff and Deakin [15] in their paper try to demonstrate how the triple-helix model enables the study of a smart city like an innovation system. Lombardi et al. [16] suggest a modified model of a triple helix focusing on the production of knowledge by universities and government and the production of innovations that are patented by industry and universities as an index of intellectual capital in smart cities.

Figure 2.3 depicts the triple helix mechanism in smart cities. Three actors are included into the model: university, industry and government. University is more involved in the first steps, especially addressing the definition of fundamental aspects of the smart city and their embedding in intellectual capital, to be further used to support smart projects. Industry has a pivotal role, supporting the codesign of smart technologies and infrastructures. Firms are mainly involved in the second phase: they collect the academic outcome transforming them into products and services. Their aim is especially to create value, but in the meantime they produce also public wealth for citizens. Government plays a fundamental role in the third phase, when smart city enters its maturity. After the pioneering steps, government should define standards and issue rules. Moreover, the government role regards also the monitoring and evaluation of value and benefits created and delivered by other subjects and by the smart city program itself. Government support and implement also the smart government, an evolution of participated governance aiming at social, cultural and environmental outcomes.

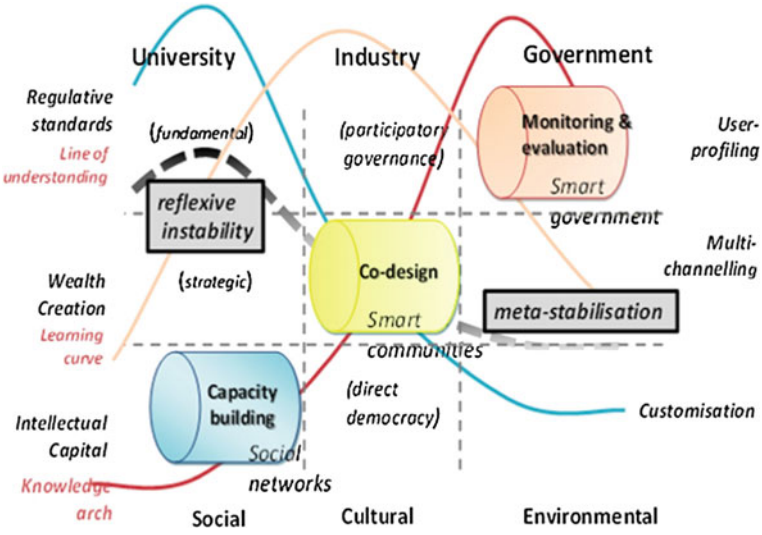

Fig. 2.3 Triple helix in smart city. *Source* Leydesdorff and Deakin [15]

Zygiaris [17] studies the role of smart city notion to transform the urban areas into green, interconnected, instrumented, open, integrated, intelligent and innovative cities. His *Smart City Reference Model* tries to generalize the different shapes and sizes of smart cities all over the world, focusing on addressing global sustainability challenges at local level. This reference model especially addresses the city conceived as a multilayer innovation ecosystem, where different actors play their own role in an integrated way to pursue shared goals.

The city's ability to raise innovation is especially based on knowledgeable and creative human capital [18, 19]; therefore, the terms smart city and knowledge city or intelligent city are often considered as synonymous, even if they not ever are [20].

In all these cases, the smart city emerges like a complex system, where both heterogeneous actors play a pivotal role and several components are strictly interrelated to each other. To give a framework to this complexity, some authors design a smart city model suggesting a framework to explore all the smart city components and their relations.

Giffinger et al. [21] design six smart dimensions that are nowadays the most used to define the smart city components. They are: Smart economy, Smart mobility, Smart environment, Smart governance, Smart people and Smart living. Chourabi et al. [22] define a smart city model built on two levels: in the internal level, Technology, Organization and Policy directly influence the smart city initiative; in the external level, People Infrastructure, Environment, Technology and Governance put their direct influence on the internal components. Nam and Pardo [8] suggest a smart city model like a complex system deriving from the interactions of three dimensions: Technology, People and Institutions.

All these models are useful to understand what a smart city is and how much different subjects involved in the smart city implementation converge or diverge in their own smart city vision. A shared smart city vision is indeed the premises for successful and synergic smart city programs involving all the triple helix subjects and to transform a smart city in a veritable innovation ecosystem.

2.3 Research Method

This paper aims at understanding and comparing the smart city vision of the three key actors—university, industry and government—composing the triple helix, whose activities support the smart city implementation. The research method is based on a deep content analysis conducted on a selected subset of both scientific and nonscientific documents published during the latest twenty years. This choice derives from the observation that the smart city concept evolves along with two different paths, not ever coordinated each other: scientific research and empirical implementation [23]. Therefore, scientific papers furnish the proof of theoretical evolution of the smart city concept and nonscientific papers collect the case studies of implemented smart projects all over the world.

The paper collection has been made differently for scientific and nonscientific documents:

(a) scientific documents have been searched on Scopus database between April and May 2015 requesting to the system to search the keywords "*Smart City*" in the title and in the abstract of contribution. Thereby, the scientific documents found were 264 and they included only English academic papers published within 1995–2015 range. Afterwards, the author analyzed the paper containing the most cited smart city definitions;
(b) nonscientific documents have been searched on Google in November 2014 requesting to the system to search on the web the keywords "*Report*" *AND* "*Smart City*". The result of this research showed many reports concerning smart city, the author selected the most important industrial and institutional reports issued by the following institutions: Between [56], Ericsson [26], Forrester [34], IBM [42], IDC [23], Gartner [29], Mc Kinsey [43], Boston Consulting Group [27], Cassa Depositi e Prestiti [30], European Commission [28]), EU-Setis [9], California Institute [24], UK Government [44], Anci Cittalia-Forum PA [54].

Collected documents have been classified depending on the nature of their issuer: public body, university or private company. The content is further analyzed applying the Nam and Pardo Smart city model (see Fig. 2.4), chosen because it designs the smart city model on three dimensions, Technology, Institutions and People, well representing the multilayer architecture of a smart city and the interests

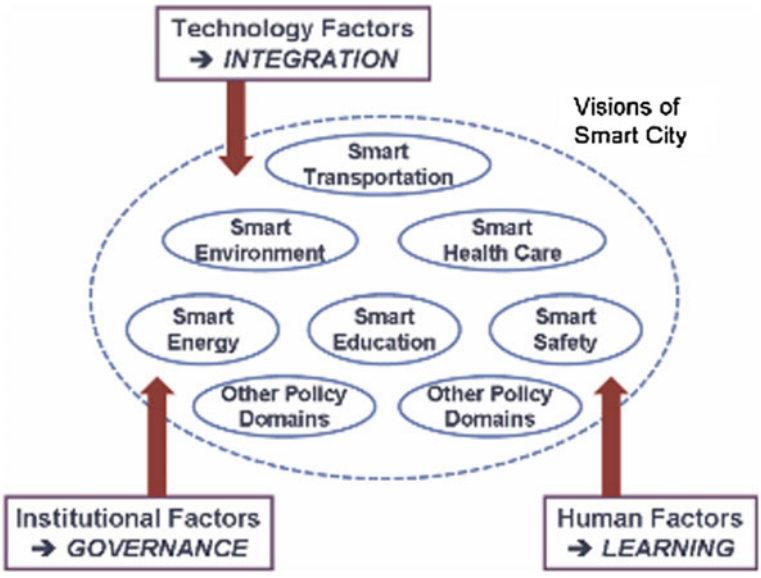

Fig. 2.4 The Nam and Pardo smart city model [8]

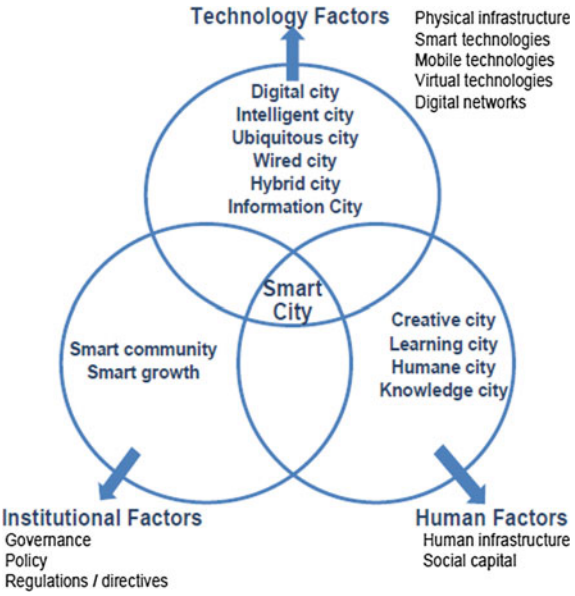

Fig. 2.5 Smart city core components [8]

of the three key actors—public bodies, universities and research centres, and private companies [8].

The analysis is then executed using manual coding and applying the keywords representing the Nam and Pardo dimensions. Finally, contents are compared respect to these three dimensions to understand if and how much the key actors share or not the same smart city vision.

In the following paragraphs, the results of this survey are shown analyzing and comparing the contents of the selected documents.

Box 1. The Nam and Pardo's Smart City Model

This theoretical model tries to understand when it is possible to consider a city a smart one, considering a set of multidimensional components. Indeed, several cities affirm to be smart, defining themselves with this label. However, the lack of a scientific and shared smart city definition prevents to clearly state what a smart city is; to be smart is considered virtuous by city councils and it multiplies the use of the smart city label, not ever in a justified way; and cities all over the world are starting to implement smart initiatives, following their own smart city vision and specificity, generating a various and jeopardized smart panorama.

After examining the most cited smart city definitions and a long list of smart city implementations, the Nam and Pardo smart city model has been chosen as it pinpoints the core components of a smart city and the strategic directions for realizing the better smart city implementation.

The authors identify three smart city core components (Fig. 2.5)

- Technology factors, including all the facilities supporting the physical smartness of a city, both physical infrastructure and ICT;
- Institutional factors, represented by the capacity and instruments for well governing the city;
- Human factors, regarding the citizens and their capability to innovate, learn and form the city's human capital.

Each factor is derived from a subset of smart city definitions and conceptual relatives of smart city.

To successfully implement a smart city, it is necessary to pursue three strategic directions concurrently (see also Fig. 2.4)

- to integrate technologies: a smart city goes beyond technology, the crucial role of technology in smarter city could produce its effect only when integrated into infrastructures, services and human behaviours;
- to govern the institutional factors: the support of local political bodies is imperative to design and realize a smart city effective initiative, also involving and coordinating diverse players and stakeholders, and establishing an administrative environment;
- to learn: even if sometimes the role of technology appears to be the pivotal aspect of a smart city, citizens are the real core component, not only because they should be the real addresser of each smart city program to improve their quality of life, but also because they should participate and cooperate to improve the smartness of their city thanks to creativity, social learning and education.

2.4 The Comparison of Smart City Vision Among University, Industry and Government

At a glance, it seems that all the aforementioned actors share the same vision of the smart city: a new way to understand the city of the future [5, 11, 15, 16] to realize economic sustainability and social inclusion, preserving the environment [17–20] with the aim to improve the quality of life of citizens [6, 9, 21, 22].

However, each category of actors has different aims and these aims influence their smart city vision. The content analysis permits to compare not only several smart city definitions, but also aims, components and instruments included in the smart city vision defined by each category of actors and to understand if and how much these visions are similar or different each other. In the following, smart city ideas are compared respect to the three core factors: technology, institution and people.

2.4.1 Technology Factors

Technology is one of the most important enabling factors to implement a smart city. Authors especially consider ICT like the main enabler of a smart city [12, 14]. Thanks to high technologies such as Smart Computing [23, 24], it is possible to support traditional hardware and software interaction [25], to collect data from the urban sensors and to deliver real-time information to support better decisions [26]. These technologies need an adequate ICT infrastructure, including broadband, optic fibre, Wi-Fi networks, wireless hotspots [27, 28]. Technology and infrastructures are therefore the premises to create a smart city [14, 29].

With respect to technology, the examined three key actors have different ideas.

Universities and Research centres develop and experiment the use of innovative technologies in urban areas and study their delivering cost and benefits. Researchers aim to finally transfer their technological knowledge to solution vendors for their concrete application [4]. Research activities regard both positive and negative impacts of such technologies on citizens' quality of life. On the one hand, technology is examined as a positive factor able to support and improve the quality of life [3]. On the other hand, doubts arise as regard as the real capability of technology to positively change the daily life of all citizens, especially thinking at digital divide [30, 31]. Sometimes implementing ICT in smart cities could generate several problems, such as a reduction in ICT security and data privacy, high cost of implementation and low returns [32, 33]. Universities generally study the most innovative technological solutions, but not ever these solutions are suitable to the smart city and especially to a large number of heterogeneous users; instead they are niche solutions useful for few recipients.

Private companies play the role of technology enablers [26, 34]. They project and implement the smart city technological infrastructure; obviously each of them is especially focused on its own technological products and solutions, i.e. smart transport, smart energy systems, ICT systems, healthcare solutions, efficient building and so on [23, 27]. Overall, they try to implement the most profitable solutions, conditioning the prioritization expressed by local governments and better suitable with the citizens' needs.

Advisors and consultancy officers are involved in studying the better technological solutions for the smart city implementation; they are the link between the innovative solutions suggested by universities and the vendors able to produce technical facilities [26, 35, 36]. They offer their knowledge and competencies to support local governments in smart city strategic planning, economic evaluation and estimate, technological prioritization about the best smart solutions to be implemented for the first [23].

Local governments are involved in planning and implementing the smart city; they generally play the director role, coordinating all the other players in their own territory [37]. A local government establishes relationships with private companies charged to implement technical infrastructure and smart technologies; the most applied instruments for supporting these relationships are public–private

partnerships (PPP) [7]. Municipalities and also the central governments are required to rule all the new topics emerging from the smart technologies implementation, such as the security and privacy requirements for cloud computing, the open data rules and so on [32, 38].

This survey shows that the three smart city key actors are playing an interconnected role in implementing smart cities, sharing some basic concepts but pursuing their own goals. The analysis of a large set of smart projects in some champions smart city [39] and the direct involving of the author in a Municipal government reveal that the key actors are sometimes in synergy, sometimes in conflict each other. With respect to the Technology factor, their ideas regarding the smart city—emerging from both the examined documents and the empirical observation—are quite different and confrontational for the following reasons:

- universities and research centres consider smart city like an innovative place where to implement their pilots and experimental solutions, sometimes neglecting the digital divide, the difficulties in funding innovative facilities and the lack of competences in Municipalities to manage the highest innovation;
- private companies try to force Municipalities to prioritize their own technical solutions, without paying enough attention to the real needs of citizens and offering standard systems, instead of projecting ad hoc solutions for a specific urban area;
- Municipalities are trying to transform cities in smart cities, but both political bodies and public managers and officers often are not capable nor to define strategic planning for the smart city implementation, nor to manage the change program; the topic is too much immature and new, and public bodies need official education and support from the central state to face such a complex topic.

From this survey, it emerges also that all the actors are not enough considering the role of knowledge and human capabilities in using smart technologies. For this reason, two situations occur:

1. solution vendors mainly suggest the implementation of technologies not requiring the citizens participation (such as smart public lighting, reducing energy consumption but impacting remotely on the citizens' quality of life) [10];
2. innovative technological solutions are implemented, but scarcely used; in this case, the impact on the citizens' daily life is minimum, because the rate of use is very low [25].

Box 2. IBM for Smarter Cities

IBM is a global player offering ICT solutions and strategies to large companies, governments and institutional bodies all over the world. From 2009, IBM has been working for designing its own smart city vision, connected with its products and services portfolio. A smart city is conceived like an

integrated urban strategy capitalizing on new technologies and insights to transform its systems, operations and service delivery.

Cities are seen like competitors to engage and attract new residents, businesses and visitors, requiring constant attention to providing a high quality of life and vibrant economic climate. Forward-thinking leaders recognize that although tight budgets, scarce resources and legacy systems frequently challenge their goals, new and innovative technologies can help turn challenges into opportunities.

At the core of a smart city strategy, IBM puts some most innovative ICT technologies such as: transformative possibilities in using big data and analytics for deeper insights; cloud for collaboration among disparate agencies; mobile to gather data and address problems directly at the source; social technologies for better engagement with citizens.

All these aspects are connected into an integrated framework including all the aspects of the daily life in city. The framework recalls the Nam and Pardo's smart city model, as it considers not only the important role of technologies, but also the imperative participation by people and institutions.

Figure 2.6 shows the IBM Smart city vision: it revolves around three core aspects, that are, planning and management, infrastructure and people. Depending on IBM, no Smart city can success without the capacity to plan and manage projects and facilities. Therefore, IBM offers instruments for supporting city planning, local administration and more specific management tools applied to public buildings or safety. Infrastructures are the physical layer of a smart city, and IBM addresses both natural resources such as water, and human artefacts such as energy plants or transportation. Finally, people are the final stakeholders of the Smart city initiative: human aspects are synthesized through education, health and social inclusion.

IBM do not only supply technological applications: it offers integration and strategic partnership. In 2014 Frost & Sullivan awarded IBM the Global Best-in-Class smart city Integrator. It recognizes the winning IBM's vision of a Smarter Planet driven by the 3 'I's:

- Instrumentation;
- Interconnectedness;
- Intelligence.

2.4.2 *Human Factors*

Human factors regard the role of people in smart city. Smart citizens and communities play a pivotal role, both because they are the main addressees of smart initiatives, and because their involvement and participation is often required for the

Fig. 2.6 IBM Smart city framework [42]

complete success of a smart project [11, 14, 40]. The Human factor is considered not only with regard to the citizen participation, but also regarding the human and social capital existing in a city and knowledge, culture and values characterizing a community [6].

With respect to this factor, key actors have some shared basic ideas and different points of view.

Universities and research centres recognize the role of a smart city program in supporting the human factor development, by attracting talented people [41], developing work and entrepreneurship [11, 17], settling excellent schools and universities [21]. Universities coined the phrase "Smart people" just to outline the role of citizens in the smart city implementation success [18].

Private companies consider people like the addressees of their technological solutions. Therefore, companies and advisory officers often have been settled where the local community is more interested in smart projects, offering their technological solutions or consulting. For example, in China large companies such as IBM are finding fertile ground for their business, in cities strongly oriented towards smartness. To have success, companies need to invest in smart employees, educating their work force to the smart city vision [42]. Private companies represent therefore an enabler factor for smarter people, attracting talented workers, educating employees and inducing the settling of better schools and universities [10, 18, 33, 43].

Public bodies should create the better conditions for implementing a smart city for all, reducing digital divide and promoting smart social inclusiveness. A key role for these aims has been played in Europe by the European Commission with acts such as the European Digital Agenda [44–46].

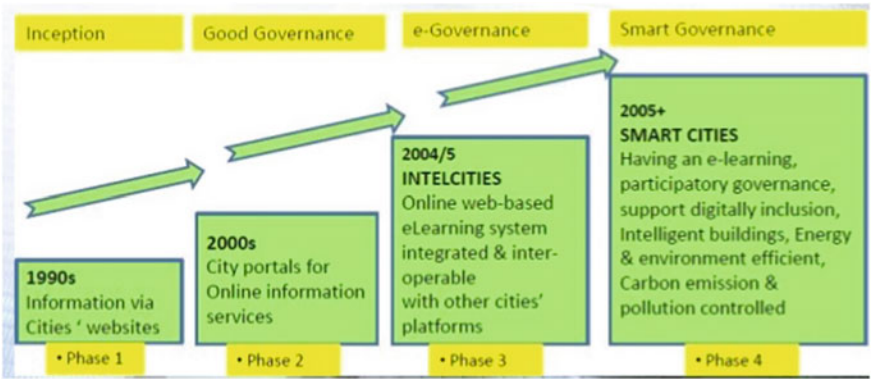

Fig. 2.7 The human role evolution in smart city governance

However, the smart city has been developing especially like a bottom-up phenomenon [47], where the citizens themselves have been the main characters in the smart city implementation [48]. People are moving independently from the governments, cooperating and implementing their own smart solutions; governments should enforce their role, promoting the citizens' involvement and participation in smart city planning, coordinating all the initiatives to gain higher synergies [49].

Box 3. The Role of Human Capital in Smart City Development

The smart city innovative strategy is a global trend, somewhere pursued by each city for itself, elsewhere pursued by the central government and for supporting cities in implementing a national-style smartness. For example, the Government of India launched in 2015 a big national program called Smart Cities Mission [www.smartcitiesindia.com]. This program aims to develop 100 cities all over the country making them citizen-friendly and sustainable. Smart cities are projected to be equipped with basic infrastructures and will offer a good quality of life through smart solutions. Assured water and power supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e-governance and citizen participation along with safety are some of the likely attributes of these smart cities.

The human role is played at the core of this urban strategy (see Fig. 2.7). It is based on three levels:

- Social capital, developed thanks to infrastructure and connectivity for shared data and information;
- Human capital, based on community intelligence and knowledge, aiming at creating a competitive environment for business-led urban development;
- Participatory governance: inclusive approach towards social and environmental sustainable city.

The human role in city governance has been evolving from 1990s to nowadays, thanks to ICT. Until 2005, citizens have been involved thanks to city portals, websites and only recently through interactive platforms. The new trend considers the citizens' involvement based not only on technological platforms, but especially on learning, participation, information and knowledge sharing, inclusion.

2.4.3 *Institutional Factors*

With the phrase "Institutional factors" Nam and Pardo [8] mean the set of actions forming the smart city governance; they individuate the following smart actions: collaboration, cooperation, partnership, citizen engagement, participation. Institutional factors therefore enable the multi-stakeholders smart city, supporting interactions and communication amongst all the players. Also in this case, the three key actors have different visions about this component.

Universities and research centres coined the phrase "smart governance" to outline the pivotal role played by governance in realizing a successful smart city [6, 21, 37]. During the latest years, academic papers suggest the importance of a comprehensive governance by both local and central governments, aiming at designing an urban smart strategy [51, 52]. This vision suggests a top-down path for implementing the smart city, where the government plays a central, directive role.

Private companies suggest a mix solution between top-down and bottom-up approach [50]. Indeed, the top-down approach does not consider enough the citizens' needs and preferences, the bottom-up approach lacks of coordination and often is nor efficient nor effective [53, 54]. A mix solution could balance strengths and weaknesses of both the approaches.

Public bodies are often driven by financial constraints instead of by smart city vision; local governments are influenced by funding policies by national or supranational bodies and sometimes lack of their own smart city plan. In Europe, for example, the European Commission defines the guidelines to pursue and implement a smart city, sustaining its own priorities with large financial amounts and influencing the local choices. However, the EU does not define common goals for the smart city and for this reason results are heterogeneous and lack of synergies [2, 10, 46]. Also private companies adhere to this trend, as EU funds can support the purchase of smart solutions from technology vendors [9, 33, 42]. This situation reduces the importance of governance aspects, such as citizen engagement and participation [15]. A crucial role in supporting the citizen's role in smart city is played by the so-called civil society, for example association, foundations, observatories and so on. They are playing a central role in sharing and communicating the smart city idea suggesting more participated and people-centred smart city models [53].

Box 4. The Role of Institutions in Promoting Smart City Excellence

The recent trend of "smartization" regarding cities all over the world has generally produced a plethora of smart solutions not harmonized each other neither at country level nor at city level. However, as several authors claim, the institutional direction is necessary to create a smart environment able to sustain the effective implementation of smart city strategies. Central or local government should create administrative processes and a governance framework for really develop smarter cities and obtain social and economic returns from smart investments.

The pivotal role of institutions in supporting smart city development has been well understood by the UK Department for Business, Innovation and Skills (BIS) for bringing together all UK smart cities and creates positive synergies from their individual experiences and best practices.

The project is based on two main pillars:

- The definition of standards for all the UK's smart cities, to support their understanding of smart strategies and orienting their decisions in a better way;
- The link between smart city programs leaded by local government and smart city initiatives lead by private companies, to accelerate urban ideas to market, to grow the economy and make cities better.

The project is developed thanks to the joint venture settled by the BSI—British Standard Institute, and the Future Cities Catapult, an accelerator provide world-class facilities and expertise to support the development of new products and services, as well as opportunities to collaborate with others, test ideas and develop business models in the urban field of study.

The output of the project is a set of standards covering all the phases of the smart city development path, from the understanding of what a smart city is, to the evaluation and performance measurement of obtained results.

At present a subset of standards has already been published. It covers the smart city concept and Vocabulary, the Decision-making framework supporting the strategic definition and the Process framework for implementing smart projects; the Performance assessment method has been published only partial.

Further steps regard the publishing of other standards for smart cities, about technical specification (Collaboration procurement, IoT, Open data and so on), Business case and Model for funding (Fig. 2.8).

The final aim of the project is to bring together cities, key industry leaders and innovators to cooperate in identifying the challenges facing cities, providing solutions to common problems and defining the future of smart city standards.

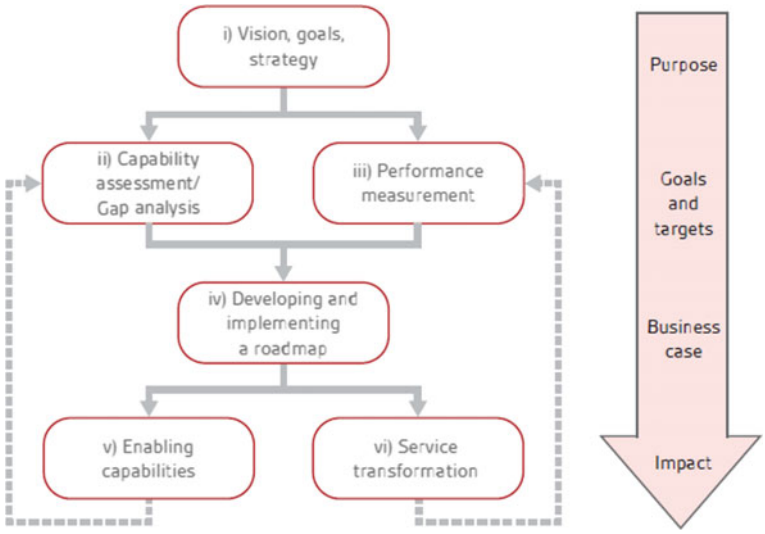

Fig. 2.8 The smart city standards [58]

2.5 Conclusions

Our survey permits to discover the different orientation that three key players have towards the smart city concept. Both scientific papers and practitioner reports reveal the presence of a triple helix, as theoretical defined by Lombardi et al. [16] or Deakin and Leydesdorff [15], even if each key player has different aims: research and knowledge spreading for universities, business and profit for private companies, local well-being and political consensus for public bodies.

Different aims synergetic linked together should drive the smart city towards its veritable final aim, that is, the quality of life for citizens. However, our survey shows that people not ever are at the core of the smart city efforts and key actors are more interested in pursuing their own objectives than to reach the common good.

Several institutional reports or empirical survey outlines that people are few aware about the smart city projects occurring in their city [54, 55]; it generally depends on the lack of local initiatives by the key actors to inform and support the use of smart devices and services [56, 57].

The comparison amongst all the papers and reports included in our survey reveals that the first stage of smart city implementation is not more suitable for the future. If in the pioneer phase a spontaneous, bottom-up wave has been useful to stimulate innovative and original initiatives, now the smart city needs comprehensive, integrated strategies to support long term, profitable and effective smart projects. The analysis of reports collecting smart projects in Italy or Europe [6, 10, 21, 54] outlines that until now smart initiatives are heterogeneous, unfocused, less effective, regarding few people, poorly funded. Without a central direction,

coordinating the interests of all the key actors with the stakeholders' expectations and needs, the smart city will remain an interesting innovative laboratory, but failing in creating public and private value for everybody in the long term. An effective strategic planning, based on a shared smart city definition collected by the participation of both key actors and stakeholders would be the right basis for a long lasting well-being in smarter cities.

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Chapter 3
Using ICT in Smart City

3.1 Smart City Is an Emerging Topic

Smart city is a topic having increased its importance all over the world during the latest ten years [1]. The main reasons are to be found in the urbanization interesting all the countries and continents, and in the continuous increasing of the number of people living in urban areas. The urban population in 2014 accounted for 54 % of the total global population, up from 34 % in 1960, and continues to grow. It is estimated that by 2017, even in less developed countries, a majority of people will be living in urban areas (Global Health Observatory). Projections show that urbanization combined with the overall growth of the world's population could add another 2.5 billion people to urban populations by 2050, with close to 90 % of the increase concentrated in Asia and Africa [2].

Figure 3.1 shows the distribution of people living in cities and the larger cities in the five continents. Both the number and the percent of urban population have been increasing during the latest 60 years and the trend is expected to continue.

Managing urban areas has become one of the most important development challenges of the twenty-first century [3]. Success or failure in building sustainable cities will be a major factor in the well-being of people all over the world. If well managed, cities offer important opportunities for economic development and for expanding access to basic services, including health care and education, for large number of people. Providing public transportation, as well as housing, electricity, water and sanitation for a densely settled urban population is a need to be accomplished, but taking concurrently into account the impact of human activities on the environment.

Cities are therefore places where economic development and cultural richness, but also traffic, congestion, difficulty to access to public services and pollution coexist, impacting both positively and negatively on the citizens' quality of daily life.

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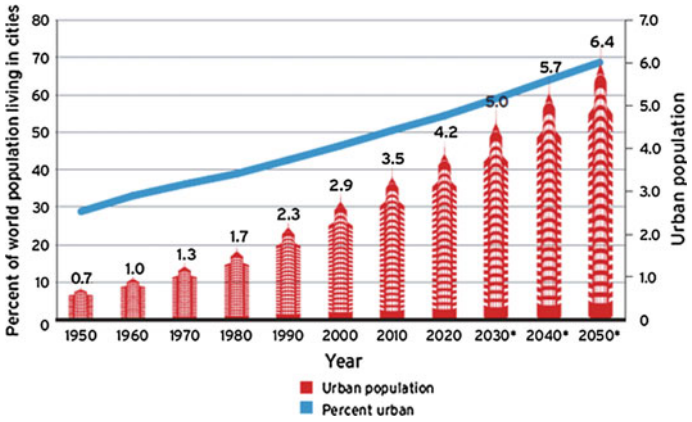

Fig. 3.1 Urban population and percent of urban population, all over the world. Source: United Nations [2]

Smart city is considered like a crucial urban strategy to face these problems, preventing pollution and congestion and supporting innovation, economic development and inclusion in the meantime [4]. However, it is not simple to say what a Smart city is. A recognized definition of Smart city has not been written until now, even if some aspects often emerge like must-to-be components for smarter cities, for example ICT. ICT is also the core component of other urban strategies, named Digital city, Wired city, and so on. As ICT is a fundamental driver of smartness in cities, to better understand its role and contribution is a critical success factor. This work aims to analyze how ICT pervades smart city initiatives, also evaluating its weight and pervasiveness in realizing digitalised urban areas.

3.2 Smart City Is a Global Trend

Smart city is described like an urban area where technology and a participated governance aim to improve the citizens' quality of life and concurrently reduce the city environmental footprint, preserving natural resources [5]. City is the subject, high technologies and governance are the instruments and people and the environment are the addressers of strategies acting in the urban area with a very large scope, including mobility, urban infrastructure, social policies, culture, economic development and so on (Fig. 3.2).

Smart city roots are faraway in the time, but only from 2010 the topic had a boom [6]. We can find the reason of this explosion of interest in several causes, such as: the increasing urbanization, the diffusion of smart phones and other smart devices that support a wired city, the EU funding for research and pilot projects aiming at using the most innovative technologies to reduce the urban footprint on the environment and the CO_2 gases emission, and so on.

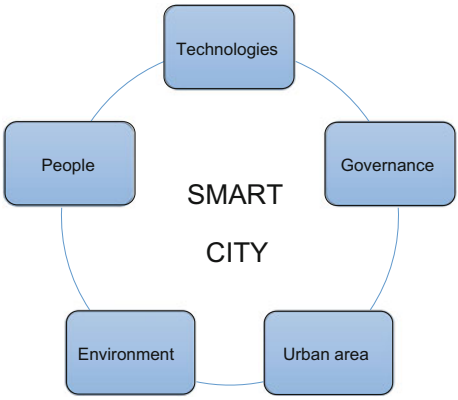

Fig. 3.2 Smart city components

This high interest regards both the theoretical studies and the real implementation of smart cities all over the world. A survey about scientific papers indexed on Scopus shows that papers with the words "smart city/ies" both in the title or as keywords in 2014 accounted for 532, up from 1 in 1997, but also up from 18 in 2010: it means that the number about this topic has been increasing exponentially in the latest four years (Fig. 3.3).

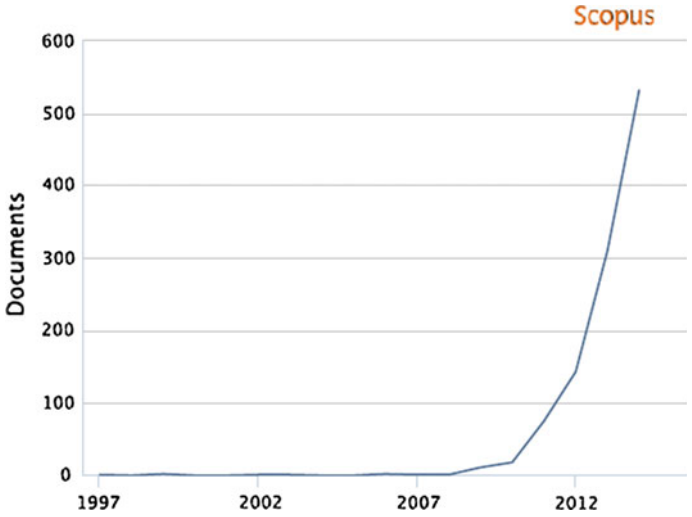

Fig. 3.3 Paper indexed on Scopus with the words smart city/ies in the abstract or as keywords, from 1997 to 2014. *Source*: Scopus.

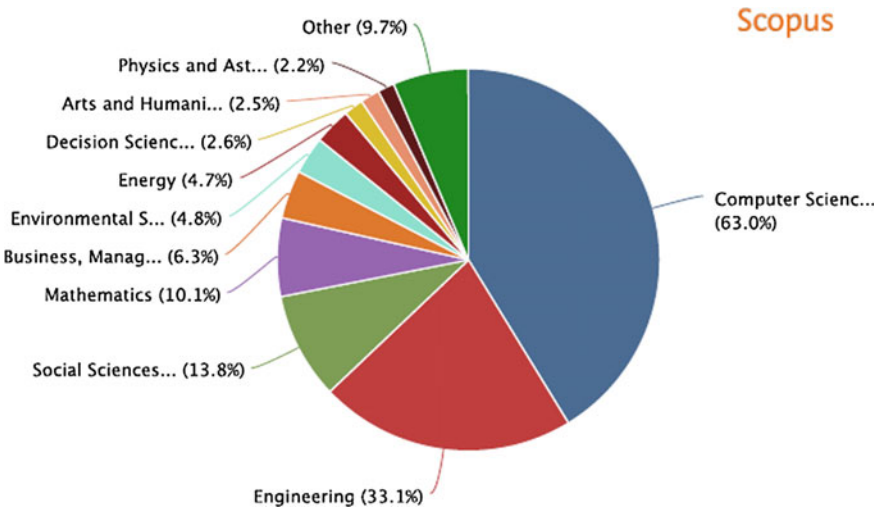

Fig. 3.4 Paper indexed on Scopus classified by subject area. *Source* Scopus

The survey shows also that papers about smart cities are published in academic and scientific journals of all the human field of knowledge [7]: not only Computer Science (accounting for 63 % of papers) or Engineering (accounting for 33 %), but also Social science, Business and Management, Environmental Science, Art and Humanities, and so on. Several papers are classified in more than one field of knowledge: it outlines the interdisciplinary nature of the Smart city research (Fig. 3.4).

The research interest affects also the smart city implementation trend. The number of implemented smart cities is continuously increasing. Even if we do not have a complete survey about the smart cities all over the world, we can find some figures supporting this fact. For example, the ICF—Intelligent Community Forum names each year the Intelligent Community of the Year, selected amongst 21 nominated cities or metropolitan areas. The ICF nomination is awarded to communities or regions with a documented strategy for creating a local prosperity and inclusion using broadband and information technology to attract leading-edge businesses, stimulate job creation, build skills, generate economic growth and improve the delivery of government services. Even if these characteristics do not perfectly feet with the Smart city definition, the most of topics overlap with smart initiatives. Therefore, we can consider the number of Intelligent Communities like a proxy of smart cities. The ICF website lists all the cities nominated from 1999 until now. There are 119 cities: it clearly appears that they are spread all over the world, with a higher density in Europe, North America and Far East.

The EU Parliament has recently published a detailed report studying the smart city phenomenon in Europe [8]. The researchers examined all the 468 EU cities with population over 100,000 inhabitants within the EU28. Applying the EU

definition of smart city, they found 240 smart cities out of 468, that is, 51 % of the sample. It means that more than half cities in Europe are somewhat smart. Smart cities are differently spread in European countries, but this phenomenon is largely shared in EU28 (Fig. 3.5). Even if the report outlines that often these cities are simply implementing one or more smart initiatives, lacking a veritable strategic plan for becoming smart in all the aspects of the urban life, this percentage reveals that smart cities are a pervasive trend regarding all Europe. EU funding is certainly strongly supporting the implementation of smart initiatives, especially during the economic crisis that prevent local bodies to invest high amount of money in smart projects from their poor budgets. Nevertheless, the EU support has not only a financial role: supporting smart initiatives, EU Commission is also spreading all over the European countries, regions and cities the awareness of better metropolitan areas, based on the three pillars of inclusion, economic development and environment preservation.

Even if the technology is the core component of a smart city, a strategic vision of the city of future including environment preservation, social inclusion and citizens' democratic participation is the critical success factor for improving the quality of life in ever larger and complex cities [9]. Smart cities are therefore not only a technological project, but also a cultural program for liveable cities all over the world. Therefore, the technology and especially ICT should not be conceived like the aim of a smarter city, but the instrument to reach social, economic and environmental goals.

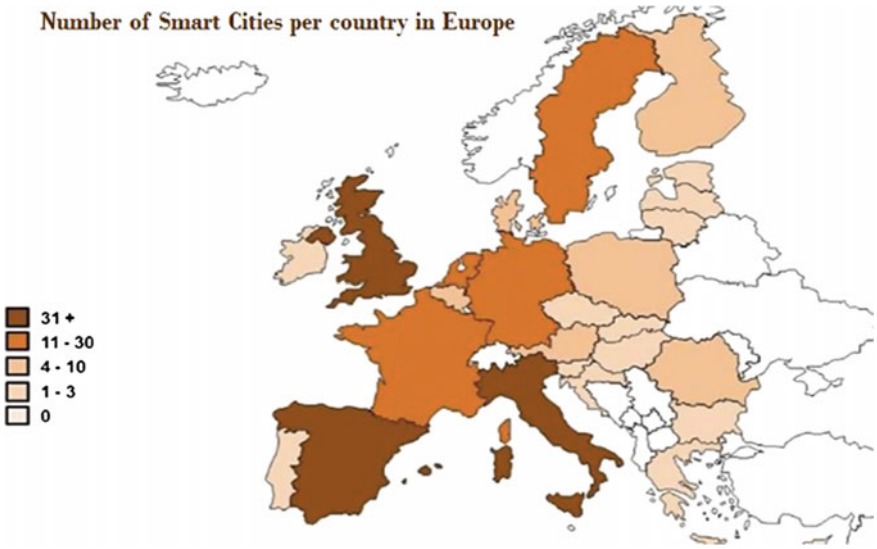

Fig. 3.5 European Smart cities. *Source* EU Parliament [8]

3.3 Smart City and Digital City Interacts Each Other

Many definitions of a city aiming at improving its smartness could be found in scientific literature, with similarities and differences depicting a jeopardized panorama [10]. Table 3.1 shows the most cited definition of what we can call "x-city", where x takes different meanings, regarding innovation and technology in city. Some of them explicitly regard the use of ICT in urban strategies, some others consider ICT only implicitly, finally other ones do not include ICT as a core component.

Several definitions regard the role of ICT in transforming the city profile in different ways. For the first, the label Digital city [15] identifies the city where ICT pervades all the aspects of the daily life of citizens. Other definitions are more focused on different aspects of being digital. For example, the labels Wired city [11] and Ubiquitous city [13] are focused on the role that ICT and especially the Internet have in connecting people, creating networks and distributing services and information everywhere and to everyone. The label Virtual city [12] better emphasizes the effect of digitalizing the city and realizing a virtual layer of the urban area, where intangible services are delivered thanks to the ICT and people connect and operate like in a second life.

The label Information city [13] is related to both ICT—the infrastructural, technological aspect—and knowledge; it indeed outlines the capacity of wired infrastructures and people to share, spread and create information and knowledge, increasing the awareness and the participation of citizens to the city life. Similarly, the Intelligent city [14] refers to the capability of a city conceived like a meta-subject to create knowledge and intellectual capital able to permeate all the aspects of the life in urban areas, from the economic to the social and cultural aspects.

Information city and Intelligent cities are only partially based on ICT or other technologies; indeed, they are similar to other labels such as Knowledge city [17] or Learning city [18], that are focused on the role and the importance of information, knowledge and culture in the quality of a city, regarding both the economic and the cultural life. In these labels, a crucial aspect regards also the relations between citizens and institutions, especially the public administration and the political bodies governing the city. ICT is not the central aim of these city visions, but an instrument for better realizing the final goal to create knowledge through both lifelong learning and information collection, processing and sharing.

Another stream of city visions regards the impact of a city on the environment. Labels such as Sustainable city [19] or Green city [20] are quite different respect x-city labels previously listed, regarding ICT or knowledge. In this case, the environment preservation and the social and environmental sustainability of the city are at the core of the urban strategies to improve the quality of life. Nevertheless, these urban strategies are somewhat based on using advanced technologies, and also ICT: for example, smart grids are at the core of green and sustainable cities;

Table 3.1 Most cited "x-city" definitions

Concept	Definition	References
Wired city	"Wired cities refer literally to the laying down of cable and connectivity not itself necessary smart"	Hollands [11]
Virtual city	"Virtual City concentrates on digital representations and manifestations of cities"	Schuler [12]
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 and Fitsilis [13]
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 [14]
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 and Fitsilis [13]
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 [15]
Smart community	"A geographical area ranging in size from neighbourhood 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 [16]
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 et al. [17]
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"	Larsen [18]

(continued)

Table 3.1 (continued)

Concept	Definition	References
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 [19]
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"	Hammer [20]

they are initiatives for applying computer intelligence and networking to electricity distribution systems, aiming at reducing energy waste and pollution.

These x-city definitions are strictly connected with the idea of a smarter city. A smarter city is conceived especially for facing the urban problems, but also to capitalize on the city strengths such as the cultural life, the economic dynamism, or creativity and beauty and craft spread in its buildings and streets. Somewhat, a smart city collects and merges all the aspects we can find in the x-cities listed in Table 3.1. Examining some of the more cited smart city definitions, we can understand how much a smart city can be seen like an idea composed by several components: knowledge, environment, technology and ICT, good governance, citizens' involvement, … In the meantime, we can understand how much ICT is still at the core of smart strategies, both directly addressed and used to support initiatives regarding the governance, the environment, the local transport and so on. We can then verify that ICT and smart city have been strictly correlated from the beginning.

In 2000, Hall studied the smart city especially focusing on two aspects: city infrastructures and services for citizens [21]. In this work, the city is seen like a body that should monitor all the physical and environmental resources to improve and preserve them, aiming at satisfying the citizens supplying them the best services, both in quality and in quantity. At that time, Hall already settled the basis of the smart city phenomenon: a crossing of material conditions and citizenship. Other cited authors who think differently, such as Hollands [11] focusing more on cultural aspects of a smart city such as entrepreneurship, innovation and intelligence; or Bowerman et al. [22] focusing on the green aspect of a smart city, careful towards the environment and its preservation.

In 2009 Caragliu et al. [5] wrote a very interesting paper analyzing smart cities in Europe. Their aim was not to individuate all the smart cities, nor to rank them, but to understand their roots and their characteristics. Also in this work, the authors focus on the two core components of a smart city, infrastructures and people. However, in this definition several aspects are clearer and better defined. Infrastructures explicitly refer to both traditional, physical artefacts and innovative technology, and the authors recall ICT like one of the fundamental components of a

smart city. People are not simply citizens, but their knowledge potential, that if well managed could create a veritable human and social capital. Smart city aims are multidimensional and include economic development, social inclusion, environment preservation and democratic government.

Other most cited authors think similarly. Nam and Pardo [23] outline the crucial components of a smart city that are technology, people and institutions. Giffinger et al. [24] describe a smart city like the interrelationship between multidimensional factors such as economy, people, mobility, government. Paskaleva [25] links the smart city effectiveness to the progress of e-government best practices. Chourabi et al. [26] evidence that the smart city is the synergy between various disciplinary areas and identify eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure and natural environment. Lombardi et al. [27] offer a profound analysis of the interrelations between smart city components connecting the cornerstones of the triple helix, involving firms, public administration and universities or research bodies.

Along with the deep and extensive academic research about this topic, also several international political institutions have been studying this phenomenon. Especially the EU Commission concentrates its funding on the smart city program: EU sees a smart city like an instrument to reduce the environmental footprint of large industrialized cities in Europe, through very specific initiatives regarding green mobility, building efficiency, renewable energy sources and low emission cooling and heating. In supporting this vision of a smart city, EU Commission has also contributed to shape a different idea of a smart city, most focused on technology than on people [8].

However, a smart city is something more than a sum of innovative technologies: it is a large urban strategy interesting a well-defined territory, all the infrastructures lying on this territory, citizens and the government and governance of all the city components [28]. A strong strategic vision should support a long-term smart program, aiming not only at preserving the environment or at increasing technological innovation, but also at improving the citizens' quality of daily life.

In this comprehensive vision of a smarter city, ICT plays a central role. Not only the smart city has its root in the digital city, but also the digital city is the core part of the smart city; ICT is somewhat innerving a smart city in all its aspects. We can compare Smart city and Digital city definitions, to discover that (Fig. 3.6):

- sometimes, smart city and Digital city are considered as the same thing (a);
- sometimes, smart city and Digital city are conceived like different things, but overlapping respect to the use of ICT (b);
- some other times, smart city is conceived like an evolution of the digital city, gradually including further aspects beyond ICT (c);
- finally, sometimes digital city is seen like a subset of smart city, that is, the part regarding the use of ICT for delivering public and private services and for connecting people and institutions (d).

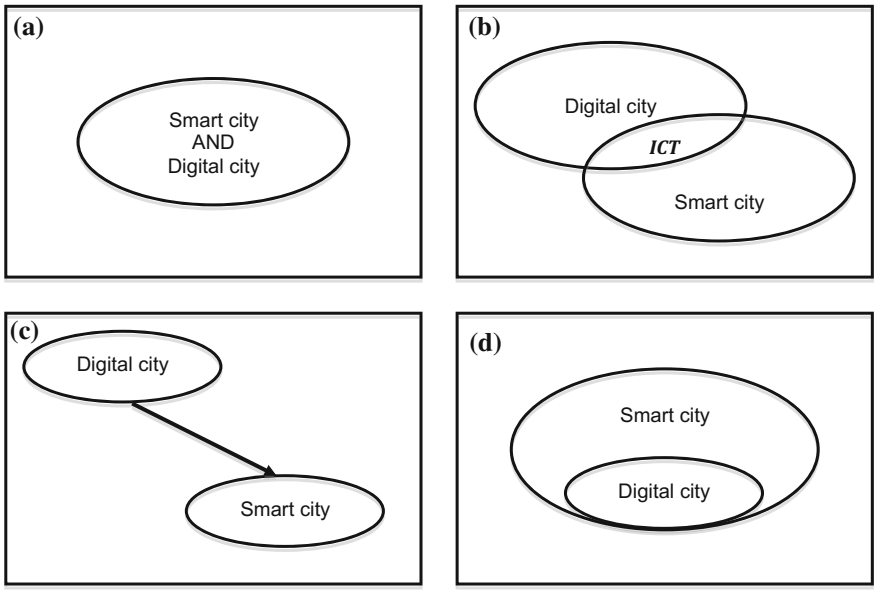

Fig. 3.6 The relationships between Smart city and Digital city

For the first, several aspects of the Digital city are the same in the Smart city: the territory to be addressed, the role of people and government, the aim to improve the quality of life offering public and private services to citizens, as it emerges from the most cited definitions [5, 24, 29, 30]. Second, the number of studies regarding the digital city has not being increasing from 2010, as it appears absorbed in the smart city field of studies [6]. Third, a deep analysis of most cited papers about smart city reveals that the ICT component is often at the center of smart projects or of the comprehensive smart strategy for the urban area. For example, Nam and Pardo referring to technology implicitly recalls ICT [23]; Karnouskos and De Hollanda focus their idea of smart city on software components [31]; Su et al. refer to a smart city based on the digital city [32]; Schaffers et al. [33] link the smart city success to the Internet; and the list could continue.

Therefore, a smart city is strongly based on ICT and the aim to improve the citizens' quality of life is pursued also using ICT in all the multidimensional aspects of a smarter city. As a smart city is a complex and multidimensional strategy, ICT pervades a smart city in very different ways. Figure 3.7 tries to synthesize the relationship between smart city and digital city, or better, between the digital infrastructure and the physical infrastructure of a smart city.

ICT pervades a smart city with two types of instruments: Digital infrastructure and Data and Information processing. Digital infrastructure regards the hardware layer of ICT in cities: broadband, cables, and more generally all the facilities used for connecting the city. These facilities recall the label of wired city and ubiquitous city.

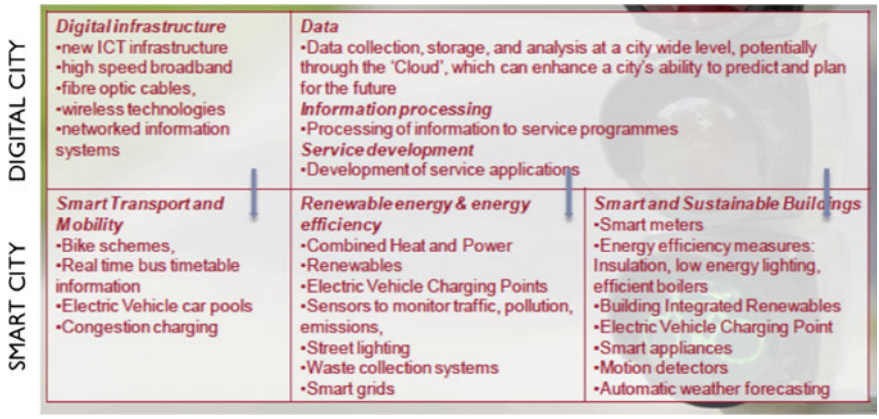

Fig. 3.7 Digital city pervades smart city

Data regards the intangible aspect of ICT, even if implemented through physical instruments: for example, database, but also data analysis and information about the city, the cloud spreading data and information to the citizens. Information processing regards the apps available for processing and using data and information in a flexible way for each person, but also apps for delivering public and private services.

ICT is used to implement also smart city initiatives, regarding several aspects such as:

- Smart mobility: ICT is used to collect, process and spread information about the traffic in city, but also to implement Intelligent transport systems;
- Smart energy: ICT is used to manage and automate the production, consumption and delivery of energy, optimizing the use and reducing waste and pollution;
- Smart buildings: several ICT instruments can be used for optimizing both public buildings and private dwelling especially to reduce energy waste and consumption.

The framework showed in Fig. 3.7 explains how ICT is not a separated dimension of a smart city, but a pervasive element of all the smart city dimensions, regarding transport and mobility, energy, buildings. New research questions therefore emerge from this framework: how and how much ICT contributes to improve the citizens' quality of life in smart city programs? How is it possible to assess and measure this contribution?

To measure the ICT contribution in smart projects is central not only to understand the relationship between smart aims and digital components, but also to support political and business decisions in choosing, prioritizing and better planning smart initiatives.

3.4 Evaluating ICT Role and Impact in Smart City Initiatives

Given the pivotal role of ICT in realizing smart city projects and initiatives, a deeper analysis should understand how and how much ICT contributes in differently shaping citizens' daily life in cities, improving their well-being. These arguments need to be studied separately.

Indeed, one thing is to speak about the ICT role in defining a smarter city and its pervasiveness in smart initiatives. It regards respectively: (a) how and how much ICT is the leading technology in smart projects, and (b) ICT as the pervasive and supporting technology in projects regarding different aspects of a smart city, such as a Smart Mobility program using ICT to govern public transport networks, or a smart energy projects using ICT to govern energy smart grids. This evaluation means to count or assess the ICT weight in smart city, conceived like an input (for example, quantity of people using broadband) or an output (the number of e-services delivered by the Municipality).

Another thing is to speak about how and how much ICT plays its role in generating public and private instruments, artefacts or services able to change the daily life of people living in cities, generating benefits and finally a higher well-being. This evaluation is seen like the final outcome of the smart city and measured especially in terms of impact or tangible and intangible benefits for citizens.

3.4.1 ICT Role and Pervasiveness in Smart City Initiatives

The most of authors studying smart city agree in involving several aspects of the urban life in this large topic [4, 11, 12]. Smart city is a cross urban strategy, regarding both physical components of a city and human and political aspects [13, 14]. Until now, almost all the European smart cities have been implementing their own smart initiatives putting in their agenda some projects with a smart content especially responding to EU requirements and obtaining EU funding. Also solution vendors and consultants have been supporting the smart city wave, driving urban innovation especially focused on some topics such as e-government, public administration digitalization, green energy. The result is a strong bottom-up movement producing a plethora of projects not ever coherent with each other and collected in non-formalized project portfolios. The analysis of these smart city portfolios, when realized and available, is very useful to understand what a smart city includes into its scope and how many projects are pervaded by ICT.

To analyze smart city portfolios, the author suggests a framework to support and classify the role and weight of ICT in smart city projects. Figure 3.8 explains the criteria adopted for this survey.

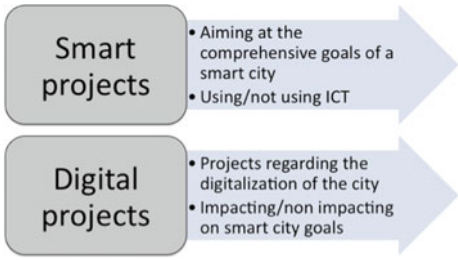

Fig. 3.8 Smart and digital projects taxonomy

All the projects have been classified as:

- smart projects, aiming at some typical smart goals such as reducing greenhouse gases, improving building energy efficiency, improving the use of renewal energy sources; smart projects are further classified in using or not using ICT: for example, a solar energy smart grid can use ICT to govern the best energy production and delivery, planning a new park in the city center positively impacts on the environment without using ICT;
- digital projects, aiming at the digitalization of the city; digital projects are further classified in projects impacting or not impacting on smart goals: for example, an app on smart phone informing trucks about the traffic around the city center impacts on smart goals, the digitalization of internal processes of the Municipality does not impact on the smart goals of the city.

This classification produces four categories of projects:

1. smart projects, not using ICT;
2. smart projects, based on the use of ICT;
3. smart projects, using no technologies, but only based on behaviours, rules, contracts and so on;
4. digital projects, not including smart goals referred to energy, environment, urban infrastructures.

This framework has been applied on the smart city project portfolio of two amongst the most relevant smart cities in Europe: Amsterdam and Genoa. Amsterdam is universally recognized as the first smart and digital city in the world. Genoa is the city winning the highest number of EU calls about smart city programs.

The analysis has been executed reading all the sheets and documents regarding each project included into the Smart city portfolio. Information have been collected mainly through the web site of Genova Smart City and Amsterdam Smart City, but also thanks to project documentation and personal meeting with smart city officials in both the cities.

In Fig. 3.9 we can see the results of our portfolio analysis.

Regarding Amsterdam our survey examines 50 projects included into the Amsterdam Smart City portfolio. 41 out of them are smart, nine are digital. Amsterdam is a city strongly focused on the environmental and energetic aspects of

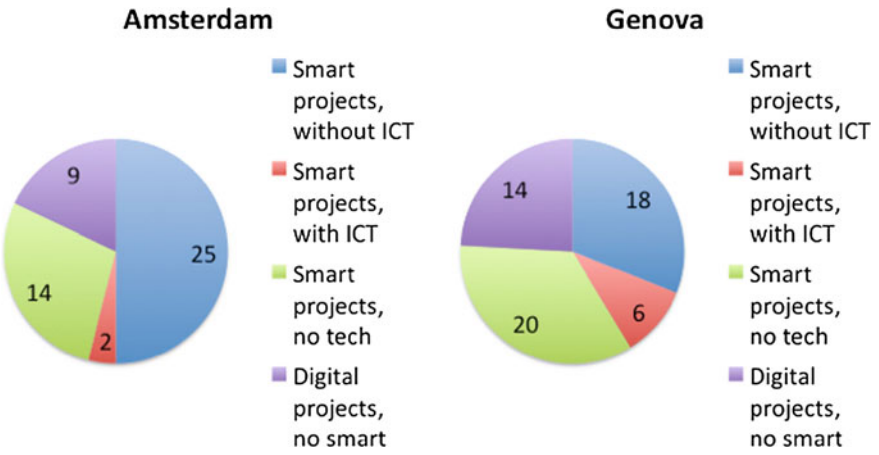

Fig. 3.9 The portfolio composition of Amsterdam Smart City and Genova Smart City

a smart city. It emerges not only from its portfolio, but also from its self-definition of smart city: "Amsterdam Smart City (ASC) is a unique partnership between companies, governments, knowledge institutions and the people of Amsterdam. It is a frontrunner in the development of Amsterdam as a Smart City. A Smart City is a city where social and technological infrastructures and solutions facilitate and accelerate sustainable economic growth. This improves the quality of life in the city for everyone". This definition is very broad and includes all the aspects of a liveable city, but is especially focused on sustainable economic growth, considered as capable for itself to improve the citizens' quality of life. The economic and environmental aspects of the city are the core goals of Amsterdam Smart City.

Amongst 41 smart projects, 14 projects use no technologies at all, and 25 are smart projects not involving ICT. Only two projects, when pursuing what we define smart goals, use ICT for reaching their objectives.

Regarding Genova, the survey examines 58 projects. 14 of them are digital, and 44 are smart. Genova is a little more mixing smart and digital technologies. Also six projects use ICT for pursuing smart goals, whereas 18 are smart projects not using ICT but other technologies, and 20 are smart projects using no technologies at all. Genova Smart City defines its aim as follows: "Our ambitious goal is to build a city that knows how to exploit the potential of high technology, creating sustainable development, effective mobility and opportunities for all. Effective and clean transport links, informed energy consumption, transparent and digital management, proactive and participatory citizenry: all of this is achievable". Also in this case, sustainable development is at the core, but it is not the only goal to be reached; Digital management is explicitly recalled, ICT is included into the smart city vision and proactive and participatory citizenry are primary aims too.

From this empirical analysis, it emerges that ICT is an important technology embedded in smart projects or at the core of smart projects, but also that cities are implementing smart projects based on other technologies or without technology at

all, only based on changing the behaviour of people or acting on the environmental aspects of the city. Two smart cities putting sustainable development at the core of their smart vision have a sensible different use of ICT in their portfolio; the choice of how and how much include ICT in smart initiatives is not the same in all the smart cities all over the world, even if to use ICT is a must for a smarter city.

The same facts emerge also from the analysis of international rankings, evaluating the smartness of a city in an international benchmark, applying several smart indicators counting the city equipment in terms of smart artefacts or intangible resources. Three main rankings are analyzed:

1. the Giffinger ranking of European medium cities [24];
2. the Smart City Wheel [34];
3. the EU Parliament survey on smart cities in EU28 [8].

Each of these rankings considers a different set of indicators; therefore, the obtained results are relative, as they depend on the selected indicators, but also on the affordability of collected data or on their updating. Nevertheless, it is interesting to outline that ICT indicators count only for a partial part of the ranking. It means that ICT is a component of smart city, but only in a small or greater part. Comparing the different weight of ICT indicators in smart city rankings it is possible to argue the different role and importance of ICT in different smart city visions.

Giffinger et al. in 2007 published the first and most known study about smart cities in Europe. The survey regarded 58 medium-size cities all over Europe; they have been ranked respect to six dimensions, further split into 31 factors and 74 indicators. Only one factor out of 31 regards ICT (Availability of ICT-infrastructure) with two indicators:

1. number of computers in households;
2. broadband Internet access in households.

ICT is not considered like a cross component of the smart city, but only like an infrastructure for itself. No social, economics or governmental aspects are explicitly linked with the use of ICT. In this case therefore, ICT weights poorly in smart city and only for itself, not permeating other smart aspects.

The EU Parliament survey on Smart cities explores 240 European cities, identified depending on the EU definition: “a Smart City is a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership. These solutions are developed and refined through Smart City initiatives, either as discrete projects or (more usually) as a network of overlapping activities”. The EU definition explicitly refers to ICT as a core component of smart solutions. In this vision, ICT is a technology, an instrument to develop solutions for further implementing smart initiatives. To support this vision, the survey uses the same six characteristics of smart cities used by Giffinger, but assigns to each characteristic an ICT “killer application” as an indicator of smartness. These relationships are showed in Table 3.2.

Table 3.2 Smart city characteristics and killer applications

Smart city characteristics	Killer application
Smart neighbourhoods	ICT-enabled infrastructure to create carbon neutral and sustainable residential areas, typically built for 10,000 to 40,000 inhabitants
Testbed micro-infrastructures	ICT-enabled infrastructure for piloting a network of technologies that interact in a given area of a city Typically this involves sensors and devices creating data and therefore by-passing human involvement
Intelligent traffic systems	ICT-enabled systems base on road sensors or GPS to monitor real-time traffic information and manage city traffic in an efficient and sustainable manner
Resource management systems	ICT-enabled infrastructure to improve the management of utilities for a city such as energy, water or electricity, e.g. smart power systems with intelligent management of energy mixes, smart grids, smart metering, heat storage, solar energy management systems, and surveillance management systems for resources such as clean tap water or wastewater or heating efficiency systems
Participation platforms	ICT-enabled citizen participation open data strategies, crowdsourcing and co-creation platforms

This analysis shows another different interpretation of the use of ICT in smart cities: ICT is conceived like a technology used to support other smart initiatives, regarding the main topics promoted by the UE Commission: cooling and heating systems, lighting or waste treatment, traffic and transport, energy and natural resources. Finally, ICT is addressed also like instrument for supporting citizens' participation, especially thanks to social media, open data and co-creation platforms.

Also the Smart city Wheel model refers to ICT like a technology embedded in smart projects and initiatives. Figure 3.10 shows the Smart City Wheel model. The main dimensions are the same suggested by Giffinger et al. but the role of ICT is here differently understood. For example, ICT is considered important in Smart government, considering both the pivotal role of open data and the use of ICT for realizing the so-called e-government, that is, the delivery of e-services. Also Smart Mobility explicitly recalls the use of ICT for supporting intelligent transport systems. Finally, Smart economy refers to local and global interconnectivity, also thanks to ICT networks [35].

Therefore we can conclude that:

- the role of ICT in smart cities is important, but not exclusive;
- ICT is assessed both for itself and as a technology supporting smart aspects such as mobility, e-government and so on;
- ICT weight in smart city depends on different smart city visions, even if based on the same smart city framework such as the one suggested by Giffinger et al.;
- ICT role in a smart city implementation depends on specific choices of each city and its strategic vision about which type of smart city it wants to implement: digital, green, cultural, or a mix of all of them, and which mix exactly.

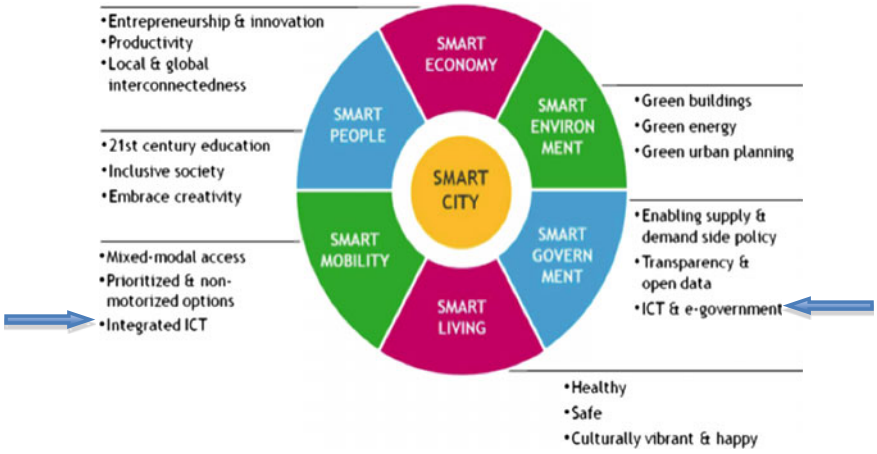

Fig. 3.10 The Smart city wheel model. *Source* Hodgkinson [34]

3.4.2 ICT Impact on Smart City Well-Being

The final aim of a smart city strategy is to pursue the citizens' well-being and to improve their quality of daily life. But what well-being is? Is it possible to measure it?

Several models have been studied to measure people well-being all over the world. A lot of them are specific of one country or geographical area and are therefore not suitable to measure the quality of life in smart city in different countries.

In 2014, OECD designed a framework called Better Life Index, aiming at measuring the citizens' well-being in all OECD countries [36]. This model considers both material and immaterial life conditions, both short-term horizon and the future long-term horizon of time. Figure 3.11 shows the dimensions of this multidimensional instrument for measuring the quality of life.

A more specific framework has been developed to measure the quality of life in smaller territories, such as regions or metropolitan areas. Also this framework considers material and immaterial conditions. Material conditions include: Income, Job, and Housing. Immaterial conditions include: Education, Environment, Civic engagement, Health, Life satisfaction, Safety, Work-life balance, and Community life.

The framework could be used to individuate the role of ICT in smart projects modifying the well-being in a metropolitan area. ICT can positively affect several aspects of the well-being in cities. For example, an Intelligent Transport System collecting and spreading information can reduce traffic; it positively impacts on Environment or Work-life balance. ICT territorial systems can be used for monitoring crimes and increasing security in city neighbourhoods. And so on.

We can therefore design a sort of Smart city value chain as follows (Fig. 3.12).

Fig. 3.11 OECD better life index. *Source* www.oecdbli.org

Fig. 3.12 Smart city value chain

The Better life value depends not only on the quantity of ICT implemented into the smart projects, but also on other qualities of the city and the citizens, that we can identify in Readiness, Intensity, and Impact:

- *the readiness* of the city depends on the infrastructure supporting the e-services and the areas in which the e-services are available;
- *intensity* refers to the number of users capable to access to the service (for example the number of users having a smart phone);
- *impact* means how much the service is able to influence the daily life of the citizens.

This evaluation is very useful especially a priori. Indeed, when choosing if or what project to implement in a complex smart city program, to be able to estimate the public value it creates is crucial to choice the best projects for the citizens, and not the most innovative but not really impacting on people daily life. For example, to implement bike sharing could be a smart idea if available bikes are numerous

(readiness), people in city are especially students and tourists (intensity of use) and the city is flat, permitting an easy use of bikes for going to work or school (impact on the daily life).

3.5 Conclusions

ICT and Smart city are not the same thing, even if smart city has its roots in digital city and digital city is finally a core component of a smart city. However, to simply consider ICT an essential facility of smart strategies is not enough for understanding the role and weight of ICT in shaping a better life for citizens in urban areas. On the contrary, the real capacity of ICT in producing public value when implemented in a large smart initiative depends on a well conceived strategic plan connecting the ICT implementation with a smart vision that links each project with citizens' well-being.

To estimate the awaited value from ICT-based smart projects, it is necessary to take into consideration the city readiness, the citizens' intensity of use and the impact on their daily life. Without this a priori evaluation it is not easy to implement smart projects surely able to produce better quality of life in urban space using ICT.

The ICT role and weight in increasing the city smartness is therefore a driver of paramount importance to deliver a higher public value to citizens thanks to a well-planned and integrated smart–digital urban strategy.

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Chapter 4
Urban Smart Dashboard. Measuring Smart City Performance

4.1 Introduction

What is a smart city? This label is recently very much used, but a clear and sound definition of smart city still lacks. In 2008, Hollands claims that several cities name themselves as smart, using the label "smart" without linking the labeling process with urban strategies really implemented. His survey reveals that a smart city is rooted in entrepreneurial and technological cities, but often without a long-term vision about how to improve the smartness of a city and the quality of life of its citizens [1].

In 2000, Bowerman et al. [2] try to trace the perimeter of smart city contents; their work depicts a smart city like the urban centre of the future, where all the infrastructures and facilities are designed and built using the most advanced and innovative technologies. In the authors' vision, a smart city is especially an engineering project, interesting several technical fields, but excluding the human aspects of living in cities.

On the contrary, Nam and Pardo in 2011 [3] suggest their smart city concept as a multidimensional framework involving technology, institutions and people. Their work is based on existing pilot implementations of smart city all over the world, and on working definitions revisited. This analysis considers not only the smart city label, but also the numerous synonymous used here and there. Their smart city framework outlines the need to integrate infrastructures and technology-mediated services, social learning for strengthening human capital, and governance for institutional improvement and citizen engagement. A smart city is therefore not only an engineering project, but a human program strongly based on both individual behaviours and public policies.

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Subsequently, the multidisciplinary nature of smart city is emerging like its distinctive aspect, both in academic research and in empirical implementation [4, 5]. Different authors focus their work on deepening the study of one of the different aspects of a smart city, also investigating on the relationships about the different aspects.

Paskalaeva [6] focuses her work on the institutional dimension, and especially on e-governance, that is, on how a smart city can use ICT for both improving the public policies and services and enhancing the relation quality between the local government and its citizens [7]. Su et al. [8] focus on the technological aspect and especially on ICT, put at the core of a smart city conceived like an evolution of the digital city. In their smart city concept, ICT is seen as the enabling technology for the multidisciplinary aspects of the daily life in city: public security, city services, environment preservation and so on.

More recently, Neirotti et al. in 2014 [9] still regret that a shared smart city definition is not available, despite smart city implementation proliferates all over the world. They depict a smart city vision based on its several components, organized in clusters regarding natural resources and energy, transport and mobility, buildings, living, government and economy and people, as already stated by Giffinger et al. in 2007 [10]. In addition, they outline the need to harmonize the smart city applications with the aim to improve the quality of life in city, supporting policy makers and city managers with useful guidelines to define and drive their smart city strategy and planning actions towards the most appropriate domains of implementation.

In the meantime, during the latest few years, several cities all over the world have been starting to implement their own smart strategy, including several smart projects and initiatives [11, 12]. This trend could be described like a bottom-up movement, because technologies and private initiatives are the real source of this new urban strategy. As already said examining the theoretical smart city definitions and the scientific literature about the topic, smart cities are multidisciplinary urban strategies, involving several technical applications and public and individual behaviours, but all the smart city initiatives are lumping in few domains, pursuing some more urgent goals such as reducing the city environmental footprint, improving the efficiency and effectiveness of public services and enhancing city innovative spirit, entrepreneurship and culture. The bottom-up movement and the multidisciplinary nature of the smart city produce a varied panorama, jeopardized and somewhat difficult to map and understand.

Several case studies have been published about smart city implementations, from Amsterdam to Barcelona, from Helsinki to Genoa, and so on [11, 13, 14]. However, no comprehensive surveys are available about the smart city portfolios, supporting the investigation about the more important and frequent urban topics addressed by smart city strategies. The report “Mapping Smart Cities in EU” issued by the European Parliament collects 240 smart cities in the European Union, but the list of

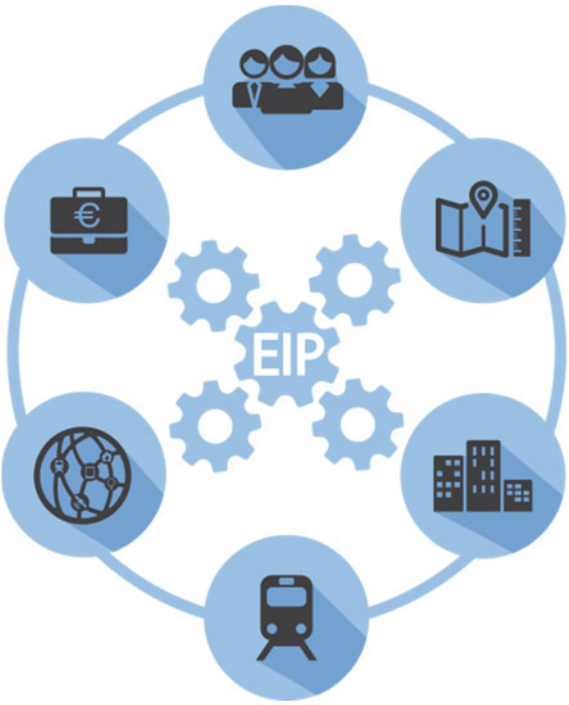

Fig. 4.1 The EIP-SCC smart city clusters. *Source* eu-smartcities.eu

smart projects cited by the authors is not reported [12]. In Europe, the EIP-SCC initiative[1] collects EU smart initiatives and projects implemented by European cities and classifies them in six clusters (Fig. 4.1):

- Business Models, Finance and Procurement include 30 initiatives;
- Citizen Focus includes 61 initiatives;
- Integrated Infrastructures and Processes (including Open Data) include 128 initiatives;
- Policy and Regulations/Integrated Planning includes 55 initiatives;
- Sustainable Districts and Built Environment include 73 initiatives;
- Sustainable Urban Mobility includes 81 initiatives.

This survey shows that smart cities are implementing a very large set of different projects and initiatives, regarding all the aspects of the urban living; several initiatives cross more than one cluster and involve more than one technology or facility. Some of them regard the economic, social, juridical aspects of living in city

[1]The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) is an initiative supported by the European Commission bringing together cities, industry, SMEs, banks, research institutions and other smart city actors. See www.eu-smartcities.eu.

and are not mainly focused on technology. The empirical observation of implemented smart cities shows a complex framework, as well as it emerges from the literature review.

It is therefore not surprising that no evaluation instruments are available, enabling cities to demonstrate performance gains in a comparable manner [15–17]. No shared definition exists, to put a common basis for designing the smart city perimeter of actions, projects and domains. No shared vision has been jointly developed by cities for driving their own smart strategies. The bottom-up implementation of smart city programs produces a collection of initiatives and projects, instead of an integrated strategy addressing well-defined goals to be reached.

In this work, the author suggests a way for building a general-specific evaluation instrument to measure smart city performance. General, based on a comprehensive and standard smart city concept; specific, because of being further adapted to the city-specific context and aim of the smart city strategy.

The conceptual basis of this instrument are: the universal idea of smart city, spread all over the world; and in the meantime the city-specific smart strategy, to be implemented taking into account the specific needs, aims and context of each city, rooted in its territory, environment and history. The processes to build the evaluation instrument are organized in five steps, from the theoretical study to the continuous improvement. In the following paragraphs these steps are examined; some conclusions and further work ideas conclude the chapter.

4.2 A Smart City Framework Supporting Performance Measurement

Even if a formal definition still lacks, we can design the conceptual boundaries of smart city and indentify the core components that define the smart city essence. "A smart city is a territorial implementation of ICT and other technologies to realize more sustainable, efficient and effective public and private services and infrastructures, to improve the quality of life and to reduce the environmental impact in the urban space" [18]. In this definition, we can find some main components of a smart city: the territorial dimension, the technologies, the output (services and infrastructures) and the goals, that is, the citizens' quality of life respecting the environment. This definition is able to describe the behaviour of cities trying to implement smart initiatives, even when they are not totally aware about their own goals, results and aims [19]. This smart city definition produces a general framework that is shown in Fig. 4.2; the framework looks like a smart city value chain, where the delivered value is embodied into the reached goals.

Other smart city value chain models have been proposed. For example, the City Council of Copenhagen developed a smart city value chain based on economic growth harmonized with environmental sustainability, to create a city safe and diverse in culture, offering leisure and convenience for living there (Fig. 4.3) [20].

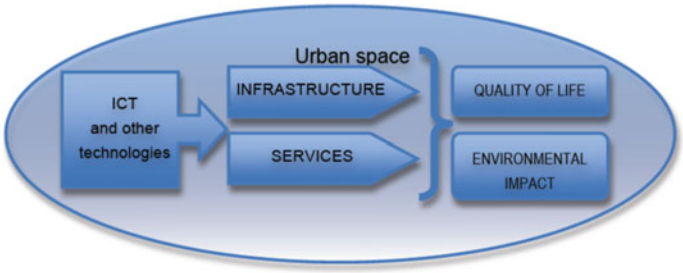

Fig. 4.2 The smart city general value chain

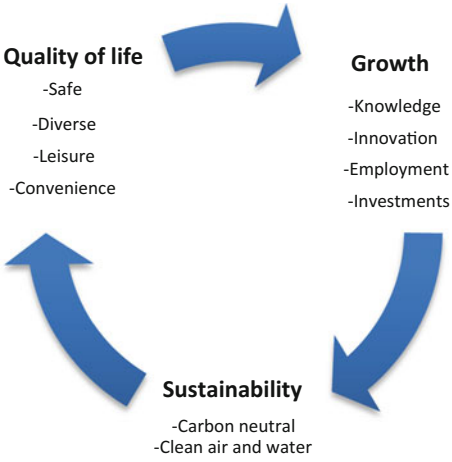

Fig. 4.3 The smart city value chain. *Source* City of Copenhagen

However, this model is very general and not capable to explain how a city really intends to implement processes and activities to realize value and quality of life for the citizens. Almost all the so-called smart cities assume that a better environmental context or the massive use of ICT, especially in public administration, can for themselves produce public value. For this reason, they generally do not measure any output, or sometimes measure their investments confusing them with performance [21].

On the contrary, cities need to develop a performance measurement model, able to explain how smart initiatives produce value and how much they are able to generate public outcome for people. In this paper, the author defines the roadmap to develop, test and apply a universal *Smart City Dashboard* to measure smart performance in urban space [22, 23]. This roadmap includes five steps, from the literature review for supporting the theoretical basis, to empirical implementation and further extension. These steps are as follows (Fig. 4.4):

1. Smart city value chain definition;
2. Performance indicators selection;

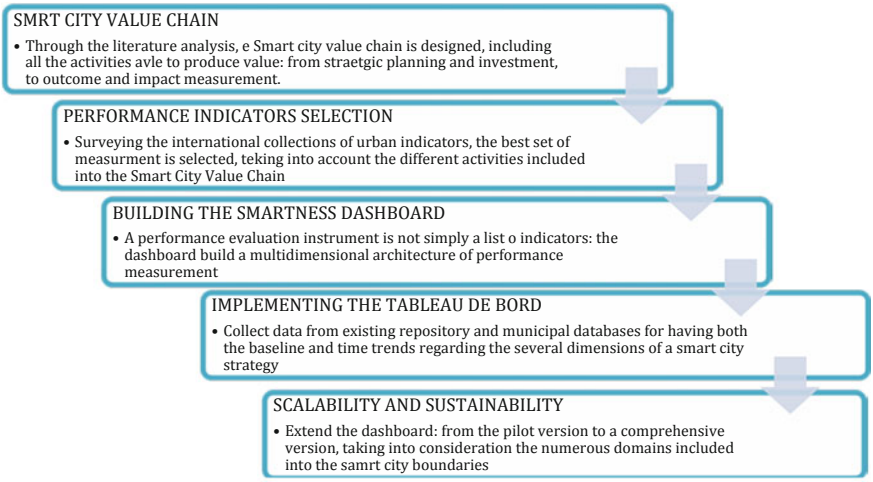

Fig. 4.4 Building the smart city dashboard, five steps

3. Building the Smartness Dashboard;
4. Implementing the *Smart City Dashboard;*
5. Scalability and Sustainability.

Figure 4.4 permits to visualize how this measurement instrument could be designed, following the different activities linked into the smart city value chain. It is indeed a multidimensional dashboard measuring the realization of smart city performance, from investments, through service delivering and infrastructure implementation, to the final outcome and impact for people, firms, public bodies and the environment.

In the first step, the international literature about smart city concept is examined and a sound smart city definition is proposed, including smart technological instruments, goals and stakeholders. The multidimensional smart city concept is used to identify the expected results from smart city initiatives and projects and therefore to design the performance measurement indicator set. To drive the roadmap description, the author uses the following smart city definition derived from the literature survey.

A smart city is a territorial implementation of ICT and other technologies to realize more sustainable, efficient and effective public and private services and infrastructures, to improve the quality of life and to reduce the environmental impact in the urban space.

A deep literature review has been applied to scientific paper databases also to define smart city performance. Even if several papers apparently address this topic, few concepts have been found really regarding this crucial aspect of implementing an effective and worthwhile smart city strategy.

Giffinger et al. [10] in 2007 for the first time addressed the need to measure the smart city performance, however, the aim of their work was not to understand or measure the value produced by smart city strategies for citizens, but to rank the medium-size cities in Europe, measuring some equipments regarding urban facilities such as schools and universities, green transport facilities, broadband infrastructures and so on. However, these equipments are considered for itself like proxy of a smarter city, but not linked with their real capability to produce public value or better life conditions. Moreover, these measurements are not ever linked with the core components or domains of a smart city, but regard all the urban equipments, from green areas to creative companies. The result of the survey is very interesting and pioneer in this field of study, but it produces a ranking of cities well implementing urban administration, instead of the evaluation of smart city strategies. It is also true that the study by Giffinger et al. has been developed before the "smart city wave" when no concrete implementations were been realized. Nonetheless, several further scientific papers about smart city take the Giffinger model about performance as a basis for defining (but in a very general way) the smart city capability to produce positive impact for their citizens (such as Nam and Pardo [3], Neirotti et al. [9], Chourabi et al. [19] and so on).

Several authors agree in considering smart city a complex multidimensional network of diverse systems interconnected in a synergistic fashion that promotes optimum performance in the urban life; therefore also the performance measurement should be deployed in a multidimensional way [24–26].

In the second step, the author examines a large number of international urban indicator sets. The examined sets are the most common ones developed by many distinguished international authorities and research bodies, to extract the most useful indicators to measure the smart city performance. Using this method, the *Smart City Dashboard* is built using qualified indicators already tested in the field.

In the third step, the *Smart City Dashboard* is built, aiming at measuring the smartness of a city, both to evaluate the reached goals and to support further decisions, investments and initiatives. To reach this aim, a Smart City Intelligence System is described; it is similar to a business intelligence system, to collect data, produce indicators, link them into a framework and support smart city governance processes and decisions.

In the fourth step, the *Smart City Dashboard* is filled up, using the statistic data from the urban database of an Italian city, already involved in a very large and deep smart strategy. This case study is useful both to verify the effectiveness and appropriateness of the indicator set, and to prepare the application of the *Smart City Dashboard* to many more cities in Italy and abroad.

Finally, in the fifth step, the flexibility and scalability of the model is investigated, aiming at both applying it to cities of different dimensions, and to dynamically apply it during the medium term, taking into account the progressive maturity of the smart strategy and the evolvement of smart technologies and goals.

In the further paragraphs, the roadmap is analyzed and explained in each stage, and in the final paragraph conclusions and further steps, a critical note about the *Smart City Dashboard* is presented.

4.3 Smart City Performance Indicators: Second Step

As a bottom-up phenomenon, a smart city is a set of distinct smart projects and initiatives, mainly technology-driven, aiming at reaching each one its own goals. Generally, these goals are quantitative, technical ones and measurable, thanks to some physical metrics such as CO_2 reduction, number of citizens using the broadband Internet, and so on. However, none of these indicators is able to measure the smartness of the city, or the capability of all the initiatives and projects together to impact on complex goals such as the citizens' quality of life or the urban environmental preservation [27]. For this reason, it is necessary to build a comprehensive evaluation framework to transform analytical indicators into a synthetic performance measurement instrument [28].

To build a comprehensive smart city performance measurement framework is a hard task, especially because the smart city strategy is a multipurpose, multi-technology program, involving several actors and requiring numerous initiatives. The risk is to create an overloaded set of indicators, a list of useless numbers unable to produce a good knowledge and awareness about the smart city strategy, its goals and its results [29]. To solve this problem, the author suggests to refer to the most qualified sets of urban indicators about quality of life and to select from these sets the most suitable indicators to measure the socio-economic impact of the smart city strategy. The author applies the framework shown in Fig. 4.1, considering not only the quantity of smart outputs—smart infrastructures and services—but also the quantity and quality of reached goals in terms of environmental impact and citizens' quality of life.

During the second step of the roadmap to build the *Smart City Dashboard*, the most qualified urban indicator sets are analyzed [30]. After a large literature survey, these sets are summarized in Table 4.1.

Analyzing these indicator sets, it immediately appears that they are very heterogeneous in the number of indicators, in their level of detail, and in the covered topics.

The Urban Audit is issued by the Eurostat, the statistical office of the European Commission [31]. It is a range of indicators covering most aspects relating to quality of life in cities in the EU, Norway, Switzerland and Turkey and covers the following domains: demography, housing, health, labour market, education, environment, etc. Some of them are relevant also for smart city performance, but this collection is not explicitly addressed to smart policies. Its main virtue is the large extension and the standardization of measurement, but data availability differs from topic to topic, as the statistics are provided on a voluntary basis only (there is no EU legislation on the collection of these statistics). The data collection exercise (formerly known as Urban Audit) is undertaken by national statistical institutes, the Directorate-General for Regional and Urban Policy, and Eurostat; as they are institutional bodies, data are validated and affordable. This database covers three city levels: cities conceived like local administrative units (Municipalities); functional urban areas consisting of a city and its commuting zone; and greater cities, an

Table 4.1 The most qualified urban indicator sets all over the world

Name	Issuer	Contents
The Urban Audit	European Commission and Eurostat	A collection of quantitative information about the quality of life in European city [31] http://ec.europa.eu/eurostat/web/cities
The European Common Indicators	Ambiente Italia Research Institute	A set of 10 environmental sustainability indicators developed in conjunction with stakeholders [32] http://www.commonindicators.eu
The Global City Indicators Facility (GCIF)	University of Toronto and Global City Institute	A large set of measures mainly regarding the performance of city public services all over the world [33] http://www.cityindicators.org
The Quality of Life Reporting System (QOLRS)	The Federation of Canadian Municipalities	A set of indicators regarding social, economic and environmental trends in Canada's largest cities [34] http://www.fcm.ca/home/programs/quality-of-life-reporting-system.htm
The Cities Data Book	The Asian Development Bank	A very large set of detailed indicators regarding urban management and performance [35] http://www.adb.org/publications/urban-indicators-managing-cities
The Global Urban Indicators	ONU	A set of measures and indicators regarding 236 cities all over the world to monitor the progress of UN-Habitat Agenda, the ONU program aiming at improving the quality of life in cities in developing countries [36] http://www.unhabitat.org
The Global Sustainable Urban Development Indicators	The White House Office of Urban Affairs	A set of indicators to measure USA's city progress in sustainable development [37] https://www.huduser.gov/publications/

approximation of the urban centre when it stretches far beyond the administrative city boundaries. Therefore, when deciding to evaluate smart city performance, it is also necessary to define what exactly we mean with the word "city": administrative boundaries, functional boundaries or larger boundaries coinciding with a Province or a Metropolitan Area? It depends on the territory to which the smart policies and programs are addressed, but this choice should also take into account the possibility of access to the required data.

Also, The European Common Indicators are urban indicators standard for European cities, but in this case indicators address only the local environmental sustainability, that is, one of the several smart city domains [32]. Several of them are relevant for smart city topics, for example air quality, water quality, CO_2 emissions and land consuming; the set includes also some indicators regarding the

Smart Mobility domain. Extracting some indicators from this set could furnish only a limited view on the smart city benefits.

The Global City Indicators Facility [33] is an Internet platform collecting data at the global level from cities voluntarily joining the program. The platform is managed by both the Global City Institute and the University of Toronto. Each member city has discretion for entry of data and descriptive materials for their city profile and city data performance measures. The Global City Indicators Facility (GCIF) is not responsible for the accuracy of this information. However, ISO standardization and third-party verification of indicator methodologies are currently being developed. The topics covered by this list of indicators are numerous, several of them are relevant for smart city domains; it is therefore necessary to apply a reasoned selection. The main virtues of this platform are the openness and the global coverage. Moreover, GCIF also launched another interesting initiative, called MetroMatch. MetroMatch is a voluntary effort to link the staff of municipalities from around the world for the purpose of sharing technical information on an identified set of topics, including wastewater management, climate change, public health, disaster response, flood control and other municipal services. It can create a shared vision about the quality of life in cities and a consequently convergent policy about the smartness of cities to further also a more convergent evaluation framework.

The Quality of Life Reporting System [34] has been developed by the Federation of Canadian Municipalities. It regards therefore only cities in this country, however, it is an interesting source of information regarding the smart city vision. For the first, it takes into consideration the quality of life, and measures the processes and equipments like instruments and not like the final aim of urban policies. Accordingly, with the smart city vision, it is built around a multi-domain basis and finally it not only measures, but suits measurement and indicators with specific urban programs and policies able to address each topic and trying to impact on it for improving the quality of life. Figure 4.5 shows domains and indicators of this national program. Reading the prospect, it is easy to find indicators relevant for the smart city and imagining to include them in the smart city's *Smart City Dashboard*.

The Cities Data Book [35] is a set of indicators issued by the Asian Developing Bank for supporting the understanding and facing of urban problem in Asian metropolis, especially the larger ones. The program has been launched considering that many cities lack data and information on urban conditions and trends, which has undermined their ability to understand and manage the complex forces of urban growth and change. The Data Book explores the theory, development and application of urban indicator systems for improved urban management and performance measurement, and presents the findings from a pilot exercise undertaken in 18 cities in the Asia and Pacific region. It is a useful instrument to compare the needs and visions about cities and smart cities in different continents. Indeed, even if the smart city idea is global, its implementation is not the same all over the world and performance measurement instruments should take into consideration the diversity of world areas.

The Global Urban Indicators [36] is a database of urban data collected by UN-Habitat, the United Nations program addressing the quality of life in cities, all over the world. Its mission is to promote socially and environmentally sustainable

DEMOGRAPHIC BACKGROUND INFORMATION (DBI)	AFFORDABLE, APPROPRIATE HOUSING (AAH)	CIVIC ENGAGEMENT (CE)	COMMUNITY AND SOCIAL INFRASTRUCTURE (CSI)	EDUCATION (ED)	EMPLOYMENT AND LOCAL ECONOMY (ELE)	NATURAL ENVIRONMENT (NE)	PERSONAL & COMMUNITY HEALTH (PCH)	PERSONAL FINANCIAL SECURITY (PFS)	PERSONAL SAFETY (PS)
DBI01 Population Growth	AAH01 Rental Housing Affordability	CE01 Voter Turnout	CSI01 Social Housing Waiting Lists	ED01 Education Levels	ELE01 Business Bankruptcies	NE01 Air Quality	PCH01 Low Birth Weight Babies	PFS01 Families Receiving Social Assistance	PS01 Youth Crime
DBI02 Household Size	AAH02 Homeowner Affordability	CE02 Women in Municipal Government	CSI02 Rent-Geared-to-Income Housing	ED02 High School Completion	ELE02 Consumer Bankruptcies	NE02 Commuting Distance	PCH02 Teen Birthrate	PFS02 Employment Insurance	PS02 Violent Crime
DBI03 Family Composition	AAH03 Core Housing Need	CE03 Volunteering	CSI03 Subsidized Child Care	ED03 Student-Teacher Ratio	ELE03 Hourly Wages	NE03 Mode of Transportation	PCH03 Premature Mortality	PFS03 Incidence of Low Income	PS03 Property Crime
DBI04 Average Income	AAH04 Substandard Units	CE04 Charitable Donations	CSI04 Social Services-Culture Occupations	ED04 Composite Learning Index Score	ELE04 Change in Income	NE04 Density	PCH04 Infant Mortality	PFS04 Children Living in Poverty	PS04 Criminal Code Offences
DBI05 Renters & Owners	AAH05 Changing Face of Homelessness		CSI05 Recreation Facilities	ED05 Education Occupations	ELE05 Building Permits	NE05 Water Consumption	PCH05 Body Mass Index	PFS05 Income Gap	PS05 Police Per Capita
DBI06 Population Mobility	AAH06 Vacancy Rates		CSI06 Cultural Facilities		ELE06 Unemployment	NE06 Wastewater Treatment	PCH06 Smoking Status	PFS06 Social Assistance Rates	PS06 Weapons Violations (non-violent)
DBI07 Immigration	AAH07 Rental Housing Starts		CSI07 Long Term Care Facilities		ELE07 Immigrant Unemployment	NE07 Waste Diversion	PCH07 Life Expectancy	PFS07 Working Poor	PS07 Drug Violations
DBI08 Language Spoken at Home	AAH08 Monthly Rent		CSI08 Recreation Programs		ELE08 Quality of Employment	NE08 Recreational Water Quality	PCH08 Physical Activity	PFS08 Community Affordability	PS08 Traffic Violations Causing Death
DBI09 Visible Minorities	AAH09 Cost of Housing		CSI09 Libraries		ELE09 Labour Force Replacement	NE09 Drinking Water Quality	PCH09 Prevalence of Asthma	PFS09 Transit Affordability	PS09 Emergency Services Occupations
DBI10 Aboriginal Population	AAH10 Overcrowding		CSI10 Health Care Professionals			NE10 Ecological Footprint	PCH10 Mental Health	PFS10 Food Insecurity	

Fig. 4.5 Domains and indicators in the Quality of Life Reporting System. *Source* Federation of Canadian Municipalities [34]

human settlements development and the achievement of adequate shelter for all. As its goals are similar to the aims of smart city strategies—sustainability and citizens' quality of life—its indicators could be easily adopted and adapted also for evaluating and measuring the performance and results produced by smart city initiatives. Moreover, as the UN-Habitat program regards all the cities in the world, indicators are standard and it permits also to compare different urban strategies and reached goals. UN-Habitat has developed a holistic and global approach towards urbanization that embraces much more than just technical considerations. Beyond its traditional core areas—such as city planning, infrastructure development and participatory slum upgrading—UN-Habitat also focuses on urban legislation and risk management, as well as gender, youth and capacity building for all actors involved in the urbanization process. The difficulties in using these indicators regard: the need to separate the general indicators from indicators linked to smart aspects of a city, and the difficulty in considering the very different situation regarding cities in different continents.

Dimension of Sustainable Urban Development	Elements necessary for sustainable urban development:
Social Wellbeing	•Health •Safety •Local or civic identity/sense of place •Access to decent – affordable – housing and services •Access to public recreation and open space •Access to a variety of transportation options
Economic Opportunity	•A diversified and competitive local and regional economy •Transportation and other infrastructure coordinated with land use •Growth plans that leverage existing assets •Access to capital and credit •Access to education, jobs, and training
Environmental Quality	•Efficient land use •Use of renewable resources •Waste/pollution minimization and management •Climate change and natural disaster mitigation, adaptation, and resilience •Carbon efficient, environmentally sound, transportation •A diverse natural environment and functional ecological systems

Fig. 4.6 Dimensions and elements for urban sustainable development, in the global sustainable urban development issued by the USA White House. *Source* White House Office of Urban Affairs [37]

The Global Sustainable Urban Development [37] is a program implemented by the USA White House involving actors all over the world: OECD, European Union, and single countries interested in participating for suggesting an instrument supporting local policies. Despite its name, this program does not simply address the environmental aspect of the urban life, but a comprehensive vision of the city; the environmental preservation is at the core, but the economic and social developments are corollaries in an integrated urban strategy. Figure 4.6 shows the three domains and some indicators taken into consideration by this model.

The list of models already developed at the international level for measuring and evaluating the quality of life in cities is long and diverse in contents, geographical range and aims. However, they are a fundamental basis for building the *Smart City Dashboard.* It is not necessary to reinventing the wheel, but indicators should be carefully selected for adapting to the smart city concept.

During this step, it is therefore necessary to harmonize the selected indicators and to connect each of them to the theoretical framework, considering goals and stakeholders to which the smart city strategy is addressed. This task is over the simple selection of indicators and it requires building a veritable performance measurement instrument as specified in the following paragraph.

4.4 Building the Smartness Dashboard: Third Step

In the third step to build the *Smart City Dashboard*, the selected indicators are used to compose a smartness dashboard, with the aim to overcome the most severe flaws of the indicator sets, that is, the lack of a comprehensive framework able to give a sense to numbers and metrics. It requires introducing indicators into a comprehensive vision of the smart city able to explain the relationship between the actions —that is, the smart projects and initiatives, the output and finally the outcome for people.

In Fig. 4.2 (see Sect. 4.2) we can identify the components of the smart city framework to link to the evaluation in the *Smart City Dashboard* as follows:

- ICT and other technologies used to implement the smart infrastructures could be measured to assess the readiness of the city to be smart: the more the technologies are used, the higher is the readiness of a city to supply better services and equipment to the citizens;
- services and infrastructures are the output of smart initiatives and could be measured to assess the intensity of the smart city: the more the citizens use smart services, the larger is the output obtained;
- quality of life and environmental quality are the result and should be measured to assess the outcome and the real impact of the smart initiatives and strategy on the citizens and on the urban space: it depends on the quantity of technologies and the quantity of output, but also by the satisfaction and real benefits gained by citizens in using equipment and services and the real impact realized on the environment.

This classification reflects the S-curve model suggested by OECD to evaluate the ICT impact on people; it is dynamically adapted to the smart city context by the author [38, 39].

This dynamic vision of the smart city goals could be intersected with a contextual vision of the smart city, including all the stakeholders as argued by Dameri [38] and including citizens, public administration and companies or economic agencies. Also a topic vision could be further intersected using the six dimensions of the smart city explained by Giffinger [10]: mobility, environment, people, living, governance and economy. Figure 4.7 describes the *Smart City Dashboard* multidimensional nature.

Each of these dimensions crossing each other could generate a subset of indicators able to outline the reached goals and performance in a specific area. For example, it is possible to evaluate the outcome of the smart city regarding citizens for the Smart Mobility, or the output of the smart city for the Public Administration regarding the smart economy; and so on.

All these interpretative dimensions of the smart city are able to give a mean to the indicator set: they are no more a list of numbers, but instruments to measure,

Fig. 4.7 The smartness dashboard

assess and explain how much the city is smart and how and how much it impacts on stakeholders in different fields and along the value chain of the smart city, from the input to the impact.

4.5 Implementing the *Smart City Dashboard*: Fourth Step

After defining the smart city dashboard and its dimensions, we have an empty box, able to guide our evaluation, but without evidence of its appropriateness. To verify the *Smart City Dashboard* it is necessary to implement it by filling up the dashboard. In the fourth step, the harder problem to face regards the availability of data to build and calculate the smartness indicators. Indeed, to collect data expressly for the *Smart City Dashboard* requires time, work and money.

However, to speed up the empirical test of this evaluation instrument, it is possible to use the rich database available in the statistic office of the larger municipalities. In Italy, all the cities and especially the county seat have a very well built database collecting statistical data regarding several aspects of the urban life. This database is a veritable data mine, and the author suggests using this source of data to implement the pilot of the *Smart City Dashboard*. The most important advantages of this choice are the following:

– data are already available on electronic support, requiring no further cost or efforts to collect them or very little ones to adapt them to the *Dashboard*;
– long time data series are available, they are very useful to compare impacts of smart projects or initiatives that appear in the medium term; one of the most serious limits to the smart city evaluation is the lack of a baseline for comparing indicators in the medium time;
– comparability between cities in the same country (Italy for example, or France, and so on) is possible, as several data are collected to comply with national rules and therefore they respond to the same format; but also at the international level, when cities apply similar rules, as it happens in Europe;

– wide set of available data, so that it is possible to choose the most suitable for the smartness measurement, in accordance with the selected indicators as explained in Step 2.

There are also some disadvantages:

– data have been collected for different aims and sometimes they are neither coherent with the smart city framework, nor easy to adapt;
– data are comparable only at the national level, as the data format is different across different countries; however, in Europe, Eurostat defines some data standards to be applied to several topics, and it permits a comparison at least at the European level;
– it is necessary to take into consideration privacy constraints regarding public data.

Finally, advantages are more than disadvantages, especially to test the effectiveness of the *Smart City Dashboard* and to eventually modify some dimensions, indicators and so on, to improve its capability to measure smart city performance. Further, the municipal source of data can be integrated with datasets obtained by other public bodies, even if not ever the granularity reaches the city level.

To improve the efficiency and effectiveness of the Dashboard, a software is suggested, able not only to collect data and to process them in order to calculate and show the smart city performance indicators, but also to create a Smart City Intelligence System able to navigate into the indicators, the stakeholders, the topics and the evolution of the smart city, and to respond to more specific needs for city government and investors.

Genoa Smart City is an interesting case to be examined. The Municipality has a very large and deep statistical database, with many data regarding all the aspects of the urban life. Moreover, recently the Information Systems Department has implemented a GIS (Geographic Information System) localizing in a map a very large set of data and information [40]. This GIS has a very small granularity and it is possible to collect and cross information regarding energy, or social disease, and economic development or cultural offering, at the neighbourhood level. This platform is now used to link smart city indicators with the territorial organization of the city and to share data and information in an open web site with citizens, companies and other public bodies.

4.6 Scalability and Sustainability of the *Smart City Dashboard*: Fifth Step

The *Smart City Dashboard* here described is a conceptual framework implemented into a software application, using a multidimensional set of indicators to measure the smart city performance. It is based on a theoretical idea of smart city, including several stakeholders, phases of implementation and topics. This instrument however

needs to be flexible, in order to respond to the fast evolution of the smart city strategy, supported both by the fast technology change and by the governance goals transformation. For these reasons, it is necessary to conceive a *Smart City Dashboard* able to be flexible to accord with the smart city time evolution.

Both spatial and time flexibility should be considered.

Spatial flexibility aims to modify the perimeter and the number of indicators, according with dimensions or characteristics of the city using the *Smart City Dashboard*. Indeed, spatial flexibility is conceived to adapt the *Smart City Dashboard* in cities that could be very different each others; the smart city strategy is the more effective, the more is city-specific and harmonized with city goals and characteristics, such as dimension, cultural heritage, economic and demographic profile and so on. The software should include the possibility to switch on or off some indicators, depending on the strategy and the specific goals of each smart city program. This idea of flexibility could be used also to customize the *Smart City Dashboard* respect to different needs of different stakeholders in the same city, or to take into consideration only a subset of topics and aims to outline some aspects considered more important respect to others [41].

Time flexibility aims to support the time evolution of the *Smart City Dashboard*, accordingly with the evolving of the smart strategy; it requires to develop a maturity model for the smart city, to support the change of the indicator set along the time, depending on the progressive implementation of the smart city strategy and the different focus and goals pursued each time.

All these aspects should be for the first examined from the theoretical point of view, and finally implemented both in the conceptual *Smart City Dashboard* and in the Smart City Intelligence System.

4.7 Conclusions and Further Steps

The measurement of smart city performance is nowadays a hard challenge, because cities are involved and committed in large smart projects and initiatives, but they are not able to understand if their choices are the better ones and if their investments in smart programs are able to generate the expected returns, both for the investors and for the citizens. The *Smart City Dashboard* suggested in this work aims to furnish a universal, extendible instrument to local and central governments, able to support strategic decisions, to drive investments, to measure reached goals and to compare different smart solutions each others. Until now, the author developed only the theoretical instrument; further step will be to test the *Smart City Dashboard* about Genoa, one of the smarter cities in Europe, at present involved in implementing a large smart strategy funded by three European Fund Projects and a large amount of its own financial resources. The use of statistical data from the municipal database could be the best way to reduce time to obtain a first evidence about the effectiveness and appropriateness of this measurement framework and to understand if it is suitable to be applied to the worldwide smart cities.

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Chapter 5
ICT Intensity in Smart Mobility Initiatives

5.1 Introduction

During the past 50 years, city dimensions have been increasing more all over the world. By 2050, 70 % of population will live in cities [1]. Cities are both the places of opportunities and places of diseases. Opportunities are more because cities are places where people live and meet, where companies are settled and schools and universities are most present [2, 3]. Diseases are high because in city traffic, pollution and waste production are worse than elsewhere and the cost of living is very high [4, 5].

Public Administration and Municipalities are facing a challenging task; to harmonize a sustainable urban development taking into account, the need of both creating job opportunities and preserving the environment, at the same time offer people the best living conditions in cities [6]. Moreover, cities are looking for competitive advantage in attracting and retaining the best, more educated and skilled human resources for innovative and performing companies, and high touristic fluxes thanks to the perceived quality of life, to have the best performance in public value creation [7, 8].

Smart city is considered a winning urban strategy using technology to increase the quality of life in urban space, both improving the environmental quality and delivering better services to the citizens [9]. Even if the globalization agenda tries to put together economic competitiveness and sustainability, these two faces of the same coin are not easy to be pursued concurrently [10]. Smart cities address this difficulty advocating innovativeness, participation, collaboration and coordination, going far beyond the mere use of technologies.

Several academic papers have been written about smart city, smart strategies and smart initiatives [11, 12], interesting a very large set of topics from waste treatment to air quality, from green energy production to buildings energetic efficiency and from open data to e-government in smart city. However, few works till now have been reasoning about more complex aspects, such as how all these topics—also

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very different each others—interact reciprocally, which benefits they could produce, how they impact on the quality of life of citizens, how much they are able to effectively solve the urban problems and how well the smart projects perform.

To respond to this questions, the present paper introduces a deep analysis focalised on one of the most important topic in smart city, that is, smart mobility. Mobility is one of the most important facilities to support the functioning of the urban area [13, 14]. However, transport produces several severe negative impacts and problems for the quality of life in cities, such as pollution, traffic and street congestion, long time to cross the city and therefore a negative impact on work and life balance, high cost of public local transport services and so on. Therefore, Smart Mobility is one of the most promising topics, as it could produce high benefits for the quality of life of almost all the city stakeholders.

Smart Mobility is not a unique initiative, but a complex set of projects and actions, different in goals, contents and technology intensity. Especially, ICT could be the pivot of a Smart Mobility initiative, but it could completely lack. The present work aims to analyse and classify Smart Mobility actions, considering their ICT content and their goals and trying to answer to the following Research Questions: Are Smart Mobility initiatives necessarily ICT intensive? Which are the main goals of the Smart Mobility initiatives? What benefits could they produce?

Our analysis faces the Smart Mobility topic taking into consideration several aspects. In Sect. 5.2, Smart Mobility is rooted in the international literature about urban development, smart city, smart actions impact on quality of life and stakeholders' expectations. In Sect. 5.3, the most recurrent Smart Mobility initiatives implemented in smart city strategies all over the world are analysed and taxonomy is suggested. In Sect. 5.4, the role of ICT in Smart Mobility and the benefits of Smart Mobility for citizens' quality of life are described. Some Boxes enrich the paper with case studies about smart mobility initiatives implemented in European smart cities. In Sect. 5.5, the reached results, research limits and further work are examined.

5.2 Smart City and Smart Mobility: Some Reference Models

The smart city topic, even if recent, has its roots in more consolidated urban strategies, deriving from different streams of study and finally merged into the Smart City vision. Thanks to a deep literature survey and analysis about the definitions and labels attributed to cities [15], we grouped the city labels in three streams:

1. Digital city: it regards the use of ICT to support the creation of a wired, ubiquitous, interconnected network of citizens and organizations, sharing data and information and joining online services, supported by public policies such as e-government and e-democracy [16, 17];

2. Green city: it regards an ecological vision of the urban space, based on the concept of sustainable development. Green policies in city regard both reducing the city footprint on the environment, reducing pollution waste and energy consumption, and preserving or creating public green areas like parks and gardens [18, 19];
3. Knowledge city: it regards the policies aiming at enforcing and valuing data, information and knowledge available and produced in city, especially through its cultural institutions, but also collected and used by companies, innovative districts and technological parks [20, 21].

Giffinger et al. [22] define Smart City as "a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of activities of self-decisive, independent and aware citizens". (See also [23]). It emerges that technology and ICT—the Digital City components—are necessary for a smart city, even if they are not the goal but the instrument, as the final aims are to improve the citizens' quality of life and to well-manage natural resources (Green City), involving citizens thanks to the participated city governance (smart city). Therefore, depending on the authors, each city is smart as far as it is committed to the implementation of smart economy (competitiveness), smart environment (natural resources preservation), smart governance (participation), smart living (quality of life), Smart Mobility (transport and ICT) and smart people (social and human capital).

Smart Mobility is therefore only one of the topics regarding smart city implementation [24]. It is, however, a crucial topic, impacting on several dimensions of the smart city, on numerous aspects composing the citizens' quality of life and regarding all the potential stakeholders expecting benefits from the smart city implementation [25]. Smart Mobility is seen like a slice of the Smart City, crossing all the components listed above [26]. Almost all of the most cited smart city frameworks consider smart mobility as one of its pillar [23, 27, 28].

Caragliu et al. [23] include transport as a core component of a smarter city: "City can be defined as '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 action and engagement". Vanolo [27] defines smart mobility as one of the main urban strategies to pursue city sustainability. The topic regards for the first the role played by innovative technologies to both implement greener transport facilities and to collect and process data for a better management of transport systems. However, the author outlines also that the better returns could be obtained, only if citizens are actively involved in smart mobility actions, thanks to their personal behaviours. Smart mobility is therefore not only a technological affair, but also a social and cultural approach.

From the literature analysis, we can gather the most important Smart Mobility objectives [29–31]. They are summarized in the following six categories:

1. reducing pollution;
2. reducing traffic congestion;
3. increasing people safety;
4. reducing noise pollution;
5. improving transfer speed;
6. reducing transfer costs.

Moreover, a successful, Smarter Mobility system in city refers all the paradigms composing the smart city, which is digital city, green city and knowledge city:

– Digital city, because the traffic system could use ICT and software applications for a lot of different aims, such as optimizing traffic fluxes, supports effective public transport routes, collect citizens' opinions and suggestion about urban mobility and so on [32].
– Green city, because the environmental impact of transport in city is one of the main causes of city pollution [33].
– Knowledge city, because the smartness of transport depends also on the sharing of civic values and on the citizens' smart behaviours [34].

Smart Mobility is therefore a multifaceted topic, involving all the smart city paradigms and generating a set of heterogeneous benefits for all the smart city stakeholders. They can act like agents of the Smart Mobility initiatives, i.e. to be the movers of the actions, or gain the resulting benefits or the both.

5.3 Clustering Smart Mobility Initiatives

Because of the enormous potential adverse impact of a poorly managed mobility system on the quality of life, Smart Mobility is often described as one of the main options to realize more sustainable transport systems [35]. It could also be seen as a set of coordinated actions addressed at improving the efficiency, the effectiveness and the environmental sustainability of cities. In other words, Smart Mobility could consist of a hypothetically infinite number of initiatives often (but not always) characterized by the use of ICT. As pointed out by Staricco, [36] there are two meanings of Smart Mobility with respect to the use of ICT: the first one refers to an efficient and effective mobility system and is independent from the role played by ICT, but it is rather connected to the use of appropriate technologies[1]; while the second one relates to a mobility system characterized by a consistent and systematic use of ICT.

The Smart Mobility sector includes a remarkable breadth of contents and implications because of the large number of variables to which it is connected. It is possible to identify several studies focused on individual applications, while it is

[1]The author reports the case of Curitiba, in Brazile, where efficient transport solutions have been implemented, and they are low-tech and low-investment solutions.

more difficult to find studies that provide a holistic and interrelated vision of these actions. Due to the complexity of urban mobility scenario, the aim of our analysis, which operates multiple level classification of a large number of Smart Mobility initiatives due to a deep literature review, is trying to provide an overview of this area through the proposal of an action taxonomy considering three aspects:

1. Smart Mobility actors: who are the main agents moving the smart initiatives;
2. Use and intensity of ICT in Smart Mobility initiatives;
3. Goals and benefits of Smart Mobility actions.

The suggested taxonomy is based on a literature review; the survey regards scientific papers about policies and technologies for Urban Mobility and Smart Mobility, especially in European cities.[2] The set of collected papers includes 114 scientific papers searched on Scopus using the keywords "Smart Mobility" in title, keywords and abstract. 109 of them have been published during the latest five years.

Thanks to a careful content analysis, we analysed all the smart mobility initiatives described in these papers, examining actors, use of ICT, goals and benefits, to design the initiative taxonomy.

First of all, the initiatives are classified into four main groups respect to the different key actors, they are:

– public transport companies and organizations;
– private companies and citizens;
– public bodies and local governments;
– the combination of all of them, when all these actors realize together integrated initiatives (for example, Integrated Transport Systems—ITS).

Each initiative is then related to a major, minor or non-existent incidence of ICT technology and it is connected to the most important and recurrent Smart Mobility goals. This study wants, in fact, introduce a deep exploration of the interrelations between initiatives, aims and enabling technologies. The final results of this taxonomy are summarized in Table 5.1. An asterisk in a cell means a relation between Smart mobility action, ICT and pursued benefits In the following each group is described; the description includes a brief illustration of the actions composing each one, the ICT intensity, and the benefits of each action on the Smart Mobility goals described above. Case studies are described, to better explain the contents of each group.

1. *Public Mobility: Vehicles and innovative transport solutions*

This group includes all the initiatives carried out by the companies or organizations, suppling the local public transport services in the city. It is composed by actions of different nature but characterized by a common factor, that is, they aim to positively change the quality of public transport from different points of view. As shown in

[2]The most innovative Intelligent Transport System have also been analysed in the catalogues of the main international solution vendors.

Table 5.1 Smart mobility taxonomy, ICT intensity and targets

	Intensity of ICT adopted			Benefits in smart mobility					
				Reduction of pollution	Reduction of congestion	Increased safety	Reduction noise pollution	Improving transfer speed	Reducing transfer costs
1. Public Mobility: vehicles and innovative transport solutions									
Electric vehicles	L			*			*		
Vehicles EUR 5	L			*			*		
Use of alternative fuels (LPG, methane, hydrogen, biodiesel, fuel cell)		M		*					*
Vehicles with automated driving		M				*			
Integrated management of public transport vehicles		M		*	*	*	*		*
Collective taxis	L				*	*	*	*	
Integrated ticketing system		M						*	*
2. Private and commercial mobility: vehicles and innovative transport solutions									
Electric vehicles	L			*			*		
Vehicles EUR 5	L			*			*		
Use of alternative fuels (LPG, methane, hydrogen, biodiesel, fuel cell)	L			*					
Vehicles with automated driving		M				*			
Carsharing (with georeferencing and geotagging)	L				*				*
Car pooling	L				*				*
Hire and ridesharing services		M			*				*
Bike sharing (with georeferencing and geotagging)				*	*		*		*

(continued)

Table 5.1 (continued)

	Intensity of ICT adopted			Benefits in smart mobility					
				Reduction of pollution	Reduction of congestion	Increased safety	Reduction noise pollution	Improving transfer speed	Reducing transfer costs
Piedibus	L				*	*	*		
Automotive navigation system		M				*			*
Eco-driving	L			*		*	*		
3. Infrastructure and policies to support mobility									
Infrastructure, changes and addressing mobility									
Parking	L								
Park and ride	L			*	*		*		
Bicycle lanes	L			*	*	*	*		
Columns recharge electric vehicles	L			*					
Message signs about mobility		M			*				*
Integrated traffic lights		M		*	*				*
Pedestrian zones or auto-free zones	L			*		*	*		
Restricted (or limited) traffic zones	L			*		*	*		
Bus lane or bus only lane	L				*	*			*
Parking guidance system		M		*	*				
Systems for speed control and management		M			*				*
Mobility management based on the level of pollutant emissions	L			*					

(continued)

Table 5.1 (continued)

	Intensity of ICT adopted			Benefits in smart mobility					
				Reduction of pollution	Reduction of congestion	Increased safety	Reduction noise pollution	Improving transfer speed	Reducing transfer costs
Integrated policies to support smart mobility initiatives									
Traffic flows division (private, public, commercial)	L			*	*	*	*		
Integrated ticketing		M							*
tariff integration between public and private transport		M							*
Incentives for the use of less polluting fuels	L			*					
Control of emissions	L			*					
Speed limit sign	L					*			
Economic incentives and/or higher taxation measures (congestion pricing, eco-pass, cordon pricing, road pricing, park pricing)	L			*	*				
Tax incentives and/or measures such as higher taxation on polluting fuels	L			*					*
Regulation of access (pedestrian areas, time bands, ZSL, STL)		M			*		*		
Redesign of city times (public schedules, school schedule, etc.)		M		*	*	*			
Redesign of the city and its spaces (residential and industrial areas, integrated neighbourhoods, etc.)		M		*	*	*			*

(continued)

Table 5.1 (continued)

	Intensity of ICT adopted			Benefits in smart mobility					
				Reduction of pollution	Reduction of congestion	Increased safety	Reduction noise pollution	Improving transfer speed	Reducing transfer costs
4. Systems for collecting, storing and processing data, information and knowledge aimed to design, implement and evaluate policies and integrated initiatives of SM									
Demand control systems for access to reserved areas (cordon pricing, congestion pricing, electronic tolling, electronic tolling with GPS, pay as you drive)			H	*	*	*		*	
Integrated parking guidance systems		M	H		*	*	*	*	*
Variable Message Signs (VMS)		M	H		*	*		*	
Urban Traffic Control (UTC)		M	H	*	*			*	*
Video surveillance systems for area and environment security		M	H			*	*		
Integrated systems for mobility management			H		*	*	*	*	*
Traffic data collection systems (section control, variable speed limit control, ramp metering, etc.)		M	H		*	*			
Expert systems for the correlation and filtering of events (Automatic Incident Detection—AID)		M	H		*	*		*	
Addressing and control systems of urban and suburban traffic (section control, ramp metering, variable speed limit, activation of the emergency lane for congestion)		M			*	*		*	

(continued)

Table 5.1 (continued)

	Intensity of ICT adopted			Benefits in smart mobility					
				Reduction of pollution	Reduction of congestion	Increased safety	Reduction noise pollution	Improving transfer speed	Reducing transfer costs
Systems for the management of fleets and logistic		M	H	*	*			*	*
Systems for managing fleets of vehicles of public transport adapted to UTC (system of planning, monitoring and reporting of public transport service, integrated electronic ticketing system, information system for users of public transport)		M		*	*			*	*

Table 5.1, this set collects either solutions involving a change in the fleet of transport vehicles and fuels (such as the adoption of electric vehicles, vehicles EUR 5, vehicles with automated driving or CNG vehicles) or interventions which improve the quality of public service without impinging on vehicles (such as the introduction of an integrated ticketing system or the provision of collective taxis).

Analyzing the ICT intensity in these smart initiatives, it is possible to notice a heterogeneous picture. The actions range from low to medium ICT intensity. In the case of interventions on vehicles, they can involve different technologies than ICT, such as the use of electric motors, or may be ICT intensive, as in the case of driverless vehicles. Regarding the integrating ticketing, ICT intensity is high only if this policy is based on a set of applications requiring the use of smart devices such as mobile phone. In this case, the SMS-based solutions do not require large investments but they need citizens' involvement, readiness in terms of technological literacy and willingness to use this system. For this reason ICT, when introduced into an environment ready to accept it, is able to determine a significant step forward for the creation of a modern and sustainable urban transport system [37].

Case study: Public transport connecting people through increased multimodality in Munich, Germany

Munich is the Capital of the German state of Baviera and the third largest city in Germany. It counts 1.5 million inhabitants and is the 12th biggest city of the European Union. The Munich Metropolitan Region is home to 5.8 million people and enjoys a very high standard and quality of living, reaching #1 in Germany and #4 worldwide according to the 2015 Mercer survey [38].

Munich is the biggest urban economy in Germany, its territory hosts the most important and innovative German companies in important industries such as electronics (Siemens), automotive (BMW), engineering (MAN AG) and so on.

For its urban population of 2.6 million people, Munich and its closest suburbs have one of the most comprehensive and punctual transport systems in the world, incorporating the Munich U-Bahn (underground railway), the Munich S-Bahn (suburban trains), trams and buses. The system is supervised by the Munich Transport and Tariff Association (MTTA). The Munich tramway is the oldest existing public transportation system in the city, which has been in operation since 1876. Munich also has an extensive network of bus lines.

In 2014, the Munich's Public Transport Company (named MVG—Munchver Verkehrsgesellschaft) committed to participate to the global aim of the Municipality, to improve the smartness of Munich also thanks to a better quality public transport system. The declared high-level goals of this initiative are manifold and address the citizens' quality of life, the fight against climate change and a city's better competitiveness.

The strategic vision of the project regards the implementation of multimodality to enhance the use of public transport instead of private one. Specific actions include both infrastructural intervention and behavioural

changes. MVG is planning to build intermodal transport hubs to connect traditional public transport systems such as underground, suburban trains, trams and buses, with new transport facilities such as car and bike sharing. Priority lanes will be reserved for buses, electric vehicles will replace traditional ones, and new tram and underground lines will be built to connect newly developed residential and business districts.

ICT is placed at the core of this new conceived urban transport multimodality. A mobile app facilitates the intermodal transition between public transport and car and bike sharing and online tickets will be introduced.

MVG and the Municipality aims at achieve sustainability in urban mobility, but also at making the city more appealing for students, tourist and business, thanks to a well-connected public transport system. To reach these goals, a strong focus regards the increasing of public transport demand despite private transport: fewer individually owned cars, fewer traffic jams and fewer CO_2 emissions.

2. *Private and Commercial Mobility: Vehicles and Innovative Transport Solutions*

This group regards initiatives carried out by private citizens and companies, even if supported and stimulated by public policies. It includes a range of interventions that can affect both the introduction of vehicles with certain characteristics, and actions regarding the mode of transport which affect the citizens' behaviours.

Among the solutions most frequently cited in the Smart Mobility literature, we can find some actions belonging to this group such as hybrid cars and carsharing. Hybrid vehicles would allow a pronounced reduction of pollutant emissions without requiring, as a primary need, the development of new technologies.

Carsharing is a service that allows to use a car reservation, picking it up and bringing it back in a parking lot and paying due to the use made. It allows reduction of urban congestion, reduction of polluting emissions (gas and noise), reduction in employment of public space and, in general, a new push towards the use of public transport [38]. Findings also show, following the adoption of carsharing, one modal shift to other alternative modes of transport respect to the private car, such as walking or cycling [39, 40]. Nevertheless, there are possible disadvantages. According to Mariotti, [41] the strong importance related to the possession of the car may partly explain the lack of role played today by most of the active carsharing initiatives.

As evidenced in Table 5.1, many of the initiatives of private mobility are low ICT intensive, as bike sharing, another very frequent initiative. It is because almost all of these initiatives depend on the behaviour of single citizens, and it does not involve the role of ICT.

Case study: Smart Mobility platforms and services by Hitachi

Hitachi is a Japanese multinational company headquartered in Tokio. Hitachi is a highly diversified company that operates several business segments, such as Information and Telecommunication Systems, Power Systems, Electronic Systems and Equipment, Automotive Systems, Railway and Urban Systems, Digital Media and Consumer Products, Construction Machinery and Other Components and Systems. Founded in 1910, it is ranked 38th in the 2012 Fortune Global 500.

As previously described, Hitachi business segments regard both ICT and transport; also for this reason, the company is committed in developing technological solutions for smart mobility in smart city. In 2014, Hitachi launched Smart Mobility platforms and services initiative, looking for partnership with municipalities, high-tech companies and universities all over the world. Its aim is to enlarge its own business, designing city-tailored solutions for improving urban traffic and reducing pollution. The declared high-level goal of this initiative is to build a smart e-mobility society that contributes to meet the European 20-20-20 climate change goals. Hitachi is therefore strictly focused on the environmental dimension of a smarter city.

The comprehensive vision expressed by Hitachi about smart city is showed in Fig. 5.1. It includes several aspects: from energy production and supply, to transportation; from environmental preservation to city management. All these smart areas could be supported by ICT instruments developed by Hitchi for a better management of urban challenges.

To reach this goal, the company offers a large set of products: electric vehicles recharging terminals, electric vehicle fleet management systems, systems and solutions for grid integration and smart energy management systems, and others. Moreover, it suggests to cooperate, basing the smart mobility planning on several previous best practises developed in Okinawa (Japan), Maui (USA), Malaga (Spain), and so on. The platform will realize the implementation of an urban electric vehicle transport system, thanks to the cooperation with cities, municipalities, IT integrators operations and maintenance companies, technology suppliers and universities.

Operation goals to be reached regard the reduction of CO_2 emissions, the lowering of the dependence on fossil fuels, the noise reduction generated by traditional vehicles and the reduction of traffic congestion.

ICT is one of the core components of the Electric Vehicles platform, supporting all the operations with intelligent systems for optimizing the vehicle management, the energy production and distribution and the traffic management.

This case study outlines the pivotal role that a private company can play in supporting, suggesting and managing an urban smart mobility program, based on its own product portfolio and business experience. Municipalities are not the driver, but the main partner of this initiative. Given the products and solutions, the joint venture of Hitachi and the other smart city players (private

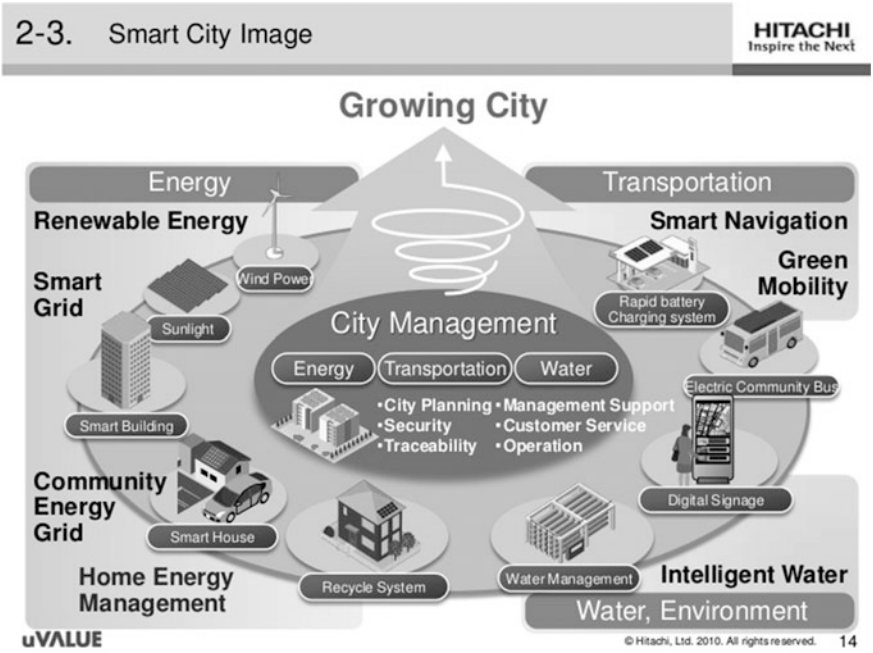

Fig. 5.1 The Hitachi Smart City vision. *Source* www.hitachi.com

companies and public bodies) will realize the best tailored-solution for different cities, capitalizing the previous competences.

At present, the initiative is being implementing in several European countries such as Poland, Baltic States and the Czech Republic. The existing partnerships shows the crucial role that a private company could play in coordinating financial investments in demonstration pilots, relieving the need of regulations and new public/private business models for supporting the further replication of best practises in other cities.

Moreover, Hitachi as a private company aiming at financial returns is particularly careful to realizing real value from smart initiatives. Therefore, projects will be implemented and supported by evaluation instruments such as performance management, benefit realization and knowledge sharing approach, able to demonstrate public and private value creation and to leverage near-term commercialisation of smart mobility solutions.

3. *Infrastructure and policies supporting mobility*

The third set includes two sub-groups of actions: infrastructure and policies supporting Smart Mobility.

The first sub-group collects infrastructural projects which, in different ways, affect urban mobility; for example, the creation of bicycle lanes or interventions aiming at changing mobility, as the creation of restricted traffic zones. The expansion or creation of bicycle lanes is an intervention that is closely linked to the use of the bicycle as a mean of private transport and could have positive effects on the spread of bike sharing; initiative that, despite the difficulties linked to the topography of each city and the possibility of theft, led to a modal shift from car to bike from 2 to 10 % in cities like Paris, Montreal and Lyon [42]. The closure to traffic of certain urban areas for time zones or periods of the day in order to reduce pollution and congestion represents another interesting solution adopted by municipalities. As highlighted by De Ciutiis [43] among the major objectives sought by the LTZ (Limited Traffic Zone in Italy), there may be safety compliance, particularly in the city center, especially in the peak hours of pedestrians, the reduction of pollution levels and the increase in revenue administration where it is expected to pay a congestion charging.

The second sub-group is represented by a set of integrated policies that can be implemented to change the mobility system, in particular by the public decision maker (for example: incentives for the use of less polluting fuels, tax incentives or measures such as higher taxation on polluting fuels). Other interventions that may alter the urban mobility are the redesign of the city and its spaces (residential and industrial areas, integrated neighbourhoods, etc.).

The two sub-groups contain actions which range from low to medium intensity of ICT: for example a low-intensive ICT is represented by an intervention amending, introducing or expanding a pedestrian zone. A low-intensive ICT initiative is the introduction of a speed control system supported by sensors, cameras and devices based on Information Technology devices.

Case study: Interconnected projects enabling Door-to-Door Mobility in Prague

Prague is the capital of Czech Republic and the 14th city in Europe. It counts 1.2 million inhabitants in the Municipality and 2 millions in its metropolitan area. Each day, 400,000 people commute to Prague for work, study, treatment or tourism, and it stresses the urban transport systems, also impacting on pollution and traffic.

In 2014, the Municipal Institute of Planning and Development (IPR Prague) launched the Door-to-Door Mobility initiative, included into the larger Smart Prague strategy. The initiative includes several interconnected projects, which enable a seamless travelling in Prague, combining several transport modes and usage of various city services, by the aid of mobile applications, devices and media.

The declared high-level goals of this initiative address the multifaceted nature of a smart city: the citizens' point of view is at the core of the initiative,

and to improve the urban mobility quality for people is the main goal, sided by other goals such as to reduce CO_2 emissions and improving the visitors' satisfaction respect to the mobility in the inner city.

To realize their initiative, several projects will be coordinated and further realized, with the aim to create positive synergies amongst different actions played by both public and private actors. Projects regard public transportation, park-and-ride facilities, multi-storey car parks, parking spaces, additional transport modes, integration of taxi services and alternative modes of transport such as electric vehicles. This initiative is interesting especially because it tries to put together all the projects regarding smart mobility to enhance the quality of services delivered to the customers. Figure 5.2 shows the Prague transport network.

ICT is at the core of the initiative, indeed the linkage amongst all the operational aspects is realized thanks to high speed internet access all over the Prague metro network, online ticketing for multimodal transport, open data and interfaces available under equal conditions to both public and private operators. Multiple funding is planned, involving also the private sector.

A special focus regards the shared use of transport data, at present collected in different logistic organizations in Prague, with great potential for use by experienced ICT operators. Prague wishes to interconnect data and made

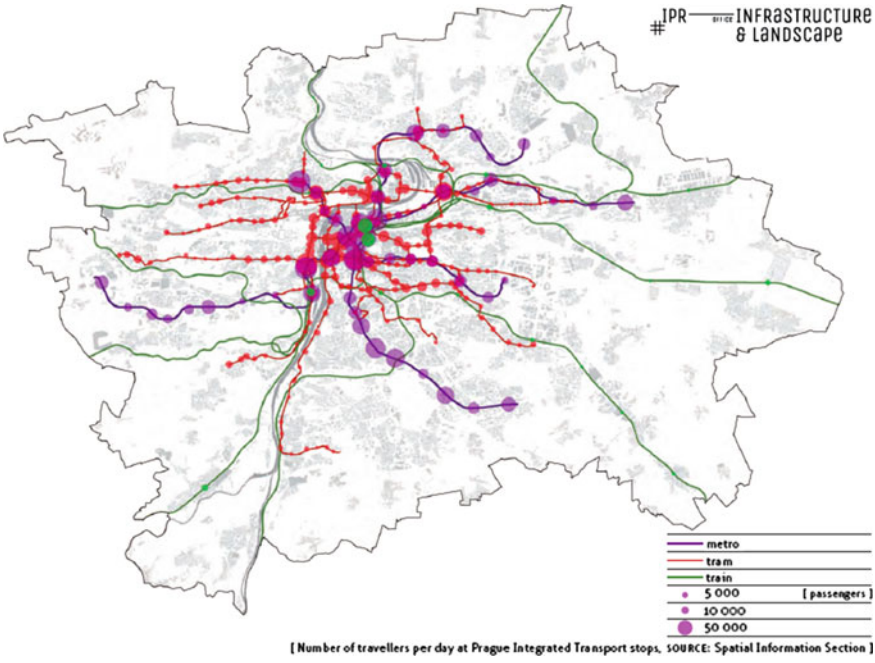

Fig. 5.2 Prague transport network. *Source* www.dpp.cz/en/

them available to partners bringing innovative solutions to the Door-to-Door living lab. The final goal is to make all the relevant systems communicate each other to realize a fully interconnected seamless transport.

To measure the output and outcome of the initiative, possible indicators are the quantity of greenhouse gases emissions saved, the share of public transport compared to individual transport, the citizens' satisfaction with transport modes, and the number of funding received from both public and private sources to finance the programme.

4. *Intelligent Transport Systems*

The fourth group consists of a large number of Smart Mobility solutions characterized by a medium-high intensity of ICT.

ITS are advanced applications to collect, storage and process data, information and knowledge aiming at planning, implementing ad evaluating integrated initiatives and policies of Smart Mobility. They are a large and heterogeneous set of applications, including the following:

- demand control systems for access to reserved areas (cordon pricing, congestion pricing, electronic tolling, with GPS, pay as you drive);
- integrated parking guidance systems;
- Variable Message Signs (VMS);
- Urban Traffic Control (UTC);
- Video surveillance systems for area and environment security;
- Integrated systems for mobility management;
- Traffic data collection systems;
- Expert systems for the correlation and filtering of events; etc.

In this set, the role of ICT is essential in supporting applications and systems of detection and processing of data and information. These systems can be very sophisticated and are designed to handle different kinds of information about activities related to mobility: you can then treat systems designed to detect and drive traffic, video surveillance systems, systems addressing the parking and so on.

According to ENEA, [43] experiences made so far in the EU countries, USA and Japan show that the introduction of ITS technologies has significantly contributed to improve the efficiency, safety, environmental impact and overall productivity of the transportation system. These applications, as pointed out by the European Commission, are an attractive solution to many of the problems of the transport sector: in the road sector it is possible to record reductions in journey times (15–20 %), in energy consumption (12 %) and in emissions of pollutants (10 %), as well as increases in network capacity (5–10 %) and decreases in the number of

accidents (10–15 %). Significant results have also been achieved in the fleet management and logistics processes of goods and in the delivery of passenger public transport.

This category is perhaps the most advanced frontier in terms of Smart Mobility solutions. It is a series of possible actions that can be implemented only under certain conditions: it is necessary, first of all, that the use of ICT is adopted in an integrated manner and to cover not only a few number of projects. The adoption of these solutions requires a holistic view, the presence of previous policies and an integrated vision across different dimensions of urban living. The rapid development of ITS technologies should be subject to reflections weighted with respect to purchasing decisions. Not taking into account the already started innovations can lead to unsolvable errors. In fact, many solutions are not expensive in the introduction phase, but they run the risk of poor acceptability by the community [23].

Case study: Distributed communications architecture for traffic management in Bilbao

Bilbao is a Municipality in Spain and the major city in the region of Biscay. The inner-city hosts more than 350,000 inhabitants and the metropolitan area has a population over 1 million people. It is the largest metropolitan area in Spain. Environ 240 thousands people enter or exit the city every day, 50 % by private car; there is only one main entrance through the San Mames tunnel.

To face the traffic problem and reduce pollution in the city center, the City council in cooperation with a pool of players launched the Distributed communications architecture, based on an intelligent system for collecting, processing and communicating information regarding traffic fluxes.

At present, actual Intelligent Transport Systems are complex architectures, composed by several subsystems working isolated. However, only data fusion permits to create a useful and timeliness information system able to predict traffic congestion.

The system is showed in Fig. 5.3. It addresses the whole Mobility and Transportation system in the city area and is based on an ICT urban infrastructure. The EcoTraffic module collects data from several stand-alone applications and connects them using the urban GIS. The output of this processing is an Open Data set delivering information to the users about all the aspects of moving in the city area: public transportation, traffic and congested roads, private transport services, parking and so on.

This ITS is not only an innovative ICT solution, but it is especially an example of multi-actors cooperation for gaining benefits for both the actors and the users. The partnerships is especially relevant due to the

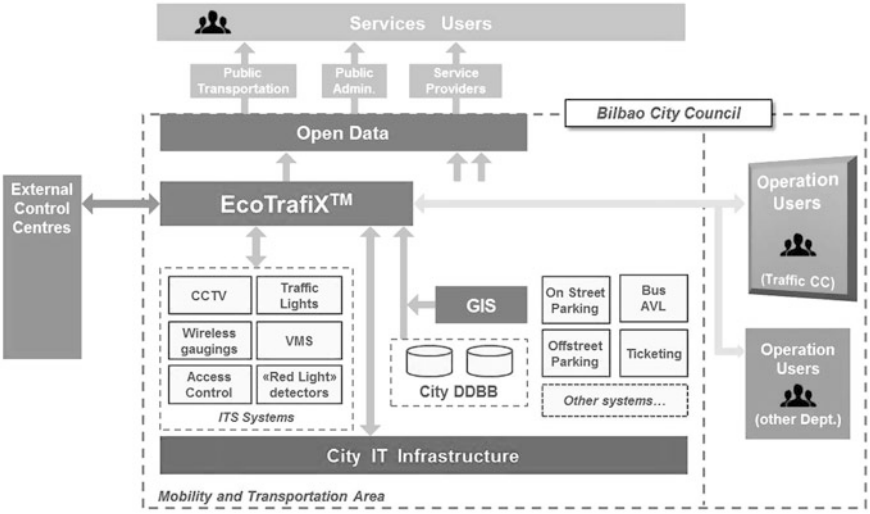

Fig. 5.3 ITS system framework. *Source* Schneider Electric, *Bilbao, Spain. Improving Traffic management operations*

complimentarily of the partners, involving public bodies, solution vendors, technology developers, transport companies and the final users.

Several benefits are expected from this project.

Main benefits to the public administration are the following: an increased collaboration between agencies to improve safety, through a series of pre-approved, coordinated, data-based, response plans; a single interface of all existing traffic and transport systems increasing operators' awareness and enabling more efficient operations; a reduction in traffic congestion; the definition of open standards to ensure interoperability for today and for a sustainable future.

Main benefits for citizens are an improved quality of life thanks to reduced traffic congestions and pollution, and the use of Open Data for involving citizens in a participated smarter city.

This case study regards a smart mobility solution completely based on ICT, but it is clear that the whole success of the initiative depends not only on the technological implementation, but especially on the capability to put together different operators and actors, joining different data and points of view.

5.4 Smart Mobility Actions and Smart Goals

The different groups shown in Table 5.1 and the actions composing them, highlighted in the first column, are related to two other macro variables evidenced in the second and third columns: the intensity of ICT for each action and the goals pursued by such actions. As already pointed out previously, the first macro column, titled "Intensity of ICT adopted", has three sub-columns, indicating a low, medium and high level of intensity of ICT. From the intersection between these columns and the rows corresponding to different actions you can then observe the level of ICT intensity. It is a systematization of a large number of initiatives discussed in the literature, with an emphasis on ICT. As can be seen from this classification, it can be state that the wide range of initiatives analysed is often but not strictly and necessarily tied to high intensity of ICT. Although the new frontier of innovation is certainly linked to the adoption of mobility solutions for ITS, we can say it is possible to adopt solutions and changes in the urban mobility without the need for large investments or sophisticated technologies. We can therefore argue that ICT is a pivotal, but not necessary technology to start the implementation of Smart Mobility initiatives; its importance, however, increases when the complexity and the maturity of Smart Mobility projects become higher. In ITS or other integrated Smart Mobility policies, ICT plays a crucial and fundamental role.

The second column, Benefits, is composed by six sub-columns, regarding the six smart goals as listed in Sect. 5.3. The highlighted goals are those pursued through the examined actions. As evidenced in the table, not all cells are complete because not all actions can be associated with a target, while some of them contribute to the achievement of more objectives.

Several findings derive from the analysis of Table 5.1 respect to the benefits associated to the Smart Mobility actions. First of all, an interesting evidence is that certain actions contribute to the achievement of these objectives more pervasively than others. Looking, for example, at some integrated systems based on ICT such as ramp metering or urban traffic control systems, it is possible to observe a positive effect that affects almost all the objectives. In this case, it is possible to say that the ICT, if properly directed, would seem to have a greater positive benefit than in other initiatives.

Finally, observing the listed objectives, it is also possible to note that these are closely related to those of a smart city as well as to the concept of well-being expressed by the OECD. In its "Better Life Index", in fact, the OECD underlines the most important areas that a society has to improve in order to enhance its quality of life. The concept of well-being is wide but it is possible to individuate some common targets to look at: the safeguard of the environment is strictly related to the reduction of PM10 concentrations in the air and green house gas emission and is one of the most important. Also personal safety and a good balance between work and life time are shared goals between well-being and Smart Mobility. It is possible therefore to argue that Smart Mobility directly impacts on the quality of life of people living in cities and to design a link between Smart Mobility actions and

well-being indicators. This could be very useful to better support Smart Mobility implementation, especially choosing the most effective actions and prioritizing the ones better impacting on citizens' well-being.

5.5 Conclusions: Results, Limits and Further Work

Several interesting findings emerge from the analysis of Smart Mobility actions rooted into the stream of studies regarding the Smart city and also its more consolidated components, that is, Digital City and Green City.

The main contribution of this paper is the proposal of an action taxonomy regarding a comprehensive approach about Smart Mobility; it deeply differs from the analysis founded in literature, generally focused on specific Smart Mobility projects.

Smart Mobility emerges from the survey like a pivotal component of Smart City strategies and Smart Mobility and Smart City goals are often overlapped. Smart Mobility contributes to Smart City aims with its specific but harmonized goals, impacting on the most important Smart City objectives such as reducing the environmental footprint of the city or improving the citizens' quality of life. The six Smart Mobility specific goals we suggest are fully linked with the larger Smart City ones.

ICT is not a must-have technology to implement Smart Mobility actions; several of them are based on other technologies (regarding vehicles or fuels for example) or on no technology at all but depend only on a more virtuous citizens' behaviour, such as using public transport or bike instead of private car. However, the role of ICT becomes fundamental when complexity, integration and extension of Smart Mobility programmes increase. Therefore, we can argue a positive correlation between the Smart Mobility maturity and the use of ICT.

From the survey, an evolving path in Smart Mobility actions and programmes emerges; it includes three phases that we can call: Starting, Intermediate and Mature. The Starting phase regards smart actions belonging to the first three groups shown in Table 5.1. Actions are often immature, not spatially coordinated, regarding only a small portion of the urban area, difficult to replicate elsewhere. It specially regards pilot initiatives implemented in European smart cities, at the beginning of this smart wave. The Intermediate phase includes several Smart Mobility governance actions, such as pilot projects repetition, integrated mobility plans, measuring benefits and negative impacts. The Mature phase is characterized by the use of ITSs, collecting, processing and sharing data, information and knowledge above a complex and integrated Mobility System. This set of initiatives is successfully implementable in cities only if they have already realized an implementation readiness, based on a large knowledge about Smart Mobility in city and a good level of citizens' involvement and awareness about Smart Mobility opportunities and potential benefits.

Finally, smart people are the winning card to implement sustainable, successful and effective Smart Mobility Systems, including both high technology applications and virtuous and aware behaviours. Especially in the most mature phases of the Smart Mobility implementation, each citizen is a proactive actor, accepting a limitation in its own transfer freedom (reducing the use of private car, for example) and embracing the pursuing of shared smart aims.

Despite the largeness of this analysis, it is possible to find some weaknesses and elements to be consolidated. The main weakness is represented by the need to move from a theoretical to an empirical analysis in order to validate the proposed classification. At present, only few initiatives are already fully implemented, the more of them are in the start phases and it is therefore impossible to evaluate the real benefits produced by Smart Mobility, regarding both single initiatives and a whole Smart Mobility portfolio.

As soon as the maturity of Smart Mobility actions will increase, the validation of our model would be stronger; it should especially regards the following:

- the validation of the suggested taxonomy, that is, the classification of Smart mobility actions in the four sets described in Table 5.1;
- the analysis of produced benefits especially for the citizens' quality of life;
- the definition of a set of indicators to measure the benefits.

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Chapter 6
Smart City and Digital City Implementation: Two Best Practices in Europe

6.1 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, composed by a large spectrum of heterogeneous solutions and 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, communication between citizens and institutions, private and public digital services, and so on. EU, several national governments and cities themselves have their own digital agenda to implement and are becoming therefore digital cities [4, 5].

This panorama is quite confused and it affects the quality and effectiveness of smart and digital city initiatives in reaching measurable and useful results. To better drive city strategies about smart investments, a clear definition of smart city and digital city is needed, able both to understand these important phenomena and to support strategic decisions [6, 7].

This chapter aims to suggest a definition of both smart city and digital city thanks to an empirical analysis comparing two implemented smart cities: 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 they goals are? 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

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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 best practices in Europe.

6.2 Smart City and Digital City: Urban Strategies for the Future City

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 the city in 2050.

In Fig. 6.1, we can see a graph showing urban population and demographic growth of the larger 15 cities all over the world. UN projects the population until

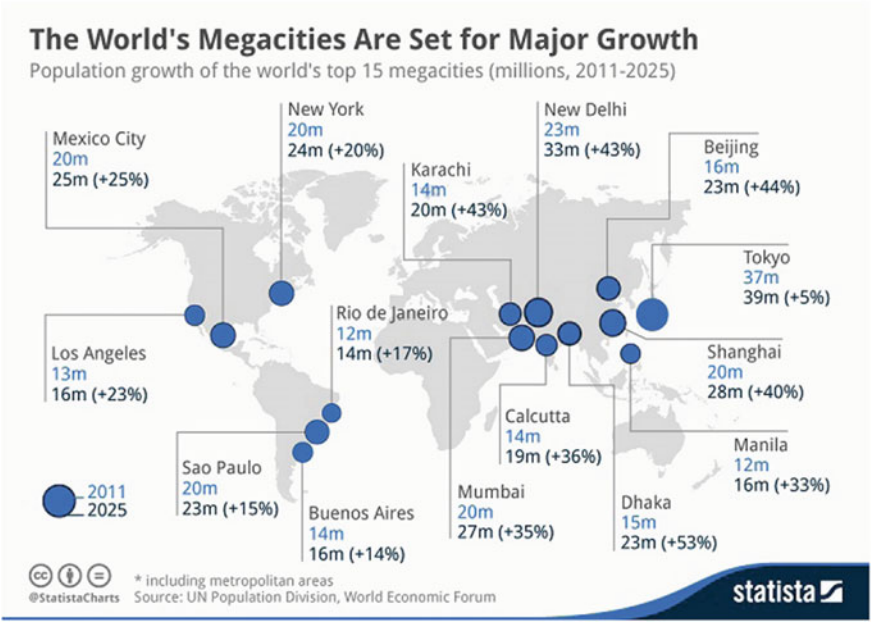

Fig. 6.1 Population number and growth in the 15 world's largest cities. *Source* UN Population Division

2023, outlining the continuous and sometimes dramatic increasing of the city dimension. 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 two percent.

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 6.1).

Opportunities in city are given by universities where to study, companies and public bodies 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?

However, the presence of people, organizations, and firms 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

Table 6.1 City threats and opportunities

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

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 manage. 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 infrastructure 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 attractiveness 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];
- an inclusive 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. It emerges from single initiatives of business, not-for-profit organizations, public bodies, local governments, universities, …aiming at using the technology to struggle against like pollution, energy shortage, water and air bad quality, poverty and social exclusion. It aims 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 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. Nevertheless, 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 generally 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. A well-conceived definition is necessary to drive choices and to increase the probabilities of success in a so difficult context. Therefore, in 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.

6.3 Defining a Framework to Compare Smart City and Digital City

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. Analysing the international literature about this aspect, several concepts emerge, potentially overlapping with the idea of a smart city. These concepts are grouped and showed in Table 6.2 [21].

Obviously, all these concepts are not in contradiction each other, as they share some aspects and are partially overlapping. Nevertheless, 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 important factors.

Table 6.2 Fundamental concepts of future city

Label	Definition
Intelligent city	It has several competences, is 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 uses technology to reduce CO_2 emissions, to produce clean energy, and to improve buildings efficiency; it aims to become a green city [25]
Technocity	It uses technology to improve the efficiency and effectiveness of its infrastructures and services. It focuses its smart projects on urban space quality, mobility, public transports, and logistics [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]

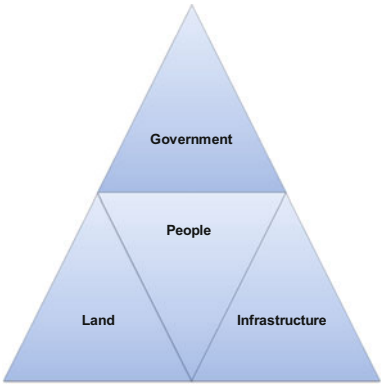

Fig. 6.2 Fundamental components of a city

To face this complexity, it could be useful to start from the analysis of the city concept, especially identifying such components functional to support a smart or digital city implementation. As showed in Fig. 6.2, 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 agency to manage and supply public services.

Also in the city tout court, all these components are not so well-defined. 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 [28]. 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 neighbourhoods to the city centre [29]. 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

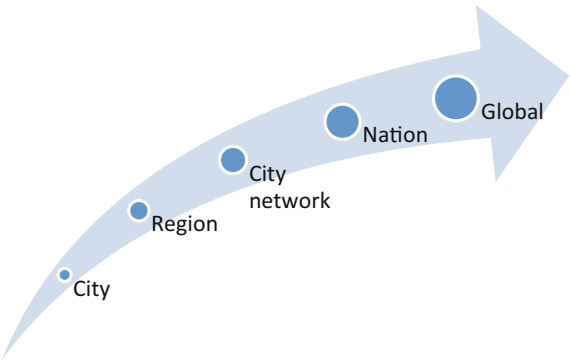

Fig. 6.3 Levels of urban policies: from the city to the global context

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 neighbourhoods and reaching their own workplace or school or university. Moreover, cities are visited by travellers 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 actions, the projects, …In Fig. 6.3 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.

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 the 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 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.

6.4 Smart City Profile

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

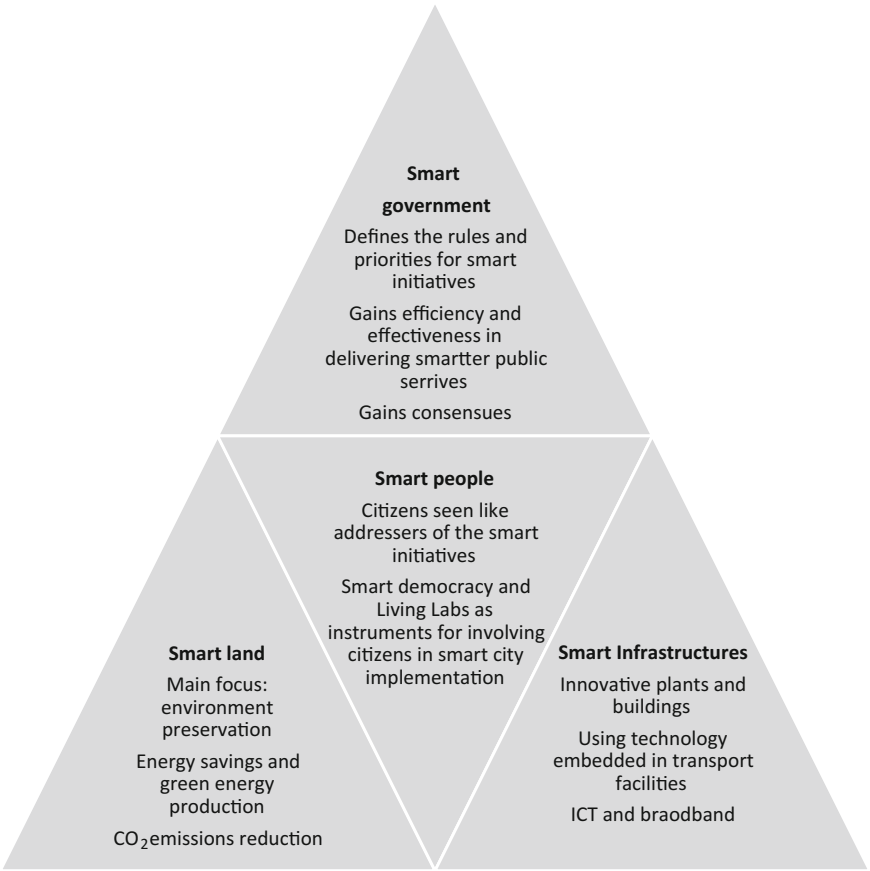

Fig. 6.4 Fundamental components of a smart city

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. 6.4.

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

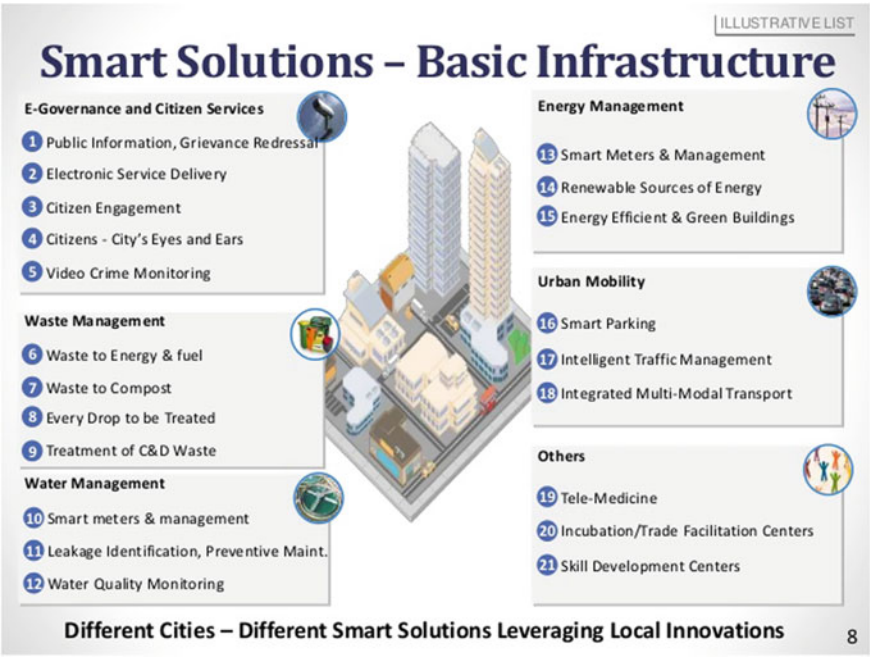

Fig. 6.5 Smart infrastructures

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. Figure 6.5 tries to cluster the most important smart city infrastructures depending on their scope. Some of them are strictly related with the environmental preservation, managing waste, energy and water. Other ones regard mobility and other public and private services such as health and education. Finally, a subset of infrastructures regard facilities aiming at an improved territorial governance and at delivering better services to citizens.

Regarding people in the EU smart city vision, the role of citizens is not very proactive, as they are mainly seen like the addressers of this strategy. The subjects actively involved in the smart city strategy are public administrations, universities, and research centres, and businesses. They play their own role (to govern, to discover, to produce), but are called 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, thanks to the capacity of the 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 citywide 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 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 as a larger plan focused not only on the energy pillar, but also 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.

This new vision is labelled "Smart cities and communities" policy, and also the label contains a stronger reference to people respect to material features. Figure 6.6 designs the policy details and structure.

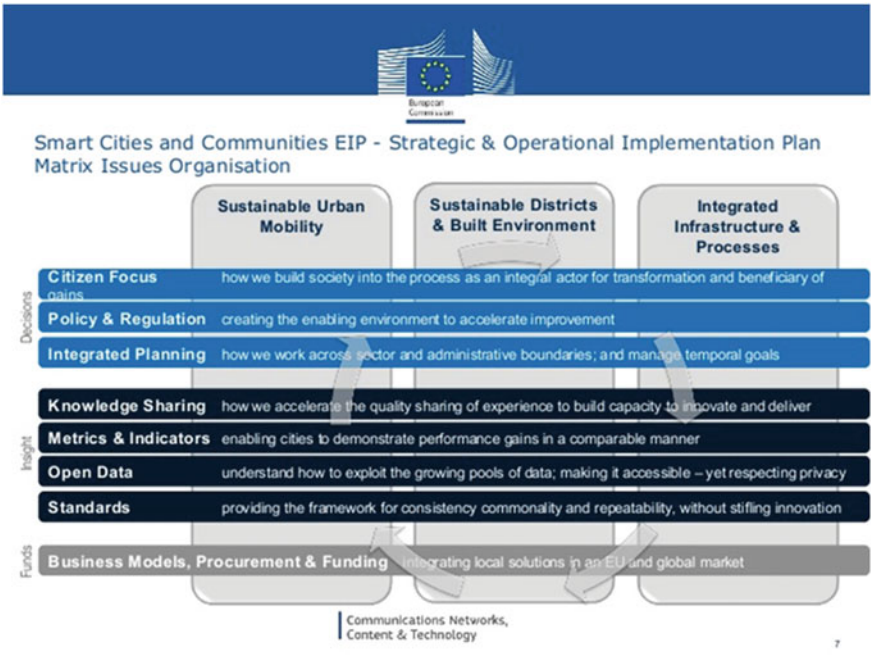

Fig. 6.6 Smart city and communities EU policy. *Source* eu-smartcities.eu/

Three main pillars are: sustainable mobility, sustainable districts, and integrated infrastructure and processes. The first two pillars are mainly focused on material facilities improving the liveability of cities and reducing pollution and energy consumption. The third pillar addresses the way the city is managed. All the three pillars are articulated respect to several cross-referential aspects, considering social and economic goals.

- Citizens Focus, Policy and Regulation, and Integrated Planning regard the need to formulate well-conceived smart city integrated strategies for delivering better results to people, and not simply aiming at the infrastructural excellence for itself.
- Knowledge sharing, Metrics and Indicators, Open data, and Standards, regard the use of ICT for implementing a more efficient and effective city, also defining common standards to facilitate best practices sharing and application reuse.
- Business models specifically addresses the need to define the long-term economic sustainability of smart programs, involving public and private agencies and firms in smart investments and funding.

6.5 Digital City Profile

The idea of a digital city has born in the nineties too, 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 updated 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 other and to create a dialogue between the citizens and the public administration;
- the e-service delivery, by both public agency and private entities and companies;
- the ubiquity of information, communication and services, thanks to the mobile technology.

Also the digital city, like the smart city, could be described adapting the basic components of the city to its characteristics, as shown in Fig. 6.7 (see also Figs. 6.2 and 6.4).

The land dimension regards the ICT 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,

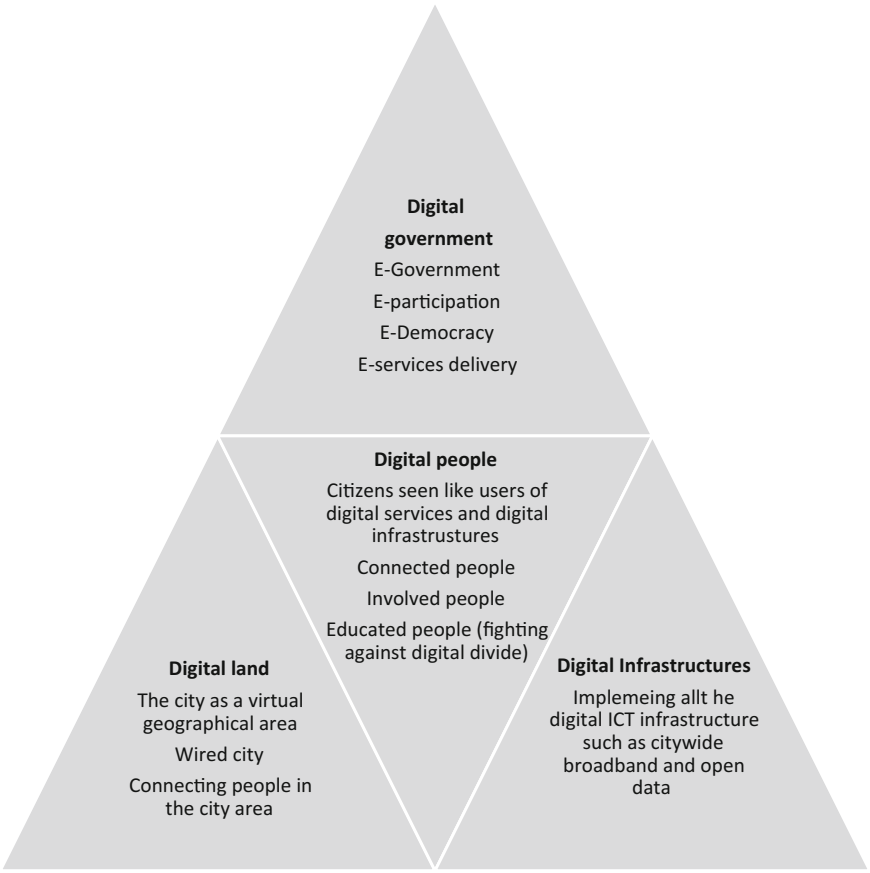

Fig. 6.7 Digital city fundamental components

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 is not enough to support the digital city implementation: the citizens' involvement is necessary too. 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 to digital city implementation is not the broadband extension 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 by 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 for this project, the lack of digital culture in the public administration. The government should increase the digital readiness of the public bodies and workers to success in the digital city strategy.

Examining these two frameworks regarding smart and digital city respectively, both similarities and differences emerge. Indeed, smart city and digital city are not the same thing, but several aspects regard the both. It requires a deepening.

6.6 Smart City and Digital City: A Comparison

The analysis of the literature and of the empirical implementation of some smart city 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 former 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 need both smart and digital projects to realize a better city for people. In Table 6.3, the main components and actions of smart city and digital city are summarized.

It is evident that the infrastructure 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

Table 6.3 Smart and digital projects taxonomy

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 **Information** – Processing of information to service programs **Service development** – Development of service application	
Smart city	**Smart transport and mobility** – Bike schemes – Real time bus timetable – Electric vehicle car pool – Congestion charging	**Renewable energy and energy efficiency** – Combined heat and power – Renewables – Electric vehicle charging points – Sensor to monitor traffic, pollution, emissions – Street lighting – Waste collection systems – Smart grids	**Smart and sustainable buildings** – Smart meters – Energy efficiency measures – Buildings integrated renewables – Smart appliances – Automatic weather forecasting

and cities. The 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.

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 pursuing a better 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 effective 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 Genoa, 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. Moreover, the empirical analysis will support the theoretical definition of smart city and digital city.

6.7 Case Study: Amsterdam Smart City

6.7.1 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.

The Digital city concept was 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.

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, that are 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.

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.

It is interesting to note that the urban strategy pursued by Amsterdam has deeply changed along the years. The European Digital City Index 2015 shows that the Dutch capital is European leader for entrepreneurial aspects, but far from to the top for ICT infrastructures. The main interest have moved to the smartness of the city, conceived like economic wellness and environmental preservation. Also the 2015 CITIE index ranks Amsterdam at the 5th place in the world as performing city, but the ranking in the Digital Governor dimension appears very low.

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.

6.7.2 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 definition 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 the subjects are, participating to the different implementation processes. In the Amsterdam Digital City experience, first mover were the citizens, organized in associations; precisely, 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 expires. 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 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 "Amsmarterdam 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, Gemeente Amsterdam, KPN and Liander.[1] 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 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 centres, 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 the environmental 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 6.4.

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 behaviour of citizens and knowledge sharing permits the successful smart implementation in urban spaces. It derives from a strategic choice regarding the active role of the citizens' intellect, awareness and commitment. Citizens are therefore both the main shareholders and stakeholders of Amsterdam Smart City.

6.7.3 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.

In this work, we examine an initiative portfolio made by 43 projects, organized by 5 themes and regarding three geographical areas inside Amsterdam urban boundaries. These projects are very heterogeneous, from different points of view: involved actors, applied technologies, citizens' role, and so on. However, all of them are mainly focused on energy transition and open connectivity. These streams

[1]Amsterdam Economic Board is a public agency joining representatives from businesses, knowledge institutes and government authorities, with the aim to enhance the prosperity and well-being of the Amsterdam Metropolitan Area. Gemeente Amsterdam is the Municipality of Amsterdam. KPN is the main Dutch landline and mobile telecommunications company. Liander is a Dutch utility company which operates in the distribution of electricity and natural gas.

Table 6.4 Key actors in Amsterdam Smart City and Digital 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-organising platform)	Formal organization

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. 6.8.

The main classification in smart city projects or digital city projects derives from the smart city definition suggested by Amsterdam Smart City and related in Sect.6.7.1. 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. 6.8, we define smart initiatives the ones aiming at sustainability,

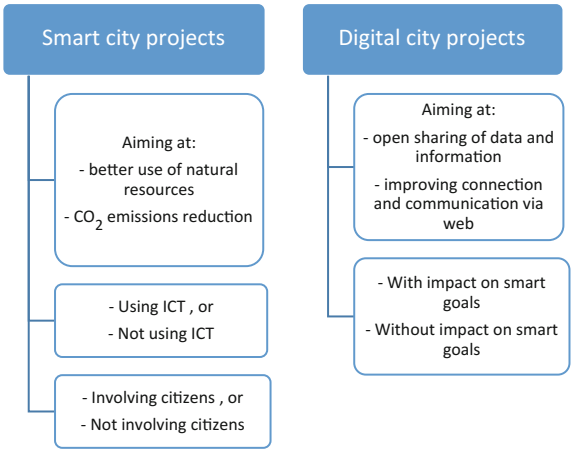

Fig. 6.8 Smart projects and digital projects: taxonomy

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 behaviour 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 technologies 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 behaviour towards a better use of energy through their higher awareness about consumption.

The project portfolio analysis is showed in Table 6.5. 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, 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. 6.8:

- 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 appeal to human behaviour, legal instruments, and so on, to improve city sustainability.

The classification of projects is displayed in Fig. 6.9.

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 behaviour to reduce Amsterdam environmental footprint. It means that Amsterdam Smart City is a strong-human-based strategy, were technologies and behaviours 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

Table 6.5 Amsterdam Smart city: project portfolio analysis

	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

(continued)

Table 6.5 (continued)

	Project	Description	Type	Spec
12	Health-Lab	Health-Lab is a collaboration between companies, government, care and research institutes to stimulate ICT & Care developments	DC	DATA
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

(continued)

Table 6.5 (continued)

	Project	Description	Type	Spec
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
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

(continued)

Table 6.5 (continued)

	Project	Description	Type	Spec
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
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, boardrooms 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

(continued)

Table 6.5 (continued)

	Project	Description	Type	Spec
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

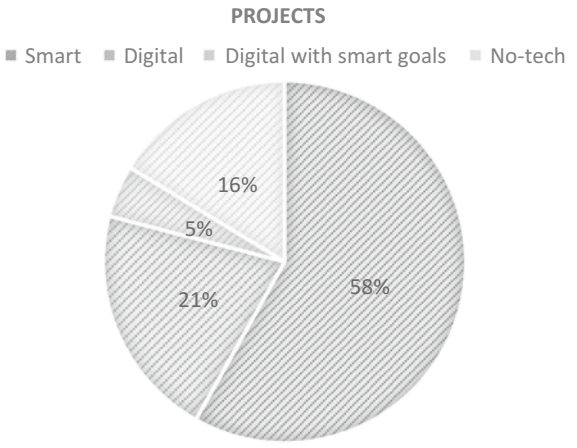

Fig. 6.9 Smart projects and digital projects in Amsterdam

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. In addition, these evidences show that the involvement of citizens and their communication are at the core of smart city strategy.

6.7.4 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 citizens, 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, labelled 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 Smart City, but with a top-down process this time;
- a special focus on people, their behaviour, their inclusion, their democratic participation to the city planning.

All these aspects—environmental attention, digital maturity and high democratic sentiment—are traditionally defining the cultural profile of The Netherlands. 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 habits 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 many 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. They often require the daily use of web and mobile devices to enjoy digital information and services. It would imply 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.

6.7.5 Conclusions

The analysis of Amsterdam Smart City 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 it 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.

Visiting the Amsterdam Smart City web site, it emerges that the city itself classifies all its smart projects in eight categories (Fig. 6.10):

- Infrastructure;
- Mobility;
- Areas;
- Open and Big Data;
- Economy;
- Living;
- Society;
- Living Labs.

Better examining these categories, we could say that:

a. Smart Infrastructure and Smart Mobility regard the material aspect of a smart city;
b. Smart Areas regards the green aspect of the city, referring especially to green areas, parks, and similar;
c. Open and Big Data refer to the use of ICT for a better sharing od data and knowledge;
d. All the other categories—Smart Living, Smart Economy, Smart Society and Living Labs—somehow refer to the way people live in their smart city.

Amsterdam is therefore evolving towards a citizens-oriented strategic view of a smart city, even if almost all of the categories include projects with both a strong technological aspect and a specific attention to the environmental preservation.

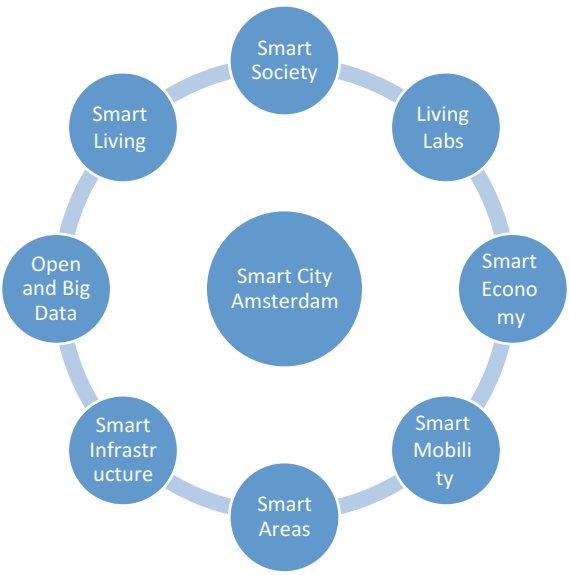

Fig. 6.10 Smart projects categories in Amsterdam. *Source* https://amsterdamsmartcity.com/

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 the following: "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 behaviour 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.

6.8 Case Study: Genoa Smart City

6.8.1 Introduction

If Amsterdam is recognized like the first digital city in the world, Genoa is the leader city in winning European calls for smart cities. Genoa 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, Genoa 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. Genoa 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 Genoa. No other initiatives had been implemented before (Fig. 6.11).

The Genoa success derives especially from the strength of the team defining the projects and a comprehensive strategic vision for Genoa Smart City. This team was initially composed by three big players, that is: the Municipality of Genoa, the real mover of the strategy; a couple of large companies in the energy and building industries; and the University of Genoa, especially the Polytechnic Faculty. This team includes from the beginning all the main actors able to activate the triple helix

Fig. 6.11 Genova Smart City logo. *Source* www.genovasmartcity.it/

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, Genoa 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, 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 Genoa 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 Genoa's smart city definition. To pursue a comprehensive result, the governance structure and processes are crucial; for this reason, Genoa 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.

6.8.2 Key Players

To drive and govern the smart strategy implementation, Genoa 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, which are: Genoa Municipality Enel Spa (the Italian main electricity producer) and the University of Genoa. 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 Genoa 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 Genoa, 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 Genoa, CNR (National Research Centre) and IIT (Italian Institute for Technology, settled in Genoa).

In Fig. 6.12 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 and dissemination. GSCA is an important example of quadruple helix and it is the main strength for Genoa, 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.

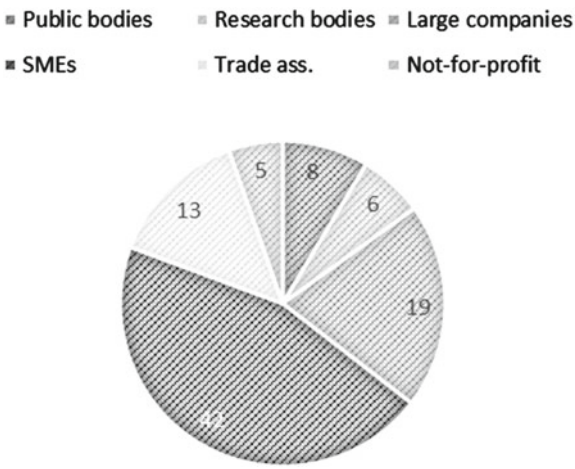

Fig. 6.12 GSCA members categories

Moreover, it should be considered that Genoa 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 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 6.6 we can compare the key players in Genoa and in Amsterdam. There are some similarities 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, Genoa choose a flat and open one. Genoa, 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 Genoa Smart City gaining the higher consensus. At present, it is first to say 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 Genoa and Amsterdam settled a formal body to govern the smart city strategy, in which the Municipality is a key actor, but the Smart city body is a separated legal entity. It is an important choice, in Italy only Genoa made it; it shows the intention to assure to the smart city an independent life respect to both the politic local Govern and all the private companies.

Table 6.6 Key actors in Genoa Smart City and in Amsterdam Smart City

	Genoa 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	Forma organization (association)	Formal organization (public agency)

6.8.3 Initiatives

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

For the first, Genoa won three large EU calls for smart city projects. Other six projects received funds from both international and national government bodies, for example from MIUR (Minister for Education, University and Research), from different calls respect to smart city topic, but similar in their contents. Initiatives are other actions drove by the Municipality of Genoa and regarding especially its own organization. All the projects and initiatives have been analysed and classified applying the schema already applied for Amsterdam, showed in Fig. 6.8 and explained in Sect. 6.7.3. The results of this analysis are showed in Table 6.7 regarding the 9 large projects and in Table 6.8 regarding the 51 initiatives.

Analysing Table 6.7, 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 many 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 behaviours 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.

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

Table 6.7 Genoa Smart city: project portfolio analysis

	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 Labs	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

Generally, we could conclude that Genoa choose to apply to EU calls, completely assuming the EU smart city vision, strongly committed in pursuing CO_2 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 6.8. 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 regards regulations about the behaviour of the Municipality, introducing a smart trend in each act, for example introducing green criteria in procurement, or regards infrastructure initiatives like cycling routes, local public transport, and so on. The projects + initiatives range composition in Genoa is showed in Fig. 6.13.

The graph shows that the highest number of projects is classified like no-tech. This outline the more comprehensive vision of Genoa Smart City. Indeed, not only Genoa settled from the beginning a formal association to govern the Smart City initiative, but it gives the highest importance to the context definition. Genoa 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.

Table 6.8 Genoa Smart city: initiative portfolio analysis

	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 6.8 (continued)

	Title	Description	Type	Spec
14	FTTH «Fiber to the home»	To offer to citizens broadband services	DC	COMM
15	Municipal building 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	
27	CycleCities	To promote an educational campaign regarding policy-makers, citizens and institutions, about the importance of sustainable transport systems	NOTECH	

(continued)

Table 6.8 (continued)

	Title	Description	Type	Spec
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
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	

(continued)

Table 6.8 (continued)

	Title	Description	Type	Spec
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

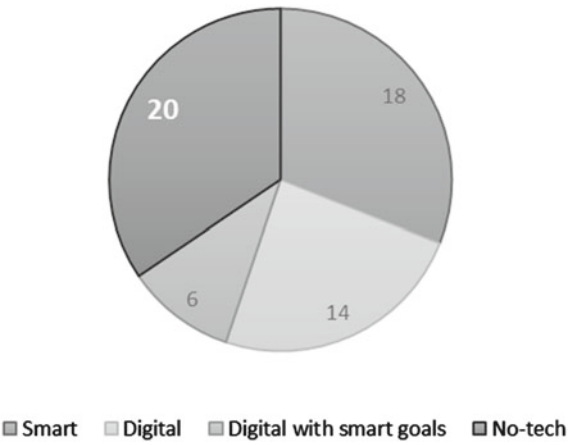

Fig. 6.13 Smart and/or digital projects in Genoa Smart City

6.8.4 Analysis

The deep analysis of Genoa Smart City case shows to us that different paths could be walk through, to improve the smartness of a city. Genoa is an interesting case especially because it demonstrate 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 follower could be better than the first movers, because they will be able to apply the best practices and the policies and guidelines developed worldwide to drive the smart city implementation.

Our analysis is useful to outline both the strengths and the weaknesses evidences in this large smart strategy. The main strength for Genoa 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 Genoa in further projects. Thanks to its nine international projects, Genova participates to a large network of European cities, both large and medium, at different stages in implementing their own smart strategies; this is an inestimable knowledge base.

Finally, Genoa 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 compromise 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 also 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 an 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 to improve digitalization and employees training in planning, using and delivery ICT applications and services.

6.8.5 Conclusions

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

The project portfolio of Genoa Smart City contains eight 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 Genoa to participate to the EU calls for funding. We could say therefore that the Genoa Smart City project portfolio is

EU-driven and it reflects the EU smart city idea indeed. Depending on this point of view, Genoa is very smart and few digital, 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 Genoa. In this second case, the portfolio composition is different. Not only can we 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, Genoa 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 Genoa Smart City experience is the more integrated view of smart initiatives and project. It emerges not only from the role of AGSC in governing the whole process of improving the smartness of Genoa, 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, Genoa links the smart project portfolio to the SEAP—Sustainable 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 Genoa in describing its own aims, as reported in Sect. 6.8.1; and the pursuing of more restricted goals, such as CO_2, more reflecting the EU definition of a smart city.

It impact also on the smart portfolio composition; on one side, the smart projects are too focused on few topics, especially energy consumption al pollution reductions; 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, Genoa 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 initiative aiming at reducing pollution and CO_2 emissions and reducing the energy consumption: it reflects the EU smart city idea;
2. the "intermediate" 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, does not help us to define a smart city thanks to the empirical analysis. In the further and last paragraph these two empirical cases—Amsterdam and Genoa—will be compared each other to extract a smart city evidence from the overlapping of these two leader experience in Europe.

6.9 Conclusions, Lessons Learned and Further Works

The analysis of these two case studies—Amsterdam and Genoa—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 that 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 Genoa 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 pursue 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. The required infrastructures are well identified too, 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 also 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 driver 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 Genoa 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 the EU funds all the big smart projects 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 Genoa smart initiative portfolio.

In addition, the smart city considers technology like a core component, but in this case, we have not 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 Genoa smart initiative portfolio, we discover that in Amsterdam the involvement of citizens generally plays a more important role than in Genoa, 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 Genoa, 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 government 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 a fuzzier 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.

Moreover, digital city is based on only a technology, that is, ICT, whereas smart city is based on several innovative technologies. It 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 Genoa 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 Genoa join 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. 6.14).

- 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 joins 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.

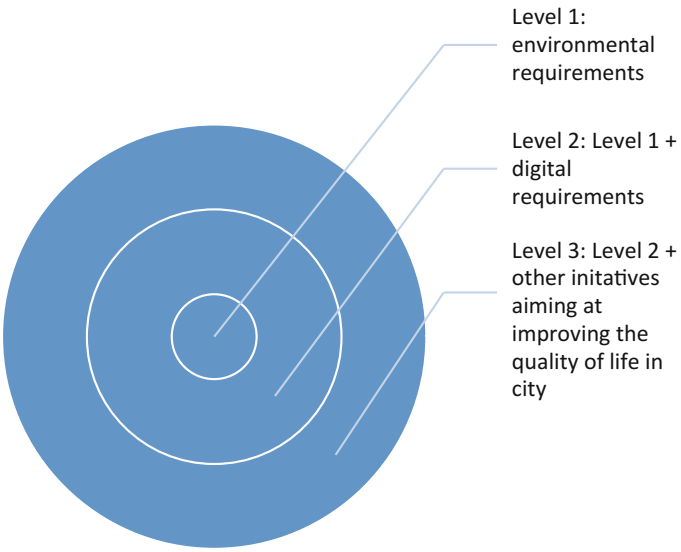

Fig. 6.14 A three-level smart city definition

- 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.

A comprehensive comparison between smart city and digital city and their different characteristics are exposed in Table 6.9. Even if smart city is absorbing digital city, these two different urban strategies need different processes and

Table 6.9 Comparing Digital city and Smart city

	Digital city	Smart city
Year	Nineties	Boom in 2009 and following
Technology	ICT	Hard technologies, especially applied to energy production, building efficiency, mobility
Focus	Information and communication by digital devices	Environmental impact of urban areas; energy
Process	Bottom-up	Top-down
Citizens	Active involvement	Active involvement not required, it depends on both the city vision and each specific smart action
Governance	No formal governance structure	Formal governance structures, driven by public bodies and especially Municipalities

practices to successfully be implemented and to gain the best results from them. For this reason, even if they are concretely fused 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 impact 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 action affecting environmental aspects such as energy use and CO_2 emission reduction or cleaner energy production by renewable sources. 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. More and 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 strategies 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 scope of smart city negatively impact 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, 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 project 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 work 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.

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