Chapter 5
Sustainable Social Innovations in Smart Cities: Exploratory Analysis of the Current Global Situation Applicable to Colombia

Antonio Alonso-Gonzalez, Lorena A. Palacios Chacon, and Marta Peris-Ortiz

Abstract In the current world most of the population is concentrated in urban areas, where people receive their education, work and leisure activities. Therefore, many challenges have appeared in cities all over the world related to growth, over-population, urban planning, quality of services, competitiveness, environmental factors and citizenship values, which have become main priorities of the managers and mayors of these cities. The Smart City concept emerges as a paradigm that aims to solve these problems and challenges, by developing policies, infrastructure, services and public awareness programs that will transform today cities, for example a future self-sustaining innovation, growth, technological development, civic and ethical citizenship and social progress. This study presents an exploratory analysis in respect of the current global situation related to the concept of Smart City, comparing the different essential definitions and dimensions described in recent literature by cited authors and related to the nomenclature of the term. The effects, challenges and opportunities that Smart Cities can offer to their citizens, has been presented, for example in different programs, projects and initiatives, that cities all over the world have implemented, focusing on sustainable social innovations, economic growth, environmental protection, quality of life, participatory governance, social and community development, citizenship education, efficient urban mobility, tourism services, health and safety. The situation in Bogota and Medellin, the two main cities of Colombia have been reviewed and studied in this work, the aspects

A. Alonso-Gonzalez (✉)
EIAM—PRIME Business School, Universidad Sergio Arboleda, Bogotá, Colombia
e-mail: antonio.alonso@usa.edu.co

L. A. Palacios Chacon
Escuela de Negocios, Universidad del Norte, Barranquilla, Colombia
e-mail: lorenapalacios@uninorte.edu.co

M. Peris-Ortiz
Departamento de Organización de Empresas, Universitat Politècnica de Valencia, Valencia, Spain
e-mail: mperis@doe.upv.es

previously mentioned have been taken into account to establish a new definition of the Smart City concept. To perform this task, a set of six dimensions and 27 subcategories are essential to define and measure this concept in the Colombian paradigm, which can be used to monitor the current status, in order to approximate evaluations of Colombian cities to the qualification concept described as the Smart City. Due to the lack of studies observed in this work, further research must be focused, not only on getting more data from Bogota and Medellin, but also having the opportunity to observe the situation in other important cities such as Barranquilla, Cali, Bucaramanga or Cartagena, currently no data is available.

5.1   Introduction

North (1981, 2005) a well-known author, states that related economic development in any society has four different interconnected structures: institutions, technology, population and ideology. This idea is complemented by other works such as the one written by Nasar (2011) and Auvinet and Lloret (2015), in which they analyzed the role of the different inventors, inventions and innovations in the economic development of society and organizations. It is important to take into account that in any observed country, economic growth is associated directly with urban growth. Theoretically, the larger a city, the better the welfare and employability are, as well as investment, quality education, communication systems, and media entertainment and recreation supply that appeal to all tastes. It also implies that information is available to the majority of the population (Hernandez-Escobar and Perez-Hernandez 2015).The concept of what a city is must be explained, so Fernandez-Güell (2015) defines a city as a "complex ecosystem of connected items or parts, where human activities are linked by communications that interact and the system evolves dynamically as a whole, where any spatial or structural alterations of its parts modify other parts of the system".

Perhaps the biggest difference between ancient and modern cities is not about the core concept but their size (Montiel-Casas 2015). Therefore, the city must be analyzed in relation to the current trends in urban development and the impact that cities have in our world today. It is important to highlight that in 2007, for the first time in history, the urban population exceeded the rural population (Sierra 2013). By 2015 more than 6 billion people will live in large cities (Boob 2015). United Nations forecasts that 70% of human beings will live in urban centers by 2050. In real terms, the number of urban residents is growing by nearly 60 million people every year (Casas-Perez 2014).

According to this astonishing growth, our planet is becoming more and more urban, and cities need to become smarter and improve their urbanization plans,

requiring new ways of managing the growing complexity of urban living (Rizzo 2015). Cities must become places suitable to provide the best conditions for their inhabitants in a comprehensive and sustainable manner (Cohen and Obediente 2014), and this scenario requires the development of sustainable and intelligent approaches to these urban environments to ensure that cities are optimized for sustainable economic activity, efficient energy consumption, minimal environmental impact and ideal wellness (Boob 2015). Because of this, today the attractiveness of metropolitan areas is no longer based solely on their ability to offer jobs and housing, but also the provision of services is increasingly important, both in quantity and quality, focused on customer satisfaction (Vasquez-Ortega 2012).

Currently, a large number of metropolitan areas around the world are moving towards the model known as Smart City, a term that covers a variety of solutions and approaches, whose prevalent points are the efficient management of resources and the improvements in quality of life. Each concept of Smart City aims to contribute from different perspectives to new benefits for existing cities, to reach greater ecological sustainability, significant reduction in emissions of greenhouse gases, the efficient management of resources in the city, promoting new information economies, and a total connectivity between elements of the city, (Alfaro-Martinez and Soria-Rodriguez 2012).This concept of the Smart City appeared around 20 years ago, and has evolved based on the number of areas and fields that have been included in the urban environment. Originally, the key component of Smart Cities was energy, however it has expanded to include, in some cases, the use of Information and Communication Technology (hereafter ICT), city government and management, or provision of public services such as health (Sierra 2013).

As a matter of fact, the concept of smart cities has been an area of research and development in recent years around the world. There are some very significant projects, for example: the Smart Cities project of the MIT Media Lab, the Smart Cities project of the European Union, and the IBM Smart Cities project. Essentially a smart city seeks to use ICT as an engine for a city's development, promoting sustainable growth and welfare of its inhabitants (Sierra 2013). Since its emergence in the 90s of the last century, the Smart City concept has been strongly influenced by technology, as a key element to address major challenges of concern in contemporary cities (Fernandez-Güell 2015).

The transition from conventional cities to Smart Cities is a priority because of the shortage of essential resources (water, energy, food, etc.) which is becoming a fundamental problem for humanity, according to the Millennium Development Goals, especially relating to sustainability and quality of life. However, it is clear that humanity is transforming urban spaces in different latitudes at different paces. For example, it is a fact that cities like Barcelona and Seoul are taking advantage over other cities, due to their capacity to finance infrastructure improvements, their designation as urban laboratories by major technology companies in the world, but also the existence of a defined digital policy that has been established by their governments to move towards more efficient and sustainable urban environments (Casas-Perez 2014).

5.2 Theoretical Background

5.2.1 Definitions Referred to the Smart City Concept

To better understand the term Smart City, some definitions will be quoted in reference to the concept and recent study results published by the authors. Cohen and Obediente (2014) define Smart Cities as "cities that through the application of technology in different areas become more efficient in the use of resources, energy saving, services provided and sustainable development, solving major problems that citizens have". Hernandez-Escobar and Perez-Hernandez (2015) use a similar definition: "multilevel systems of innovation where technological mechanisms are deployed in physical, institutional and digital spaces. The mainstays of these Smart Cities are innovation systems complemented by digital spaces providing strategic intelligence, digital media, networking and collaboration".

It may be observed, that there is a strong implication of the technological dimension to achieve the objectives defined by the concept. In this line of research, Sierra (2013) defines Smart Cities as "the cities that improve their services through the generation of different applications related to ICT, enhancing the citizens' quality of life, increasing competitiveness in the productive sector, and facilitating interaction with governments. For this purpose, it should be considered that the development of some aspects, for example security, competitive intelligence, data analysis, data mining, and software development on mobile platforms. In this definition, the authors specifically highlight ICT as the most important technology today. Boob (2015) continues defending ICT as a cornerstone of the Smart City concept as "a transformation of the existing urban development and its infrastructure by using and harnessing ICT to improve economic and political efficiency and enable social, cultural and sustainable urban development to reach a high quality of life, with a sustainable management of natural resources, through people, public and participatory governance". Montiel-Casas (2015) follows the same line defining "Smart Cities as a concept that integrates the use of new ICT, energy efficiency, e-government (local participatory democracy), transparency in management (open data), effective recycling and urban waste management, forming a technologically advanced structure that should benefit all populations."

The question is if ICT or technologies in general terms are the only important issues to consider in the definition of the term. Patiño (2014) starts questioning this reasoning explaining that "during the last decade the term Smart City has been used as a concept associated with the ability to maximize the use of ICT to meet the modern challenges of urban issues, although there is still no universal consensus on its meaning". Following this skeptical view relating to the latest definitions that are focused only on the importance of ICT, Casas-Perez (2014) specifies that "a Smart City is not only a digital concept, but also a sustainable entity, in a way that not all digital cities are smart. The fundamental difference lies in the ability of the smart city to solve problems. This implies that smart systems are embedded within the city infrastructure, by automating the delivery of information and delivery of basic

services". Villanueva et al. (2014) also defends this point of view of a Smart City as a universe to help citizens to improve their quality of life, explaining that "the concept of Smart City intends to evolve processes and daily activities that citizens carry out from their current situation to a more efficient state from an energy point of view, time and cost. To do so requires the collaboration of different actors in their areas of activity, as well as the introduction of new technologies". Therefore the authors add the importance of the problem solving and introduce the sustainability dimension to the definition of the term.

At this point, it has been mentioned that the authors support the importance of ICT as the core issue of the concept, and others highlight the relevance of problem solving for citizens, and the sustainability of the entire project. However, there is another key trend which includes the importance of the human factor and its combination with the infrastructure, environment and services. Rizzo (2015) introduces a variation of the concept Smart City, using the term "Human Smart Cities (hereafter HSC) as ecosystems where physical and digital infrastructures are introduced and implemented in a systemic relation with the cities human capital. The HSC are both systematic and anthropocentric, and are designed so they can operate at scale, being able to achieve things that cities need, and creating large areas in which social relation and empathy are possible". Ishkineeva et al. (2015) expand the idea that the combination of human, tangible and intangible capital defining a Smart City as "a city where investments in human and social capital and in traditional and modern infrastructure, provide sustainable city development and a high quality of life, with an intelligent use of natural resources and a smart use of the cities potential based on a participative management. A Smart City is a city with an effective networkable business climate, smart professions, clever and free people who are able to make decisions and participate in urban life and development. New ICT will switch to a totally new way of smart management and a method to build conceptually, a new city format. Another interesting definition of the concept related to human capital but focused on the dimension of education, reference Vasquez-Ortega (2012) who introduces another vision related to the term Smart City: "a smart city has smart people in terms of education, referring to the relationship between city government, the administration and its citizens, where the population is taken into account and especially where it is possible to ensure their rights in a legally effective and transparent model. Also, it often refers to the use of new communication channels for citizens, for example, e-governance or electronic democracy".

5.2.2 Different Dimensions to be Considered into to the Smart City Concept Approach

It is necessary to act in multiple and different dimensions in order to advance towards the concept of Smart City, but common elements allow us to develop each of these axis, as defined in the previous section: the use and application of new

technologies and specifically ICT, focused on problem solving for citizens', in a sustainable way, and combining human capital, infrastructure and city systems and services. What is necessary now is to recognize how the different authors have defined these dimensions according to a cites infrastructure, services and systems.

Paskaleva (2011) sets three dimensions to measure the level of development of a Smart City: the level of exploitation of network infrastructure (to improve economic and political efficiency and enable social, cultural and urban development), the level of vision and strategy to create a competitive city within the smart city (opportunities of ICT to increase local prosperity and competitiveness at a multi-actor, multi-sector, and multi-level urban perspective towards sustainability), and the level of sustainable and inclusive approach of the cities (placing the main responsibility on the human and social capital of urban development). Casas-Perez (2014) also defines three basic dimensions necessary in order to be considered and developed by a Smart City, but based on other approaches, for example: innovative economy (innovation in industries, clusters and urban districts; workforce education, employment and knowledge; knowledge generators), urban infrastructure (transport; energy, water and other services; environmental protection; safety), and governance (public services management; direct and participatory democracy; services to citizens; and quality of life).

There are other views that increase the number of dimensions to six. A research project performed by the European Smart Cities Association includes six dimensions as essential to define the concept of Smart City: smart governance (political strategies and perspectives, transparency, community participation in decision making), smart people (diversity, creativity, participation in public life), smart living (cultural facilities, housing quality, health and safety issues), smart environment (sustainable resource management, pollution prevention, environmental protection), smart mobility (strong ICT infrastructure, sustainable transport systems), and smart economy (high productivity, entrepreneurship, ability to transform) (Kanter and Litow 2009). Cohen and Obediente (2014) also develop their study six areas or components, grouping 28 indicators that are used to measure and rank smart cities: environment (smart buildings, resources management, sustainable urban development), mobility (efficient transport, multimodal access, technological infrastructure), government (online services, infrastructure, open government), economy (opportunity, local and global productivity, connections and networks), society (integration, education, creativity) and quality of life (culture and personal welfare, security, health). Number six is also used by Hernandez-Escobar and Perez-Hernandez (2015) to define the dimensions of a Smart City, defining the concept as an urban entity that has a sustained outstanding performance in six disciplines: smart economy, smart mobility, smart environment, smart people, smart life and smart government. Each of these disciplines have specific lines of action that are aligned with the central objective of the Smart City model and are subject to measurement, to determine whether the score is within the established parameters. These six dimensions described by the previous authors are also used by Sierra (2013), identifying government, infrastructure, mobility, energy, environment and services as the main dimensions to measure a Smart City.

Vasquez-Ortega (2012) includes two more elements to be considered in the identification and measurement of the Smart City concept, which summarize eight different dimensions that should be taken into account: efficient energy management, business environments and knowledge economy, transport and urban mobility, e-government and citizen participation, environmental issues, urban planning, tourism and cultural activities, and health and personal care. Each of these categories drive the city towards the category of Smart City, committed to the environment, with artistic architectural elements and buildings equipped with the latest technological solutions in order to facilitate and combine a rural citizen interaction with an organized urban environment, and helping ordinary citizens to make their life easier.

5.2.3 Effects Derived from the Smart City Concept Related to Sustainable and Social Innovations

Nowadays, for any city with a population ranging from 0.2 to 1.0 million, it should be mandatory to focus its growth and development towards the Smart City concept, taking the implementation of this model as a whole instead of as a sum of different systems (Boob 2015). But the Smart city concept is also crucial for modern cities that are planning their future existence, sustainability and proper development. An irrational urban development becomes ineffective and hence non-competitive, while the attractiveness of the city for its citizens, prospective investors and partners are strongly connected to its level of competitiveness (Ishkineeva et al. 2015).

In this section a review will be made of some of the advantages that Smart Cities could offer to citizens, due to the different services offered by its urban model. As explained in the previous sections, data is at the heart of many visions of the future city: information about traffic, the movements of people, and air quality. In the smart city, this data can be integrated, monitored, analyzed and visualized to improve city management, highlighting three important objectives: data integration, data analysis and visualization and predictive analytics (Saunders and Baeck 2015). The safety of citizens is another aspect that can be improved as part of Smart Cities projects, using technological surveillance services to increase security or to identify and characterize trends in the application of ICT in city projects that provide support for decision-making, relating to public policies in each of its components, providing citizens a better quality of life within the concept of a sustainable city (Sierra 2013). The importance of public sector information has increased dramatically, and therefore the data that is associated with this area, known as open government data (including availability and access, use and redistribution, and universal participation), is becoming an important source to generate new services and applications (Patiño 2014).

Efficient energy management in Smart Cities is also an added value that should be taken into consideration, due to an observed trend of an increase in the urban

population in the next few years, which in these cases must be supported by proper management of green energy (Balaji 2013; Benitez and Ortega 2015; Klingert et al. 2015). Benchmarking this efficiency on the management of energy, is also important, selecting specific indicators to measure the performance in particular key fields related to energy (Fertner and Gorth 2015). So that, Smart ICT can be described as greener sustainable technologies, that not only use less energy but help to improve performance and reduce environmental impact of the whole of society (Cohen and Obediente 2014).

Urban mobility, city logistics and transport management, as well as the regulation of vehicular traffic, can achieve significant improvements through the implementation of smart technologies applied to control and optimization of the traffic flow in a Smart City (Ben Ahmed et al. 2015; De Domenico et al. 2015; Djahel et al. 2015; Klimek and Kotulski 2015). It is important to highlight that there are ecological models and initiatives that have been developed and successfully implemented in Smart Cities, such as public bike rentals (Graham and Zhang 2015).

Another major improvement that Smart Cities can implement in the environment is the combination of technologies and public services in data collection relating to pollution, for example using sensors installed in public transport vehicles, is a way to register this data and save time and energy reducing installation and operational cost of every sensor nodes (Jamil et al. 2015).

Health services is another area that could be improved in Smart City projects, through the concept of electronic health, used to encompass the many possible applications of ICT in this field, whether intended for health authorities, health services providers, health professionals, as well as custom systems for patients and citizens (Sierra 2013).

Another technological use that can be applied in Smart Cities of the future will allow an increase in the efficiency of services and monitoring systems applied to the tourism sector, thanks to the advantages of new technologies such as Near Field Communication technology (hereafter NFC), which offers a high level of security in the recording of information and a low probability of error in data collection, and it can be applied to monitor the data path of a tourist in real time (Agredo et al. 2015).

However, it must be highlighted that the Smart City concept should not only be focused on infrastructure, systems and services offered to citizens to improve their quality of life, but also in the increase of competitiveness for the whole city in terms of the economy, production and logistics for business. As Dattagupta (2014) explains "a Smart city is an attractive card which will attract a large number of foreign investors. It will pave the way for jobs, investment, better lifestyle, and opportunities for global and human capital. As many experts point out, Smart Cities are a great business opportunity, attracting an affluent middle class as well as other social stratum. This effort is encouraged by the planners and decision makers to meet the needs of all origins, sectors and social classes rather than just emulating the western model of cities".

Reviewing successful cases of Smart City models around the world, it is evident how technology solutions have been implemented for almost any kind of activity

related to the city: administrative management and e-government, vehicle control and public transport services, sustainable development, efficient energy control, environmental issues, and education of human capital are some of the areas that have been improved (Hernandez-Escobar and Perez-Hernandez 2015). In addition to this, and as Paskaleva (2011) says, "in the era of the digital economy, the performance of cities is influenced not only by their physical infrastructure, but more and more by their knowledge and social capacity (intellectual and human capital)," so technology is important, but it is not the only element that must be taken into account. It should be combined with the development of infrastructure and the education of citizens. Kamel-Boulos et al. (2015) explain this idea: "by focusing on people, smart cities and regions stand better chances of becoming healthier and happier cities, but it should always be remembered that technology is not a panacea but rather an enabler, and that other factors are equally important in creating happier and healthier cities and regions".

Most people perceive work as an important issue in their life. Without work, or with a unstable job, there is no access to small or large ranges of tangible and intangible assets that a city could offer. So a comprehensive dialogue must be undertaken concerning the construction of a Smart City, with the proposal of an understandable productive city concept, implying the real basis for the realization of many human aspirations in the urban context (Mancheno and Teran 2013). Quality of Service must also be considered, in order to impact on the development of Smart City services (Martinez-Ballesteros et al. 2015). But above all, the Smart City concept should be considered as a broader and capable term to reach another important concept: the Happy City, the place where citizens can have the necessary elements to develop the vital, physical, emotional, psychological, playful, and creative fulfilment. Possibly there can be no greater ambition for people than to be happy and develop a transcendent life (Montiel-Casas 2015).

5.2.4 Challenges and Opportunities for Smart Cities

The advance and progress towards the establishment of a true Smart City starting from a conventional city requires financial and human resources in abundance. In many places, the Smart City initiatives are legislated and driven for this purpose by specialized offices and local governments (Hernandez-Escobar and Perez-Hernandez 2015). What is clear is that conventional cities must overcome some challenges to advance towards the Smart City concept:

- Organizational barriers: due to their singular territorial organization, some cities, municipalities, provinces and regions should be consolidated to create a single, integrated, horizontal and global vision that deviates from their vertical and conventional disconnected development, in order to create a real convergent progress for all their citizens (Cohen and Obediente 2014). In fact, in many cases a divergence can be identified between the proponents of the current Smart City

term and the group of urban planners and architects, which could question the sustainability of the Smart City concept in the medium and long term (Fernandez-Güell 2015).

- Legal barriers: in relation to the issue of sharing information between different governmental agencies, some public institutions and administrative offices could have relevant and valuable information but it is not correlated and shared with other public entities or government agencies, because of legal obstacles that prevent such compatibility of information sharing, disabling the operation of how a Smart City should work (Cohen and Obediente 2014).
- Citizen participation barriers: if citizens are not aware of what a Smart City means and the benefits it brings or the behaviour of citizens cannot be measured, it is difficult to create a Smart City. Citizen participation is key and it is one of the barriers that must be overcome in the short term (Cohen and Obediente 2014). Complexity, diversity and uncertainty are also challenges inherent to citizenship that must be tackled (Fernandez-Güell 2015). Many Smart City strategies offer citizens little chance to engage in the design and deployment of new technologies. While citizens trend to be the implied beneficiaries of Smart City projects, they are rarely consulted and often ignored about what they want and their ability to contribute to make their city a better place to live (Saunders and Baeck 2015).
- Lack of awareness of how others are trying to improve their cities: Smart City projects are often too insular and too isolated, with developers talking to each other, but not linking their work to others groups that are trying to address urban challenges and improvements, such as people working within the city government in areas from transport and planning to economic development and public participation (Saunders and Baeck 2015).

To tackle and overcome these barriers, some aspects must be taken into account. For example the organizational barriers can be passed through technological developments related to ICT, as for example Web 2.0 technology to allow a direct and immediate access to information by town planners and urban managers to make sustainable decisions based on opinion from all levels of the urban community (Raut and Raut 2015). The CIVITAS project is an example of a software platform for development and support services to deploy in a smart city. This ambitious project aims to develop a logical nervous system that allows the collection and distribution of information generated in daily activities of a Smart City (Villanueva et al. 2014). Improvements in the levels of efficiency and interconnectivity between the different devices and city services must be developed, towards the so-called Internet of Things (hereafter IoT) (Misra et al. 2015). However, it must be taken into account that the use of computers, software and communication technologies are an integral part of smart cities and must be associated with energy efficient controls, the so-called green computing trend (Anusha et al. 2015).

It is quite understandable that Smart Cities will have smart infrastructure (roads, water, solid waste management, and drainage networks), but it is also obvious that the private sector will play a major role through investment in Smart Cities.

To overcome any legal barriers that could be against a Smart City project, the central and regional government need to design specific formats to generate or improve the urban data base in major urban growth variables (such as income, infrastructure, business, finance, and education). Furthermore, the collection of information on basic socio-economic status is essential to enable the various government departments to formulate appropriate urban development strategies at sub national levels. This would help to raise the standard of urban management practices and monitor the implementation of the various urban policies (Tripathi 2015). Smart cities conceived as ecosystems should provide policy makers with some practical guidelines to integrate soft and hard domains. Three areas for smart government should be implemented: economic development, a vibrant political life and strong support to encourage innovation (Rochet and Pinot de Villechenon 2015).

As it has been defined so far, the Smart City concept is generated when technology pervades all human activities, modifying to the extent that can also change their environment (Hernandez-Escobar and Perez-Hernandez 2015). Following this argument, some authors like Biancalana et al. (2015) propose models to overcome the citizen participation challenge, which they call Personalized Extended Government model (PEG), to encourage and facilitate the exchange of public domain and community information in a personalized perspective, respecting the public administration and citizenship information needs. Other authors like Muñoz de Dios et al. (2014) highlight the necessity to emphasize the intelligent character of the environment, and not only focus on the energy efficiency or the incorporation of wireless communications, but also on the specific actions that are able to guarantee and allow multiple benefits towards improving the quality of services that are provided. Papa and Lauwers (2015) mention "one key element is the interactive and participatory process to commit citizens and not just users towards the smarter paradigm. The open and active involvement of people and stakeholders would be far more effective. Thus, broad coalitions should be formed to include specialists, researchers, academics, practitioners, policy makers and activists in the related areas of technology, transport, land use, urban affairs, environment, public health, ecology, engineering, green modes and public transport. It is only when such coalitions form a real debate, that Smart City concept can take place. There must be a willingness to change and accept a collective responsibility. It is crucial to create conditions for a continuous process of learning and innovation".

In general, all these challenges and barriers (organizational, legal, lack of citizen participation, and isolation) can be overcome by involving higher education institutions such as universities in this process, and becoming active members in these ecosystems. A Smart City should be the orchestrator of collaboration with educational institutions, being the most effective way to manage these new networks and ecosystems (Erkkilä 2014). Nowadays, universities can assist in helping public policy makers and activists thanks to their deep understanding of public learning and innovation in the modern city (Hambleton 2015). Cities with greater percentages of their populations possessing a college education are more likely to become active groups pursuing smart growth policies on their urban environment (O'Connell 2008). New postgraduate degrees and urban ITC systems are increasingly being

offered in Smart Cities by universities to meet the demands of a new society with new types of digital skills, expertise and knowledge (Kamel-Boulos et al. 2015). According to this point of view, new ways of learning must be implemented with proper resources to teach in a different way these concepts in order to prepare smart citizens for Smart Cities (Wolff, Kortuem and Cavero 2015). Innovation is another important and transversal key to avoid collapse and to promote sustainability of cities, regions and their infrastructures (Kamel-Boulos et al. 2015). Due to this, innovation and problem solving competences are unique qualities of intelligence and must be enhanced at this educational level (Sierra 2013), improving entrepreneurial competences in citizens (Alonso-Gonzalez et al. 2017b), encouraging the integration of the population at risk of social exclusion (Alonso-Gonzalez et al. 2017a) and taking into account the importance of a proper educational environment within the current urban community (Peris-Ortiz et al. 2017).

5.2.5   Examples of Smart Cities All Over the World

Many cities are experimenting with ICT to improve their services and become closer to the Smart City concept, and there are countless initiatives of Smart Cities worldwide, though the great capitals are the ones that often have greater financial capacity to address the necessary inputs that provide advances to their projects (Vasquez-Ortega 2012). In this section, different successful projects implemented in cities all over the world will be presented, highlighting the good progress in the areas that have been improved in relation to the Smart City concept.

Many cities are using ICT to converge their goals with the Smart Cities ones, such as Amsterdam (Holland), which has developed its Sharing City program as an initiative to promote a collaborative economy to make the most of knowledge networks and sharing communities, using smartphone apps and other ICT. The next step is to extend the initiative to disadvantaged groups (Saunders and Baeck 2015). These kind of collaborative initiatives using smartphones are also being successfully implemented in Beijing (China) through its I Love Beijing initiative, consisting of a mobile app and an online map that city maintenance staff uses thanks to users reports concerning issues such as potholes and broken streetlights. The app grew from a successful pilot project where unemployed people were given hand–held digital devices and asked to report issues they spotted around the city. The app also includes a map of over 600 informal food markets in Beijing (Saunders and Baeck 2015). Lima (Peru) is also focusing on ICT initiatives, improving data transmission and open access to all citizens through a set of services including public investment projects in the municipality, a map of the museums in the city, and traffic fines information. (Patiño 2014). Some of these initiatives are supported by collaborative or crowdsourced initiatives. Jakarta (Indonesia) through its Smart City Plan has focused on citizen engagement rather than the IoT and Big Data, developing the Smart City Platform which consists of three crowdsourced apps: an issue reporting app, a flood map and a traffic management tool (Saunders and Baeck 2015).

Another aspect that can be observed in several cities is the free access to information and the development of an infrastructure capable of facilitating citizen access to that information. Buenos Aires (Argentina) and its network initiatives is an example, entering into the world of Smart Cities and focusing on access to information for its citizens. The city has deployed the largest network of free public access to the Internet in Latin America, which covers a large part of the metropolis and the subway network (Sierra 2013). Montevideo (Uruguay) is another example of this free information access policy related to government services, being the first city in Latin America which had open data for its citizens. As a result of the release of data, several initiatives now provide services for citizens have emerged. Some of these were developed by the city, while others have been implemented by entrepreneurs, civil society or just curious people (Patiño 2014). Along the same lines of thought, a similar initiative can be found in Burgos (Spain) with its Smart City project, developing a communications network that integrates wireless communications and fiber optics. Based on this network, Burgos has reduced its operational and management costs and developed self-provision services, giving access to free internet to all its citizens in streets, squares and public buildings, integrating municipal services like bike rental or other services related to city events (Sierra 2013). Stockholm (Sweden) also enjoys broadband connectivity through fixed and wireless next generation networks. 90% of residential buildings and 100% of the public buildings have access to these networks (Noreña-Rendon 2013; Sierra 2013).

Road traffic, city logistics and public transport are other areas that can be improved through the concept of Smart City. Washington D.C. (USA) is developing its Smart Highways project based on electric signals, sensors and a computerized management system that displays the slowest lane, which ones are in service or out of service due to accidents, measure traffic lights at intersections, and monitor traffic using a centralized security camera system. (Noreña-Rendon 2013). Marseilles (France) has put public transport services at the heart of its development as a Smart City. By the management of the public transport system, the city has established a communications network that provides both free connection for passengers and other services in order to improve the quality and safety of transport. The plan includes initiatives such as the introduction of NFC technology to give citizens access to an initial set of 22 different services (Sierra 2013). Masdar (Abu Dhabi) is another city focusing its priorities on public transport. It has developed the Personal Rapid Transit system as a computerized network to achieve public transport efficiency, based on the automated movement of a fleet of electric vehicles which feed energy from the road, so they do not need batteries and each car can accommodate three people (Noreña-Rendon 2013). Singapore (Singapore), as part of its Smart Nation Program, is developing the Singapore's Intelligent Transport System, which includes Electronic Road Pricing and sensors attached to taxis that help the government to monitor traffic conditions, reducing the number of journeys by private cars in Singapore (Sierra 2013; Saunders and Baeck 2015). London (UK) has also succeeded in its campaign to encourage citizens to use more public transport services, including the subway, buses and taxis, thanks to the improvement of public transport in different areas such as road infrastructure, quality, safety and efficiency in

services provided, accompanied by measures such as tolls to reduce traffic jams and the entry of private vehicles in some areas to prioritize the movement of public transport (Noreña-Rendon 2013).

As it has been demonstrated in other sections, environmental initiatives are also a dimension to take into account in Smart Cities, Barcelona (Spain) and its LIVE project is an example of this, a smart initiative implemented which acronym means Logistics for the Implementation of Electric Vehicles. It is a project that aims to promote the development and mobility of electric vehicles in Barcelona and its metropolitan area (Noreña-Rendon 2013). There is also a pilot project that uses sensors on rubbish bins to optimize van collection routes by sending them only to full bins. The city estimates that the system could save 10% on waste disposal costs (Saunders and Baeck 2015). The city of Barcelona has set a goal of developing a standardized and replicable model of Smart City, through the design of each of the elements that comprise: service models, networks of sensors and platforms for service management communications, etc. (Sierra 2013). Genoa (Italy) is applying a similar project based on a circular economy to improve waste management, using intelligent rubbish bins as an example of a feasible waste-related project in the context of Smart Cities (Del Borghi et al. 2014). Stockholm (Sweden) and its Vision 2020 strategy is the best example of how to implement and maintain efficient Smart City models focused on the environment. This city won the Green Capital Award in 2010; as such this award is only given to cities that have significantly reduced air pollution percentages, and also setting its main goals to become one of the most accessible cities in the world, based on its urban transport system (Noreña-Rendon 2013; Sierra 2013). Another city that could be considered as a model of environmental Smart City initiatives is Vancouver (Canada), which is implementing a series of ambitious green programs to become the greenest city by 2020, focusing on an environmental model and developing specific projects as for example: Green Economy, Weather Leadership, Zero Waste, Nature Accessibility and Local Food (Vasquez-Ortega 2012).

Efficient energy management is another area that some cities are seriously taking into consideration, as for example Malaga (Spain) with its Smart Energy Management, as a world reference in the field of energy efficiency. Since 2009 the city has developed an important project which will prevent 6000 tons of CO_2 being deposited annually into the atmosphere, and a reduction of 20% in energy consumption. To this end, measures such as the introduction of electric vehicles and the power grid transformation into a smart grid have been adopted. The city has several lines of action: Smart Green (intelligent management of power storage and distribution), Smart Generation (self-generation and power storage from renewable sources) and Smart Energy Management (efficient management of end use energy) (Sierra 2013; Vasquez-Ortega 2012). Glasgow (UK) is another city with efficient energy management, implementing intelligent streetlights, a pilot project which is testing whether sensors on streetlights will save energy by allowing lights to automatically turn on and off when people walk past them at night (Saunders and Baeck 2015). Singapore (Singapore), as part of its Smart Nation Program, is also implementing an Intelligent Energy System (IES) using a two-way flow of information on the

power grid, and allowing a reduction of energy consumption by around 3% (Sierra 2013; Saunders and Baeck 2015). In London (UK), the Canary Wharf group launched the Cognicity Challenge, a pilot project to apply Smart City technologies on the Canary Wharf estate, which aims to help businesses to reduce electricity costs by intelligently monitoring electricity usage (Saunders and Baeck 2015).

In the area of government and participatory democracy, Bangalore (India) has implemented the Next Bangalore initiative, which combines a website where residents can submit and debate ideas. The initiative has helped to create a vision of what residents want their area to look like, as well as keeping a record of their everyday needs and problems. Buenos Aires (Argentina) is another example of these new political trends, raising the concept of open government in different spheres of interaction with other actors as entrepreneurs, technological and academic institutions, in order to integrate them into the process of urban innovation, developing five main categories: security, education, green agenda, mobility and culture, to which they could submit projects (Patiño 2014).

There are cites that have other initiatives to improve citizens urban services and their quality of life. For example, Gijon (Spain) has one of the most advanced citizen identification services. Through a single citizen card, city residents can access various services such as free internet, bike rental, citizen virtual office, public transport pools, art center's and library services (Sierra 2013). Rio de Janeiro (Brazil) has implemented the Intelligent Operations Center that provides information of critical systems, services and infrastructure throughout the city, so that operative services have an integrated vision. As a result, there has been a 30% decrease in the response time in an emergency (Sierra 2013). Santander (Spain) and its Smart Santander project is another example of combined initiatives to accomplish a Smart City objective. The Spanish city has focused on the application of the concept of IoT and Internet of the Future (hereafter IoF), proposing an experimental research platform for the development and application of services related to a Smart City (Sierra 2013). Santander is home to one of the largest city wide sensing pilots in the world, with over 12,000 sensors collecting data on everything from parking space availability to air quality. The developed platform will be attractive to all stakeholders involved: companies, user communities, and other entities willing to use the experimental platform for the development and evaluation of new services and applications, and internet researchers who can validate their new technological developments (Sierra 2013; Saunders and Baeck 2015). Another city which combines different Smart City initiatives in different areas is Madrid (Spain), with some interesting Smart City services focused on citizens, security, environmental sustainability and mobility. Examples of Smart projects that has been implemented are Home Telecare (serving over 120,000 seniors, one of numerous services appreciated by locals), the Integrated Security and Emergency Centre of Madrid (CISEM, coordinates firefighters, police, emergency services, civil protection and traffic agents), bus fleet management (allowing continuous, instantaneous and automatic location of the 2100 buses from the central control station), and the remote control of hydraulic infrastructures associated with the Manzanares River (automatically managing dams for river regulation) (Sierra 2013).

5.3 Methodology

5.3.1 Analysis of the Current Situation in Colombia

In Latin America, 80% of the population lives in urban areas. Cities face challenges in migration, transport, health and urban planning. Unfortunately, the design of public policies of urban management in many cases are being performed individually and separately, preventing synergies in the generation of new innovation processes that could improve the lives of its citizens (Patiño 2014).

The specific situation in Colombia demonstrates that cities are increasing their development and complexity. Citizenship has requirements that need to be satisfied, and in order to build a strategy for this, and according to the results of the National Survey of Logistics, several proposals to transform cities in sustainable environments are being implemented, as for example, spaces for scientific research, technological advances applied to solve citizens' problems, and institutional initiatives, for example Colciencias (Vasquez-Ortega 2012). Through private initiatives, the citizens' quality of life in Colombia continues to evolve thanks to the hospitality industry, providing residential telephone services that have created and improved services that have brought ICT to Colombian homes, improving the quality of life through the proper use of logistical tools that promote technological development of the country towards the Smart City concept (Vasquez-Ortega 2012). Nevertheless, it must be emphasized that in Colombia there is a growing concern in relation to inefficiencies in the goods supply chain demanded by cities, because of increasing urbanization in Colombian society, this problem is the main challenge that needs to be tackled, in order to reach the maximum level of services for Colombian urban citizens (Vasquez-Ortega 2012).

Another area where Colombia has become a reference model in citizenship services is the e-government initiatives. Colombia is a leader in electronic and participatory government in Latin America and the Caribbean, according to UN reports. In this field there are some interesting projects, for example: Government Online, Governmental Intranet, the standardization of procedures and online city services, and the development of the first Online Government Services for terrestrial digital television and other initiatives within the program Vive Digital, such as Online Notaries, Online Congress, and Zero Paper initiative (Vasquez-Ortega 2012).

According to the literature revised in the current work, it has been found that there are very few academic studies related to the Smart City concept, in reference to the most important cities in Colombia. Significant research work was found for two cities, namely Medellin and Bogota, the capital of the nation. Medellin is close to be considered a Smart City, thanks to all the projects that have been implemented with the help of the cities' Mayor and numerous organizations that oversee the quality of life of the cities' population (Vasquez-Ortega 2012). Medellin is the first city in Colombia with a governmental program related to the Smart City model. The Medellin Smart City program has been implemented in four strategic initiatives: open government, citizen participation, social innovation and sustainability. These

initiatives improve citizens' quality of life through access to better information, empowering tools necessary to transform their realities, finding relevant solutions to the city problems, and during the process reducing environmental impact (Sierra 2013). Mobility is one of the biggest problems in Medellin and its metropolitan area, and it has been a familiar problem not only in Colombian cities but worldwide. Understanding this phenomenon in order to find solutions to improve the quality of life of citizens and it has become one of the top priorities for many local governments (Noreña-Rendon 2013).

In the case of Bogota, the main approach towards the Smart City concept has been developed in urban mobility areas under the Mobility Master Plan. Thanks to this initiative, the city has structured the new Integrated Public Transport System (SITP), as an instrument to ensure better quality of life for its citizens, optimizing levels of service levels on journeys made in the city and integrating in the same project the TransMilenio system. This system has established itself as a world leader in mobility, with a gradual and controlled implementation that will change the history of the city, eliminating many problems suffered in the past associated with public transport and mobility (Sierra 2013).

5.3.2 Smart City Concept: Proposal of a New Definition and Dimensions Applied to Colombian Cities

According to Mosannenzadeh and Vettorato (2014), to create Smart Cities it is necessary to identify the main goals and provide a defined Smart City plan, set the main sub-systems and their relationships, and the key stakeholders involved in these plans. Then, ICT implementation should enhance the functionality of urban services and infrastructure, integrating the plans and implementing the different sub-systems through collaborative work between stakeholders who are involved in the creation of a Smart City.

With the intention to establish a strong definition and set the dimensions that could help to initiate the Smart City concept for Colombian cities and urban policies, the first task to be be performed in this section is an intensive review of the Smart City term presented by the authors cited in this paper: Vasquez-Ortega (2012), Sierra (2013), Casas-Perez (2014), Cohen and Obediente (2014), Patiño (2014), Villanueva et al. (2014), Boob (2015), Hernandez-Escobar and Perez-Hernandez (2015), Ishkineeva et al. (2015), Montiel-Casas (2015), and Rizzo (2015). As it was highlighted in the previous section, there is a strong implication for the technological dimension to achieve the objectives defined by the Smart City concept, and specifically new technologies related to ICT, but although this concept is a cornerstone of this discipline, it should be noted that other authors also add importance on problem solving capacity and sustainability of the whole project, as well as other academics who uphold the importance of the human factor and its combination with infrastructure, environment, systems and services, in order to achieve the global

objectives of the Smart City concerning its citizens: productive competitiveness, efficient mobility, smart energy management, premium services, e-government, quality of life, and environmental awareness. Taking into account all of these terms and observations, they can be combined to propose a new definition that integrates all the concepts studied so far and referred to as Smart Cities: "A Smart City is a urban and metropolitan hub based on ICT and other new technologies that help citizens to interact through their personal devices, offering the best experience and mobility results, energy management, premium services, participatory democracy, health and safety, environmental impact, and any other section which could be relevant for citizens, integrating human capital, city systems, infrastructure, and its related services, in order to maximize the citizens' quality of life, education and professional career development, and personal and social happiness".

This definition is a proposal as a result of the combination of the views and studies of authors, researchers and academics cited in this work, and therefore it could be applied to the requirements of Colombian cities, so that they would be considered contemporary Smart cities. Once this new definition has been proposed, a study of the different dimensions that should be measured is mandatory. For this reason in a previous section, the studies were introduced in reference to this question and presented by Kanter and Litow (2009), Paskaleva (2011), Vasquez-Ortega (2012), Sierra (2013), Casas-Perez (2014), Cohen and Obediente (2014), and Hernandez-Escobar and Perez-Hernandez (2015). From the combination of this research made by these authors, and using the model described by Kanter and Litow (2009) from a project performed by the European Smart Cities Association as a basis, the proposed model includes six dimensions and 27 subcategories as essential to define and measure the concept of Smart City, which can be used to monitor the status of Colombian cities in their advance towards the Smart City concept:

- Smart Government (political strategies and perspectives, transparency, and community participation in decision making by online services)
- Smart Citizenship (diversity and integration, education, innovation and creativity, and participation in public life)
- Smart Infrastructure (personal welfare, housing availability, tourism and cultural infrastructure and services, health and safety)
- Smart Environment (smart buildings, sustainable urban development, sustainable resource management, pollution control, and environmental protection)
- Smart Mobility (strong ICT infrastructure, multimodal access, efficient and sustainable transport systems)
- Smart Growth (business environments, knowledge economy, innovation and competitiveness, workforce education, local and global high productivity, opportunities for entrepreneurs, and the ability to transform connections and networks)

Both Colombian cities considered in this study, Bogota and Medellin are in different early stages of implementation of all these defined dimensions. In comparison with other Smart City projects identified by authors like Vasquez-Ortega (2012), Noreña-Rendon (2013), Sierra (2013), Del Borghi et al. (2014), Patiño (2014), and

Saunders and Baeck (2015), in the case of Bogota the city is focusing its projects on urban mobility and public transport. The SITP and TransMilenio initiatives are similar to the ones developed in Marseilles (France). Citizens are also using smartphone apps like Waze to monitor the traffic flow in order to increase their efficiency in urban mobility, which is similar to Singapore (Singapore) and its Electronic Road Pricing program, and Beijing (China) and its I Love Beijing initiative. The Ciclovia program is also having a great impact on citizens' awareness, thanks to pedestrian access on main roads and streets in the city on Sundays and Bank Holidays, thus reducing traffic and pollution and increasing healthy activities like jogging, biking and roller skating. Technologies related to ICT are also being used to enhance citizens' participation with their interaction with government institutions and other services, in a similar way to Lima (Peru) and Amsterdam (Holland), although in Bogota these projects are in the early stages of implementation.

Medellin can be considered as the Colombian city closest to the Smart City concept. The infrastructure that has been developed in recent years has placed this city as one of the most advanced in terms of urban mobility and services. As it was highlighted in the previous section, Medellin's Smart City program is being implemented in four strategic stages: open government, citizen participation, social innovation and sustainability, leading the city towards advanced initiatives, similar to the ones implemented in London, Santander, Madrid, Buenos Aires or Amsterdam.

5.4 Conclusions and Future Research

Since ancient times, cities have become a recurrent ambivalence: on one hand, they have acted as a powerful site to exchange ideas and opportunities; while on the other hand, they have led to conflict and isolation. The explanation for these seemingly contradictory phenomena is complex and offers different points of view depending on the social, economic, innovative, environmental and political dimension in which the city is observed. Cities have historically acted as poles and territorial catalysts of both economic and social transformation and the majority of the most qualified, creative and entrepreneurial population of the planet is concentrated in these urban centers, but they are also a focus of social and environmental problems. Obtaining a balance between those two positive and negative outputs ultimately depends on the actions and desires of individuals and groups that populate the cities (Fernandez-Güell 2015). In this way, the Smart City concept arises trying to solve these shortcomings, having as a main goal the efficient management of resources and improvements in quality of life.

The first part of this work was an extensive review of the recent literature, in order to understand the Smart City concept as an evolution of the conventional city term. Even though, there is no consensus on the definitions, there are some elements to highlight. The first one is the relevance of technology as a key resource in the development and growth of these kinds of cities. Secondly, the importance of better and more abundant resources provided to its citizens. Thirdly, the need of optimizing

the use of increasingly scarce resources, which drives the concept of sustainability and sustainable development. Lastly, the main goal is improving the quality of life in urban areas. In addition to this, the next part of the document, analyzed the different dimensions that need to be considered in the Smart City concept approach. These dimensions are described as the most important determinants to understand and measure these Smart Cities.

The effects, challenges and opportunities that Smart Cities can offer to their citizens were also introduced. Some factors to point out are the needs of proper development to ensure the existence of urban areas. One important input for the proper functioning of Smart Cities is the quality and quantity of data available at all levels. It is also important to reiterate the importance of education on overcoming the challenges of these cities. The first part of this study gave examples of different programs, projects and initiatives that cities all over the world implemented, as for example Amsterdam (Holland), Bangalore (India), Beijing (China), Buenos Aires (Argentina), Gijon (Spain), Glasgow (UK), Lima (Peru), London (UK), Madrid (Spain), Malaga (Spain), Rio de Janeiro (Brazil), Santander (Spain), Singapore (Singapore), and Vancouver (Canada), focusing on different areas such as sustainable economic growth, environmental protection, quality of life, participatory governance, social and community development, citizenship education, efficient urban mobility, tourism services, and health and safety.

The literature revised in the current work has found very few academic studies relating to the Smart City concept relating to the most important cities in Colombia. The two cities where significant research work was found were Medellin and Bogota, the capital of the nation. Medellin is the first city in Colombia with a governmental program similar to the model of Smart Cities, with its "Medellin Smart City", a program that has been implemented in four strategic approaches: open government, citizen participation, social innovation and sustainability. In the case of Bogota, the main progression towards the Smart City concept has been developed in urban mobility area through the "Mobility Master Plan". Reviewing the two Colombian cities studied, the previous aspects have been taken into account to establish a new definition of the Smart City concept and a set of six dimensions and 27 subcategories as essential to define and measure the concept of the Smart City. This model can be used to monitor the status in Colombia, in order to approximate the current valuations of Colombian cities, to qualify for the concept described as the Smart City.

Due to the lack of studies relating to the concept of Smart Cities and its relevance to Colombian cities observed in the current work, further research must be focused not only on getting more data concerning the situation in Bogota and Medellin, but also having the opportunity to examine the situation in other important cities such as Barranquilla, Cali, Bucaramanga and Cartagena, where there is no current information available. These future studies should be focused on refining the definition of the Smart City concept and establishing quantitative criteria based on the six measurement dimensions and 27 indicators defined. To further understand the phenomenon of Smart Cities in Colombia, it is necessary to first do a diagnosis of the current status of the main cities, pointing out the challenges and opportunities. In a second stage, the main goal would be to analyze the applicability of the six dimensions on solving those problems.

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