Smart Sustainable Cities: Definition and Challenges

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Abstract In this chapter, we investigate the concept of Smart Sustainable Cities. We begin with five major developments of the last decades and show how they can be said to build a basis for the Smart Sustainable Cities concept. We argue that for the concept to have any useful meaning, it needs to be more strictly defined than it has previously been. We suggest such a definition and bring up some of the concept's more crucial challenges.

Keywords Smart city · Sustainable city · Sustainable development · Definition of sustainability · ICT

1 Introduction

Increasing environmental awareness and concern, urbanization and technological development have together resulted in an urgent need and opportunity to rethink how we construct and manage our cities. Over the last decades, these interlinked issues developments have started to converge under the new heading of Smart Sustainable Cities.

This chapter aims to provide an introduction to and discussion of the concept of Smart Sustainable Cities. The chapter also aims to suggest a definition of Smart

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Sustainable Cities and to present some core challenges involved in operationalizing the concept. While there are a numbers of definitions of smart cities and sustainable cities, the combination of these two has been less explored. Moreover, given the diversity in definitions of smart cities and sustainable cities, making such a combination is not an easy task. A definition of Smart Sustainable Cities is nevertheless needed to provide a joint understanding of the concept and to function as a basis for further discussions on what Smart Sustainable Cities aspire to deliver.

Following the introduction, the chapter continues by presenting five different developments that form the basis of the concept of Smart Sustainable Cities. This historical backdrop is important since it provides an understanding of how the concept has emerged. The chapter then proceeds to a somewhat more detailed examination of two closely related concepts, namely smart cities and sustainable cities, and what can be learned from these in developing a definition of Smart Sustainable Cities. In the final part of the chapter a number of challenges for Smart Sustainable Cities are presented and discussed. The chapter concludes with a discussion relating directly to the aims formulated above.

2 Five Developments

In the following, we look into five developments that can be seen as the seeds from which the concept of Smart Sustainable Cities has grown.

2.1 Globalization of Environmental Problems and Sustainable Development

A series of UN conferences over the last 40 years have highlighted the increasingly global character of environmental problems. Until the Stockholm conference in 1972, environmental problems were mainly seen as local issues. They were created locally and had local effects. But over the last 40 years, it has become increasingly clear that this is not the case. The Brundtland commission report from the World Conference on Environment and Development [1] put the concept of sustainable development on the agenda, and the subsequent conferences in Rio and Cape Town kept it there. Under the slogan "think global, act local," the Agenda 21 action plan clearly pointed to the importance of local implementation and action to abate global environmental and social problems.

One of the most evident examples of global environmental problems is climate change. Ever since 1988, the Intergovernmental Panel on Climate Change (IPCC) has explored the causes and potential effects of climate change and has in subsequent reports sharpened their conclusions: climate change is real, and it is being driven by human activities (see e.g. [2]). Moreover, there are a number of other, perhaps equally important global issues that need to be addressed. The rapid

decline in biodiversity, the imbalance in the cycles of nitrogen and phosphorous, and the acidification of oceans and changes in land use are other examples of issues where humankind has exceeded global thresholds or is on the verge of crossing them [3].

2.2 Urbanization and Urban Growth

When the 20th century began, about 12.5 % or 200 million people lived in cities [4]. A 100 years later those numbers had increased to 52 % or 3.6 billion people [5]. According to these statistics, more than half of the world's population now lives in cities; a share that is only expected to increase. According to UN DESA, "urban areas of the world are expected to absorb all the population growth expected over the next 4 decades while at the same time drawing in some of the rural population" [5, p. 1]. In 2050 the urban population is estimated to account for 67 % of the global population, albeit with large regional differences. In more developed regions, 86 % of the population is expected to be urban dwellers in 2050, while in less developed regions the urban proportion is expected to be 64 % [5]. According to UN DESA, most of the urbanization will take place through the growth of already existing urban areas. However, contrary to what one might think, the largest part of the growth is expected to take place in relatively small cities.

2.3 Sustainable Urban Development and Sustainable Cities

With more than half of the world's population living in urban areas, this is also where the use of energy, land and other resources is increasingly originating. The ongoing concentration of the global population in urban areas thus implies that these are increasingly important when it comes to addressing issues of sustainable development. In other words, sustainable urban development has become a prerequisite for sustainable development [6].

Combining sustainable development and urbanization issues, the area of sustainable cities has become of interest for research, education, policy making and businesses—an interest that has been manifested in all parts of society. In academia it can be seen in scientific journals, university education, research programs and university departments specifically devoted to addressing sustainable urban development.

In the public sector of policy making and planning, the perceived need for sustainable urban development can be seen in international forums, charters and organizations, in national programs and targets, as well as in local comprehensive plans and environmental programs. Combining the local and the international, networks such as ICLEI (Local Governments for Sustainability), C40 Cities climate leadership group and the Clinton Climate Initiative—Cities program (CCI)

aim for mutual learning and sharing of experiences on how to best advance sustainable urban development in practice.

The concept is now also increasingly used by actors in the private sector, especially by consultancies and companies in the construction of buildings, city districts, or entire cities. In Sweden, one example of this is "SymbioCity" a marketing platform developed and run by Business Sweden with the explicit aim of promoting Swedish eco-profiled companies on the international eco-city market [7]. Business Sweden is however not entirely private but jointly owned by the Swedish Government and private businesses [8].

In policy making, planning and the private sector, the concept of sustainable cities has tended to focus mainly on infrastructures for urban metabolism—sewage, water, energy and waste management within the city.

2.4 Information and Communication Technologies

While the increased interest in sustainable development comes from an understanding of the pressure that humanity imposes on global ecosystems, and urbanization is a consequence of people moving to conurbations, the ICT development is commonly understood to be a technological development. Townsend [4] on the other hand depicts the development of Information and Communication Technologies (ICT) and urban growth as a symbiosis. Townsend argues that writing, as the first information technology, was invented to keep track of increasing market activities in the Middle East some 6,000 years ago, and that this made it possible for cities to grow. Much later, the emergence of more advanced communication technology in the form of the telephone and the telegraph supported urban growth by making it possible to keep track of the increased complexity in the industrializing cities.

The development of ICT has had an enormous impact on how people live their lives and on how work, leisure and society are organized. The reduction in the cost and size of computing capacity has facilitated a number of new products, services and business models. From an environmental perspective, the development thus far has been double-edged. On one hand, ICT has made it possible to dematerialize music and books for example and has made it possible to communicate without travelling (see the chapter by Coroama et al. [9] in this volume). On the other hand, it seems that the ICT development has increased productivity, leading to even cheaper products and fuelling the consumption society. Moreover, despite the opportunities for substituting travel with telecommunication, global air travel is increasing [10].

Townsend [4] points out two recent changes in global ICT development and uses those to provide a basis—but also a challenge—for cities to become smart. The first is the transition from wires to wireless, including both telephones and Internet access. The second development concerns the increasing number of devices being connected to the Internet, the transition towards an "Internet of Things".

2.5 Smart Cities

The origin of the concept of Smart Cities can be traced back to at least the Smart Growth Movement of the late 1990s [11]. Gabrys [12] find the roots of the concept earlier, namely from what they call the "cybernetically planned cities" of the 1960s, in proposals for networked or computable cities in urban development plans from the 1980s onwards.

To a great extent, Smart Cities is today a concept advanced by the business sector. It is a catchword that draws enormous interest from companies involved in ICT and infrastructure. Townsend [4] chooses to highlight a few of them, and describes their different interests as: "[i]f Siemens and Cisco aim to be the electrician and the plumber for smart cities, IBM's ambition is [to] be their choreographer, superintendent and oracle rolled into one" [4, p. 63]. From the business side, repacking ICT solutions in a "smart city" framework holds the potential of launching a kind of wholesale concept, and to direct this to the public sector of city administrators.

Most of the ICT included in the smart city concepts already exist. The novelty is thus not so much the individual technologies, products or services but the interconnection and the synchronization of these and the systems they include, so that they work in concerted action. This is also where the challenge is and what makes the market so interesting for the big companies that have the potential to develop those broad solutions.

3 Developing a Definition for Smart Sustainable Cities

There are essentially two approaches to crafting a definition of Smart Sustainable Cities. The first is based on an inductive (bottom-up) approach, by which the definition is developed by looking at and synthesizing how others have defined the concept in theory and/or in practice. Depending on how congruent the identified definitions are, this process may result in one definition or a typology of definitions. The second way is based on a deductive (top-down) approach whereby the process of developing a definition starts out with a hypothesis or a normative statement about what Smart Sustainable Cities should be, on the basis of which a definition is then elaborated. In practice these "ideal types" of approaches are typically combined, either consciously or unconsciously, but with one of them being the dominant approach.

3.1 Sustainable

In this chapter we have chosen to develop a normative and deductively crafted definition of Smart Sustainable Cities. A key reason for this derives from an understanding of the word "sustainable" as a normative and socially constructed

concept with the purpose of pointing out a desired state or trajectory of development. This means that the definition of sustainable development (or sustainable or sustainability) cannot be based on an inductive approach. The concept has to be defined top–down.[1] For the purpose of this chapter, we depart from the classic definition of sustainable development, as coined by the Brundtland report in 1987 [1]. Since this definition has been both misinterpreted and misused, we also want to highlight that we adhere to the full definition, including the clarification of needs and the limitations to development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" [1].

The definition of sustainable development by Brundtland has a global perspective. In applying it to anything less than the whole world, some kind of addendum is needed. The Swedish government has solved this by defining a so-called "generational goal" stating that "the overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems *outside Sweden's borders*" [13, our emphasis]. Such an addendum can be useful not only for nations but also for smaller units such as cities.

3.2 Smart

The word "smart" is seen here as an instrumental rather than a normative concept. Moreover, smart is understood here as a feature rather than a sign of performance. This means that the opposite of "smart" is not "dumb" in this chapter, but rather "without the use of advanced information and communication technology". This means that smartness per se is not seen as holding any value. As an instrumental concept, smart is seen here as a prefix denominating an empirical category of products, services and product-service systems in which ICT play a major role. However, it should be stated that not everybody would agree with this interpretation. Hollands [14], later echoed by e.g. Kitchin [15] and Allwinkle and Cruiskshank [16], sees smart not as instrumental but as an intended outcome, which makes smart just as normative as sustainable. On the other hand, Neirotti et al. [11] remark on the importance of not being misled by the word smart: "the

[1] Top–down here refers to the conceptual and cognitive process of developing the definition and should not be confused with the extent of participation in the process.

number of 'smart' initiatives launched by a municipality is not an indicator of city performance, but could instead result in an intermediate output that reflects the efforts made to improve the quality of life of the citizens" [11, p. 25].

If, instead, we had used an inductive approach, we would have concluded that smart is as much a normative concept as a sustainable one, an idea that we will return to in the following section. This would also have led us towards looking at a partly different literature, e.g. including many kinds of innovative city planning. In our view, it is somewhat unfortunate that "smart" has to some extent become interchangeable with "ICT-supported". But at this point, we find that the concept of Smart Cities has grown so strong that it is better to use it and sharpen its definition than to let it mean everything and therefore nothing. We base this on a belief that connecting "Smart" in "Smart cities" to advanced ICT is the most constructive way forward. Thus, it is a normative choice to use the concept instrumentally.

3.3 Cities

"Cities", as the object to which both smart and sustainable are attached, is also an empirical category. Here it is used to designate the types of human structures and environments where smart solutions for sustainable development may be found. In contrast to smart, the concept of cities is however not seen as instrumental. The reason for this is that the existence of cities is not seen as optional but is taken for granted. Thus, rather than looking at whether or not cities as such are beneficial to sustainable development, the focus is on how cities can be made more sustainable.

The empirical basis for an inductive definition of Smart Sustainable Cities is weak. Indeed, it is the combination of smart and sustainable that is missing; considering smart or sustainable cities separately offers more material to draw on.[2] Still, the material on smart cities and sustainable cities is relevant for a deductive definition in that it provides a basis for filling the concepts of smart and sustainable with meaning that is related to and thus relevant for cities. Therefore, we explore how these concepts have been defined by others (Sects. 3.4, 3.5), before presenting our own definition of Smart Sustainable Cities (Sect. 3.6).

3.4 Definitions of Smart Cities

Most of the literature on smart cities focuses on either specific types of ICT (e.g. e-services or travel planners), specific opportunities and challenges (e.g. big data),

[2] A search for "smart cit*" in Title, Abstract or Keywords in SCOPUS gave 683 hits. A search for "smart cit*" AND "sustainable*" gave 100 hits, and a search on "smart cit*" AND "green*" gave 33 hits, 12 of which also appeared in the search on "sustainab*". A search on "smart sustainab* cit*" gave 1 hit only. Searches made in February 2014.

or specific domains of application (e.g. smart transportation or smart land use planning). Still, a number of examples of smart city definitions can be found:

- "places where information technology is combined with infrastructure, architecture, everyday objects, and even our own bodies to address social, economic and environmental problems" [4, p. 15];
- "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" [17, p. 50];
- "are characterized by a pervasive use of Information and Communication Technologies (ICT), which, in various urban domains, help cities make better use of their resources" [11, p. 25];
- "A 'Smart City' is intended as an urban environment which, supported by pervasive ICT systems, is able to offer advanced and innovative services to citizens in order to improve the overall quality of their life" [18, p. 169];
- "a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership" [19];
- "A Smart City is a place where the traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses" [20]; and
- "effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens" [21, p. 4].

In further specifying the concept, many researchers such as [17–19] refer to the work carried out at the Centre of Regional Science at the Vienna University of Technology [22], which sees the smart city concept as including six axes or types of action:

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

Neirotti et al. [11] present a slightly different approach, based on a conceptual framework comprising a number of application domains and sub-domains that they see as classifying a smart city. However, with few exceptions, the applications domains are essentially the same as the six axes:

- Natural resources and energy
- Transportation and mobility
- Buildings
- Living
- Government
- Economy and people

3.5 Sustainable Cities

As mentioned above, initiatives on "sustainable cities" have typically focused on technical solutions for a more efficient urban metabolism. The sustainability of a city has typically also been focused on sustainability impacts occurring within the city's administrative boundaries. Together, these two practices result in a situation in which only parts of the challenges and solutions related to sustainable urban development are identified.

The main reason for this is that few (if any) cities are self-sufficient. To support the life of its citizens, the city is dependent on a hinterland, from which resources are taken and to which pollutants and waste are disseminated. In the historical past, this hinterland was located in close proximity to the city, more or less starting on the other side of the city wall. However, due to the processes of industrialization, urbanization and globalization, an increasing share of the goods consumed in the city is produced further and further away. This means that the environmental impacts of the consumption taking place in a city are scattered over the globe, and, consequently, that the environmental impact of a city cannot be delimited to the urban metabolism within the city boundaries. Thus, a better understanding of the concept of sustainable cities requires a global perspective in which sustainability assessments and urban developments are made in a way that takes into account the global consequences of local action or inaction.

A global perspective can be taken in essentially two different ways. One is to use a production-based accounting approach with a full life-cycle assessment, meaning that the impact of a city is determined by the production taking place within the city boundary, including all impacts upstream and downstream of the production. The second way is to use a consumption-based accounting approach by which the impact of a city is determined based on the consumption of a city's inhabitants, no matter where the production of the consumed goods takes place [23]. A consumption-based account thus builds on a relational understanding of space and emphasizes both intra- and inter-generational justice. As a result, the system boundary delineating where ICT solutions can be used includes not only the infrastructures, technologies and everyday life in the city, but the entire life-cycle of products and services consumed by the citizens.

To abate global environmental problems as well as the distributional inequities of environmental and social costs and benefits, a consumption-based accounting perspective is the only feasible way forward.

The issue of system boundaries is also relevant when looking at the social aspects of sustainability. Here, all of the Smart City concepts found focus entirely on the use phase of ICT, completely disregarding the quality of life of people involved in the other phases of ICT's life-cycle (e.g. working in mining, production and disassembly). While this way of drawing the system boundaries for the analysis might make sense at the level of urban governance and planning, it is important that these other aspects are not forgotten.

3.6 What Could We Mean by Smart Sustainable Cities?

Smart Sustainable Cities (SSC) should be seen as an aggregate concept. As shown in Fig. 1, this means that all three parts need to be present for an entity to qualify as a smart sustainable city; if not, the entity is instead a smart city, a sustainable city, a case of smart sustainability—or something else.

In some of the identified definitions of a smart city, sustainability is an integral part. Thus, one might argue that the smart city is the smart sustainable city, and that the word 'sustainable' can be left out without further ado. However, there are a number of reasons why it should be kept.

Firstly, while some smart city concepts include sustainability, this is not the case for all of them. In a literature review of smart city concepts, Kramers et al. [24] found that few of these included explicit environmental sustainability objectives. In contrast to this study, a recent mapping of smart city initiatives in the EU found that "smart environment" and "smart mobility" are the most common types of actions, with 33 and 21 % of all smart initiatives respectively [20]. This also correlates well with the findings of Neirotti et al. [11] in which "Transportation and Mobility" and "Natural Resources and Energy" were found to be the two most common types of application domains for smart city initiatives across the 70 investigated cities. One potential explanation for why the studies by Kramers et al. [25], on the one hand, and by Neirotti et al. [11] and commissioned by European Parliament [19], on the other hand, lead to different conclusions is that there is a divide between how smart cities are interpreted in theory and how they are carried out in practice.

Secondly, none of the identified smart city concepts set up any baseline for sustainability or define what sustainability (or a sustainable city or sustainable urban development) is. And while a smart city concept might get away with not defining sustainability, this is more problematic for a smart sustainable city. A definition of sustainability is important to know what to strive for, i.e. to know for what purposes the smart technologies should be used. It is also important to assess whether the smartness delivers the intended outcomes or not. And it is crucial when it comes to dealing with conflicts between two or more sustainability objectives. None of the smart city definitions identified provides a hierarchy or prioritization of smart aspects or types of applications, which in practice means that smart economy, smart mobility, smart environment, smart people, smart living, smart governance, and such are all assigned the same value.

As a first attempt to define Smart Sustainable Cities, we have chosen to base the concept on the Brundtland definition, while taking the above discussion into account:

A Smart Sustainable City is a city that

- meets the needs of its present inhabitants
- without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and
- where this is supported by ICT.

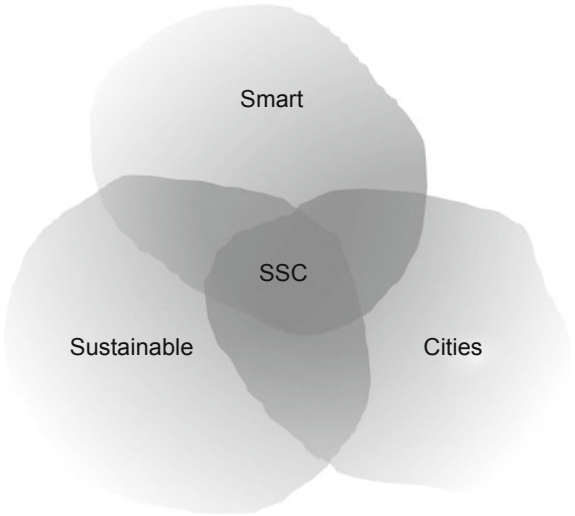

Fig. 1 Cities can be made sustainable without the use of smart (ICT) technology, and smart technologies can be used in cities without contributing to sustainable development. Smart technologies can also be used for sustainable development in other cases than cities. It is only when all these three aspects are combined, when smart technologies are used for making cities more sustainable, that we can speak of smart sustainable cities (SSC)

The definition is a rewrite of the Brundtland definition, complemented with "for other people", in order to emphasize the global responsibility of any city with sustainability claims, and ICT as an instrument to achieve sustainability. With this definition, we assert that ICT in a Smart Sustainable City is used to solve local and global environmental problems while supporting a good life for its citizens as well as intra- and inter-generational justice.

The definition has commonalities with a recent preliminary definition from the International Telecommunication Union's (ITU[3]) Focus Group on Smart Sustainable Cities. Their definition,[4] or a close variant, is likely to become the UN standard definition of Smart Sustainable Cities later in 2014.

[3] ITU is the United Nations' specialized agency for information and communication technologies.

[4] "A smart sustainable city uses information and communication technologies (ICTs) to provide enhanced quality of life to its citizens, improved efficiency of services and sustainable development. Such a city meets the needs of today without sacrificing the needs of future generations with respect to economic, social and environmental aspects" [22].

4 Five Challenges for Smart Sustainable Cities

Smart Sustainable Cities is an underdeveloped concept. In the previous section, we suggested a definition for it. In this section we present five challenges that need to be addressed for smart sustainable cities to materialize.

4.1 Strategic Assessment

Once Smart Sustainable Cities are defined, it is evident that assessments in relation to that meaning become necessary. Methods and practices need to be developed and implemented. Methods are required that can be used to identify which solutions are needed, and that take a systems perspective on evaluating the effects of the proposed solutions. Without this, "Smart Sustainable Cities" risks becoming just a label without validated content. In developing assessment methods, it is important to keep in mind that in practice it is the assessment, or the indicators included in an assessment, that defines the important characteristics of a smart sustainable city. As mentioned, it is also important to consider how to prioritize between different objectives in case of conflicting interests. Such conflicts may arise between sustainability dimensions (e.g. the conflict between biofuel and food production) or within them (e.g., the conflict between biofuel production and biodiversity).

4.2 Mitigating Measures

Historically, infrastructure development and investment have led to substantial improvements in wellbeing and wealth. Through the implementation of systems for transport, power, water and sewage management, life for billions of people has been improved. As a part of this, infrastructures have also made it possible to create and develop more efficient systems for trade and businesses of various kinds. Infrastructure development is in many ways a backbone of modern society. However, infrastructures have also made it possible to ruin ecosystems and exploit natural resources to an extent that threatens the existence of that same modern society. ICT is in this sense functioning in the same way as other infrastructures; today it plays an increasingly important role in maintaining and developing society and has the potential to support a resource-efficient sustainable society. But it also has the capacity to be used to make modern society an even more efficient machine for over-exploiting the earth. An example of this is using ICT to increase traffic flows in cities. If measures are implemented that make it easier to travel, travel will increase along with its negative environmental impacts. Therefore, the improvements in traffic might need to be paired with other measures. Similarly,

counter-measures may be needed to realize the sustainability potential of ICT in other cases as well. Cities must craft mitigating measures at the same time as they encourage technology for efficiency improvements, and they must closely follow how ICT is shaping society.

4.3 Top-Down and Bottom-up

The actual products, services and systems of the smart sustainable city may originate as large-scale suggestions from big companies such as Cisco, Ericsson, IBM or Siemens. One potential benefit of such top–down solutions is that these giants have the economic capacity to fully implement the assessments called for above, and they can function as concrete suppliers of the tools and services that city administrations may want to implement. However, there is also a risk that the strength of the corporate giants can enable them to monopolize smart sustainable city development to the extent that it kills creativity. The bottom–up approach can be represented by hacker communities and other types of grassroots or small-scale initiatives. Many cities have great expectations on the potential for innovation through involving people in formulation and solving of problems. A weakness of this approach is that it can be very difficult to take the solutions to the next level, thus leading to many fragmented small-scale solutions without the power to actually make a big change. Another weakness of this approach is that it can be very difficult to assess the actual outcome. It may be argued that supporting many initiatives will increase the chance of yielding successful ones. This may be true, but it is also likely that others will turn out to be bad from a sustainability perspective.

4.4 Competence

As mentioned in the previous challenge, initiatives from big enterprises can be very effective. They may also be efficient ways of implementing good solutions. However, currently ICT knowledge among companies is so much higher than among city governments that the cities become weak customers. They do not have the capacity to adequately specify their needs or to properly evaluate the offers they receive. This can lead to either bad investment decisions or paralyzed decision making. It is probably in the interest of both city administrations and ICT companies to increase city administrations' competences with regard to ICT solutions for Smart Sustainable Cities. This need has been recognized by the EU Smart Cities Stakeholder Platform, which has developed guidelines for public procurement for smart cities [26].

4.5 Governance

The smart sustainable city calls not only for interconnecting devices but also organizations, requiring a reconsideration of which actors need to be involved in the planning and governance of the city [27–30]. Moreover, for the diverse ICT in the city to work through concerted action, a coordinating body must play a role. This is also important from the perspective of sustainability because of the aforementioned need to strategically assess and evaluate the effects of ICT investments. Lee et al. propose a "[d]edicated smart city team formed with diverse roles and skills to promote smart city development [that is] also recognized by other city's agencies" [30, p. 6]. With a focus on Smart Sustainable Cities, this team could then be given the assignment to promote smart sustainable city development. Over time, such a body could also develop the competence needed to scrutinize offers from ICT companies as well as play a role in balancing top–down and bottom–up approaches.

5 Concluding Discussion

Smart Sustainable Cities is an aggregate concept. In this chapter we have shown that each of the constituent concepts—smart, sustainable, and cities—is important in its own right. Cities can be made sustainable without the use of smart (ICT) technology, and smart technologies can be used in cities without contributing to sustainable development. Smart technologies can also be used for sustainable development in venues other than cities. It is only when all three aspects are combined, when smart (ICT) technologies are used to make cities more sustainable, that we can speak of Smart Sustainable Cities (SSC).

Indeed, the concept of Smart Sustainable Cities is not relevant for all actors and perspectives. For example, from a sustainability perspective it could be argued that whether or not a city uses ICT is a rather unimportant issue as long as it becomes more sustainable. Therefore, the concept of a sustainable city would be enough. And from an ICT industry perspective it could be argued that industry works with smart solutions, while the sustainability part is not their business, and therefore the concept of the smart city is appropriate and sufficient. Those standpoints are valid, but from a more holistic perspective, the concept of Smart Sustainable Cities is needed, exactly because of the two standpoints above.

Connecting the concepts of sustainable cities and smart cities may also raise awareness about the potential of using ICT to promote urban sustainability among planners, IT companies and policy makers. The concept of Smart Sustainable Cities can thus be used as a common framework or joint vision for elaborating new collaborations, business models and ways of carrying out urban development. This in turn highlights the need to avoid getting caught up only in the technological challenges of developing Smart Sustainable Cities and rather taking a proactive approach to actor-networks, governance, and policy innovations.

Defining Smart Sustainable Cities is also important because of the ongoing competition on how to interpret this concept. It has become a concept with positive connotations, and thus it is seen as good to be associated with it. In practice, this can lead to a loss of power for the concept the concept losing its power. By focusing the definition, ICT development based on sustainability concerns can get a competitive edge. By simultaneously emphasizing both smart and sustainable, ICT development could be driven more by sustainability problems, instead of by a pure technical development in which newly developed "solutions" may not actually be solutions to any specific problem.

In this chapter we developed this definition of Smart Sustainable Cities:

A Smart Sustainable City is a city that

- meets the needs of its present inhabitants
- without compromising the ability for other people or future generations to meet their needs, and thus, does not exceed local or planetary environmental limitations, and
- where this is supported by ICT.

However, even if such a definition were to gain broad acceptance among private and public actors, a number of challenges for the practical use of the concept would remain:

- Assessment methods need to be developed and used in order to ensure that cities identified as Smart Sustainable Cities are in fact sustainable;
- Mitigating measures will most likely be needed for implementing policies for Smart Sustainable Cities. Otherwise, rebound effects may well cancel out the positive effects;
- The relationship between top–down and bottom–up initiatives needs further exploration;
- Strategies for strengthening city governments' competences are needed; and
- Governance models for smart sustainable city development must be considered.

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