Smart City and Digital City: Twenty Years of Terminology Evolution

R.P. Dameri[1] and A. Cocchia[2]

Abstract During the latest years, Smart city and Digital city have been recurring topics, especially after 2010. Smart and digital urban development is used like strategy to improve the quality of life in the cities. However, smart city and digital city are not well defined nor their boundaries are clearly identified. Smart and digital, referred to cities, are indifferently used, even if they have different meanings. The lack of a clear definition of smart city and digital city impacts on the difficult to sustain a strategy definition for urban development and to measure performance and reached results. It prevents local and central governments and companies to define a development path to implement smart and digital urban projects. This paper aims to investigate about the evolution of smart city and digital city concepts during the latest twenty years. A deep literature survey permits to compare each other several smart city and digital city definitions and finally to design the contents and the boundaries of each of these urban development paths, to better support urban strategies design and city performance evaluation.

Introduction

Smart city and digital city are more and more used concepts both in scientific literature and in technical reports. Also politicians, city governments and hi-tech companies use these smart city and digital city concepts to refer to the ideal city, more suitable to respond to the needs of its citizens (Hollands 2008). Indeed, during the latest fifty years, the world population has been moving from the country to the city, generating an increasing of urban problems such as traffic, pollution, energy consumption, waste treatment and so on (Caragliu et. al. 2009). To improve the urban quality of life, a comprehensive sustainability strategy is needed, aiming at creating the best conditions for people living in cities. To support this strategy, technology plays a key role (Dameri 2012); indeed, it is used to implement actions, projects and programs aiming at different goals, such as:

[1] University of Genova, Department of Economics, Genova, Italy, e-mail: dameri@economia.unige.it

[2] University of Genova, Department of Economics, Genova, Italy, e-mail: cocchia@economia.unige.it

- to improve environmental quality in urban space, reducing CO_2 emissions, traffic and waste;
- to optimize energy consumption, by building efficiency and renewable energy production;
- to increase quality of life, delivering better public and private services, such as local public transport, health services, and so on.

More generally, we could say that a smart city strategy aims at using the technology to increase the quality of life in urban space, both improving the environmental quality and delivering better services to the citizens (Hall 2000).

One of the most important technologies used to support the smart city strategy is ICT (Dameri 2013); for this reason, digital city is often used like a synonymous of smart city. Also other synonymous are used, but digital city is the most recurrent. However, it is not clear if these two words – smart and digital – really want to say the same thing or if they defines different cities, strategies and technologies. This is not only an academic or theoretical topic, but also an operational one, because to correctly define the type of city we desire is the first step to well drive the political, economic and technical choices to implement useful and profitable projects and actions to build our ideal city.

For this reason, the aim of this work is to investigate about the evolution of smart city and digital city concepts during the latest twenty years, in order to understand if they are completely different each other or if they somewhat overlap and share some contents. To accomplish with this goal, the authors follow two main steps:

1) to carry out a large literature survey aiming to identify and compare each other the most recurrent and validated definitions about smart city and digital city;
2) to outline the contents and the boundaries of smart city and digital city, in order to individuate both similarities and differences and to understand how much smart city and digital city are overlapping strategies and how much they are different.

The final output of this work is a deep analysis and comparison of smart city and digital city definitions, useful to support both a well-conceived city development strategy and the design of a performance evaluation framework.

Research Method and Strategy

During the latest twenty years, smart city and digital city have been used like synonymous, even if they have different meanings and perhaps suggest different contents. To investigate the terminology evolution about smart city and digital city, the research activity has been organized in the following steps.

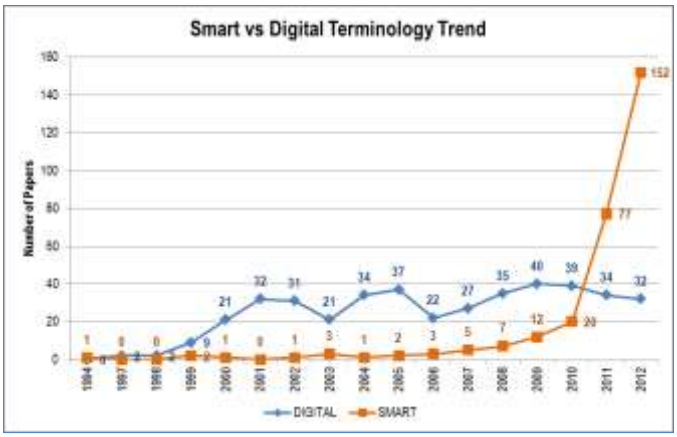
1. To extract from a database a representative subset of theoretical and empirical academic publishing regarding smart city and digital city. The search was carried out between February and April 2013 and the selected database was Google Scholar. The system was request to search the keywords *"Smart City" OR "Digital City" OR "Smart Cities" OR "Digital Cities"* only in the title of contribution and excluding all citations and patents. Afterwards, the Google Scholar was request to sort the found results by year of publication within 1993-2012 range. The system found 843 writings. From this result, all duplicates, thesis, power point presentations, book introductions, all works not in English language and all papers without the full abstract available were excluded. Summarizing, these criteria exclude 115 contributions leading to a total of 705 writings relevant to the present study.
2. To collect and store the 705 selected papers in a matrix in order to organize them by year of publication and by "smart" or "digital" label, according to the adjective used in the title. The final aim of these labels is to show in a graphic the time distribution of papers regarding smart city or digital city during the latest twenty years and, at the same time, to analyze how and when these two concepts have being conceived.
3. To select the most cited and validated definitions of smart city and digital city introduced in the papers.
4. To compare the selected definitions each other, in order to individuate if smart city and digital city have some similarities or differences, and if and how much they overlap.
5. To design the boundaries and contents about smart city and digital city, depending on similarities, differences and overlaps highlighted in the previous step.

In the further paragraphs, the results of this survey are showed, analysing both the time trend and the content of the selected papers.

Smart City and Digital City Terminology Evolution

To analyse the time trend of terminology evolution, the 705 selected papers have been labelled as "smart" or "digital" according to the adjective used in the title to describe their content. Afterwards, all writings have been sorted by year of publication. The time trend regarding the recurrence of these two labels is showed in Figure 1.

Figure 1. Smart versus Digital terminology trend from 1993 to 2012



The graph shows that the digital city concept was born before the smart city idea, conceived in the nineties in the context of Internet adoption in everyday life (Ishida 2002). It is based on virtual environment and ICT (especially Internet) in order to improve the citizens quality of life through the supply of e-services (Anthopoulos et al., 2012). During the considered time frame, the number of theoretical and empirical academic papers about digital city has constantly been increasing, but the trend is quite linear, without peaks or huge hikes. Therefore, the digital city idea develops along with the ICT development, and it is mainly represented by e-Government policies and projects, before to become a comprehensive urban strategy, called digital city indeed.

The smart city concept was born also in 1994, but papers regarding this topic are few or zero for several years. They began to strongly increase in 2010, when European Union started to use "smart" to qualify sustainability projects and actions in the urban space (Al-Hader et al. 2008). Indeed, the smart city idea is mainly connect to:

a. EU SETIS strategic objectives. The EU SETIS project aims to implement smart city initiatives to reduce the greenhouse gas emissions up to 40% by 2020, integrating the most appropriate technologies and policy measures in the following fields: building efficiency, energy networks, sustainable transports, low-carbon energy production and so on;
b. the use of the word "smart" to qualify a family of smart electronic devices. From 2007, when Apple launched the i-phone (the first smart phone), the adjective "smart" has started to identify devices able to combine data processing, Internet connection and mobile telecommunication, in order to supply real-time digital information and services to their users and to improve their quality of life.

The terminology analysis allows us to understand which are the main shared features and differences between digital city and smart city idea:

- digital city is mainly based on one unique technology, ICT and especially Internet (Anthopoulos et al. 2012); this urban strategy aims to supply information, communication and e-services to citizens and to connect them both themselves and with the public administration. Therefore, the digital city concept is more focused, its technological basis is well defined, its boundaries are more clear and the desired results are more narrowed and easier to measure;
- smart city is more difficult to delimit (Dameri 2013). It regards both sustainable technologies, able to reduce pollution and energy consumption, and communication technologies, based on the large use of smart phones or other smart devices. Moreover, also ICT could be at the basis of sustainable urban strategies, such as smart software used to support a better local public transport planning. The use of the smart label to address sustainable cities is driven by EU programs, but the smart city idea overcomes this definition to collect under this urban strategy heterogeneous technologies and policies. Moreover, the smart city concept is not entirely based on technology: also energy savings through more aware behaviour, or larger urban green areas, are sometimes considered smart actions.

Therefore, there is a terminological confusion about smart city and digital city, for several reasons: the use of the word smart to indicate ICT devices; the EU impulse to use the word smart to indicate environmental policies; the use of ICT also to implement smart projects; and so on.

A deeper analysis of smart city and digital city definition, in the further paragraph, will be useful to better separate these two ideas, not completely different, nor completely equal.

Smart City and Digital City Definitions

To better understand similarities, differences, boundaries and contents of smart city and digital city ideas, a deeper analysis of most important definitions has been carried out. In Table 1 and Table 2, respectively, the most cited and meaningful smart city and digital city definitions are listed. Each table discloses the definition and the reference. To compare these definitions each other, a text analysis has been fulfilled and some words have been evidenced, to extract the meaningful of these concepts. We use bold character to outline the human component of smart/digital city and italic character to outline used technologies.

From a comparison of these definitions, it emerges that both smart city and digital city are addressed to the citizens, aiming to improve social inclusion, e-

services, economic and political efficiency, urban development, in order to enhance citizen quality of life. However, they are different on other points of view.

Table 1. Smart City Definitions

#	Smart City Definitions	Ref.
1	"A Smart City is a city well performing city built on the 'smart' combination of endowments and activities of self-decisive, independent and aware **citizens**".	Giffinger 2007
2	"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. 2009
3	"Smart City is the product of *Digital City* combined with the *Internet of Things*".	Su 2011
4	"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
5	"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 2012
6	"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 2013

Table 2. Digital City Definitions

#	Digital City Definitions	Ref.
1	" 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 & Shaofu 2001
2	"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 2007
3	"The concept of Digital City is to build an arena in which **people** in regional communities can interact and share knowledge, experiences, and mutual interests. Digital City integrates urban information (both achievable and real time) and create public spaces in the *Internet* for people living/visiting the city".	Ishida 2002
4	"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 2008

For a deeper analysis of these differences, we consider the constituent elements of a city; we define at this aim the following elements:

- land, that is, the physical area on which the city is built;
- infrastructures, that is, the physical features making a city: buildings, transports, other facilities;
- people, that is, inhabitants and other subjects working, studying and living in the city;
- government, that is, the political bodies driving the city.

Each of these constituent elements has different characteristics in case of smart city or digital city.

- *Land*: concerning smart city, this dimension is mainly considered as physical land corresponding to the administrative boundaries of city, region or city networks. In digital city land is mainly considered as virtual land, that is, a virtual representation of the city, such as network community, networked society, virtual space, and so on, in which people can share data, information and knowledge each other (Ishida 2002). Therefore, smart city has physical boundaries, while digital city has virtual ones.
- *Infrastructures*: smart city includes all types of infrastructures, both physical ones such as streets, bridges, buildings, broadband, railways, etc. and virtual infrastructures such as some elements of ICT (software and telecommunications). Digital city infrastructures are only represented by ICT, especially Internet and technologies such as Internet of Things, cloud and ubiquitous computing, Web 2.0, and so on (Anthopoulos et al. 2012). ICT is present in both these concepts, but in smart city all the innovative technologies are considered useful for implementing a better urban space.
- *People*: in smart city , people are represented by all individuals who lives the city, such as inhabitants, workers, students, tourists and so on. In digital city, people are considered from two points of view: enablers, who are able to stimulate the digital city implementation, and recipients who are able to use the e-services and to gain real benefits from them (Dameri 2012). So, in smart city, people can also not be able to use ICT but they must have the "smart culture" to enable a virtuous behavior in order to reach the sustainability; while in digital city, people must be able to use ICT in order to enable and enjoy e-services (Komninos 2008).
- *Government*: concerning smart city, governmental authorities are mainly local Public Administration, central Public Administration and International Institutions (such as European Union). They aim to improve sustainability and citizen quality of life. Concerning digital city, government is oriented to e-government and e-governance because its main purpose is to improve the relationship among citizens and between citizens and Public Administration through the network and e-services supply.

Finally, examining smart city and digital city and considering in details their constituent elements, several differences emerge; smart city and digital city are two urban strategies aiming at improving the quality of life for citizens, but they use different technologies, different instruments and address different areas and different citizen targets. Therefore, a city can pursue both a smart and a digital strategy, a mix of them or only one of these paths; important is to be aware of this, to better address efforts, resources and investments towards the desired results.

Conclusions and Further Studies

Smart city and digital city are often confused each other, and these two terminologies are used indifferently to indicate an innovative urban strategy, aiming at improving the quality of life in urban areas, especially in large cities. However, a deeper analysis of their meanings and their contents reveals that smart city and digital city define different development paths for cities, with different instruments to be used and different goals to be reached, even if smart city and digital city have several overlaps and common strategies.

Similarities and differences in smart city and digital city have been evidenced, and they are useful to both drive local and central governments to orient their policies for urban innovation, and to measure and evaluate reached results for public administration and citizens in improving the quality of life in even larger and complex cities.

References

1. Hollands R. (2008), "Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?", *City: analysis of urban trends, culture, theory, policy, action*.
2. Caragliu A., De Bo C., Nijcamp P. (2009), "Smart city in Europe", 3rd Central European *Conference in Regional Science.*
3. Dameri R.P. (2012), "Defining an evaluation framework for digital cities implementation", *IEEE International Conference on Information Society* (i-Society).
4. Hall P. (2000), "Creative cities and economic development", *Urban Studies*, Volume 37, Issue 4, pp. 633-649.
5. Dameri R.P. (2013), "Searching for Smart City definition: a comprehensive proposal", *International Journal of Computers & Technology*, Volume 11, Issue 5.
6. Ishida T. (2002): "Digital City of Kyoto", *Magazine Communications of the ACM – How the virtual inspires the real*, Volume 45, Issue 7, pp. 76-81, ACM New York, NY, USA.
7. Anthopoulos L., Tougountzoglou T. (2012), "A viability model for Digital Cities: economic and acceptability factors", *Web 2.0 Technologies and Democratic Governance*, Volume 1, pp. 79-96.
8. Al-Hader M. and Rodzi A. (2009), "The Smart City Infrastructure Development & Monitoring", *Theoretical and Empirical Researchers in Urban Management*, Volume 2.
9. Giffinger R. (2007), *Smart Cities: Ranking of European medium-sized cities*, Centre of Regional Science, Vienna.
10. Su K., Li J., Fu H. (2011), "Smart City and the applications", *IEEE International Conference on Electronics, Communications and Control (ICECC)*, pp. 1028-1031.
11. Setis-Eu (2012), setis.ec.europa.eu/implementation/technology-roadmap/
12. Qi L. and Shaofu L. (2001), "Research on Digital City Framework Architecture", *IEEE International Conferences on Info-Tech and Info-Net*, Volume 1, pp. 30-36.
13. Schuler D. (2002), "Digital Cities and Digital Citizens", *Digital Cities II: Computational and Sociological Approaches, Springer LNCS*, Volume 2362, pp. 71-85.
14. Komninos N. (2008), "Intelligent Cities and Globalization of Innovation Networks", *Routledge*, London.
15. Dameri R.P., Cocchia A. (2012), "Defining a comprehensive framework for EHR evaluation", *International Journal of Electronic Governance and Research*, Volume 1, Issue 3.