Social Emergence, Cornerstone of Smart City Governance as a Complex Citizen-Centric System

36

Claude Rochet and Amine Belemlih

Contents

Abstract

We consider the smart city not as an addition of "smarties" (technological devices) but as a system capable of evolution all along its lifecycle, described as Urban Lifecycle Management (Rochet and Volle, L'intelligence iconomique,

C. Rochet (✉)
Paris Dauphine PSL University, Paris, France

Fondation Robert de Sorbon, Institut Franco Allemand d'Etudes Européennes, Paris, France
e-mail: claude.rochet@wanadoo.fr

A. Belemlih
Paris Dauphine PSL University, Paris, France

EM Lyon Casablanca Campus, Casablanca, Morocco

Transilience Institute for Territory Resilience and Transformation, Casablanca, Morocco
e-mail: abelemlih@transilience-institute.org

J. C. Augusto (ed.), *Handbook of Smart Cities*,
https://doi.org/10.1007/978-3-030-69698-6_29

les nouveaux modèles d'affaires de la III° revolution industrielle, De Boeck Supérieur, Louvain, 2015) since a city never dies and must be able to reconfigure itself while its internal and external environment changes. The literature on cities as evolving ecosystems (Batty, I/S: J Law Policy Inf Soc 11(1):127–151, 2015) considers this evolutionary process cannot be steered in a top down way, either by a supra rational actor or on a self-regulating basis as claimed by the authors of the first order cybernetics. By integrating all the developments around citizen-centric smart cities, we propose a complex system and social emergence lens to better understand the process of emergence of "bottom-up" dynamics within local communities leading to socially smart cities.

Introduction

The recurrent problem appearing in the attempts to define smart cities is the understanding of how a smart city grows and evolves out of a sum of technological devices. Michael Batty's groundbreaking opus *The New Science of Cities* (2013) defines the challenge, in the line of thought of Jane Jacobs and Chris Alexander, as comprehending the city "*as systems built more like organisms than machines*," that is, a network of flows. Consequently, if we want the city to be smart, we need to monitor the growth of the city and predict its evolution with modeling tools up to the age of the digital economy. We need to analyze the smart cities dynamics through the lens of complex systems architecture, to envisage which competencies, and specifically public ones, may be updated to take on this task of modeling (e.g., Batty 2013; Khatoun and Zeadally 2016). Following Batty and other complex systems scientists, the city aspiring to be smart is to be conceived from the bottom-up and no longer from the top down as it has been the rule until now in the tradition of urban planning, therefore putting emphasis on the role of the ordinary citizen as a key actor.

Overall, as will be seen in the next parts of the chapter, smart city discourse is evolving between two antagonistic perspectives, with a growing tendency advocating for the second view, promoting bottom-up and citizen-centric approaches, although the top down, data and technology-driven perspective remains dominant on the ground until now (e.g., Satyam and Calzada 2017 for a review of these trends) (Table 1).

The Smart City: A Collection of Smarties or a System?

Mainstream definition of smart cities, adopted by the European Union, relies on Giffinger's categorization (2010): a city is smart if it gathers "smart" characteristics: smart people, smart governance, smart transportation, smart buildings, smart economy, technology… Basing on such criteria, EU accounts up to 240 smart cities in Europe! This approach is meaningless from a systemic point of view: we may have smart people working with cutting-edge technologies in BIM (Building Information

Table 1 Smart city discourse evolving between two antagonistic perspectives. The authors:

Smart city perspective between...	... and
Techno-centric smart cities (e.g., Calzada 2018), ***data-driven*** cities (e.g., Calzada and Cowie 2017), or ***Datapolis*** (Pisani 2015), driven through **technology vendors** (e.g., Greenfield 2013; Morozov and Bria 2018; Rochet 2018), or **top down** policies (e.g., Batty 2013; Innes and Booher 2000; Rochet 2018)	***Citizen-centric experimental cities and urban laboratories*** (e.g., Calzada 2018; Karvonen and van Heur 2014), ***Participolis*** (Pisani 2015), ***Smart community*** (e.g., Gurstein 2014; Mellouli et al. 2014; Meijer 2016), driven ***bottom-up*** (e.g., Calzada and Cowie 2017; Morozov and Bria 2018; Peña-López 2019)
City built ***like a machine*** (e.g., Batty 2013), understood as a ***mechanical system*** that can be ***fixed***, or ***steered*** and ***controlled*** through data levers (e.g., Innes and Booher 2000), or conceived as a ***Cyborg city*** (e.g., Gandy 2005; Picon 1998)	Smart city as ***evolving*** ecosystems (e.g., Batty 2015; Innes and Booher 2000), ***complex systems*** composed of interdependent components (e.g., Batty 2013; Khatoun and Zeadally 2016; Holland 1995;), and ***far from equilibrium*** systems (e.g., Batty 2012)

Modeling) positive energy buildings (Volk et al. 2014), using trendy solar transportation cars, and overall producing a "stupid system as a whole" (refers to the expression used by Rachel Keeton 2015).

Attempting to make sense of the broad range of existing experiences under the umbrella of "Smart City" concept, Albino et al. (2015) examined 22 accounts and cross-referenced these with urban developments which labeled themselves as smart cities. Their conclusion was that a single definition was impossible because of wide variations in the meaning of common terms, and any attempts to include everything inevitably cover too much or too little (Albino et al. 2015).

Overall, a growing literature stream has been taking a critical view of the hegemonic smart city discourse (Calzada and Cowie 2017), especially when we look at the increasing number of nuanced critiques of a technology deterministic and hyper-connected understanding of a smart city (Calzada and Cobo 2015).

Rather than cities being understood as mechanical systems that can be disassembled into their component parts and fixed, or steered and controlled through data levers, cities are conceived as consisting of multiple, complex, interdependent systems that influence each other in often unpredictable ways (Innes and Booher 2000). A smart city is therefore more than the sum of "smarties" (smart grids, smart buildings, smart computing...) in spite of we have no precise and operational definition of what a smart city is (Lizaroiu and Roscia 2012). In the recent literature, the smart city tends to be defined as complex "*self-organizing learning systems that can be creative and sustainable*" (Innes and Booher 2000, p. 183) that is to say systems where the whole is more than the sum of the parts and has autopoietic properties (Neirotti et al. 2014; Batty 2013).

In contrast with a metaphor that the world is like a machine that can be taken apart and fixed, complexity theory suggests that the cities are more like living organisms, growing, evolving, adapting to its environment and facing random events, unanticipated changes or patterns that make top down public policies often fail (Bak 1996; Holland 1995, 1998; Innes and Booher 1999). What makes a system, and most of all

an ecosystem, is integration. Integration is an emergence, which is a state defined as a process which cannot be described by a fixed model, consisting of invariant distinctions. Hence, emergence must be described by a metamodel, representing the transition from one model to another one by means of a distinction dynamic (Heylighen 1992). The literature on cities as evolving ecosystems (Batty 2015) considers this evolutionary process cannot be steered in top-down way or on a self-regulating basis as claimed by the authors of the first order cybernetics (Heylighen et al. 1991). There are many diverse players who make millions of decisions each day which add up to the evolving form, structure, and character of cities and which collectively shape their economies, their vitality, and their evolution (Innes and Booher 2000). These decisions are "*largely beyond the reach of any formal urban policy or plan, much less of any top down regulatory strategy . . . (and) the best planners can do is to help the players in these places to influence the direction of change*" (p. 178).

Therefore, if we apply the law of requisite variety developed in the stream of complexity theories, we see clearly, as had stated Karl Weick (1995), that in the context of complex social systems, "*human thoughts and action must be highly varied to grasp the variations in an ongoing flow of events*." In other words, for such a transition stated above to succeed at the scale of a social system (city, district, etc.), the metamodel and its underlying process must be "*as complex as the system they (actors involved) intend to regulate*" (Weick 1987).

The purpose of this chapter is first to understand the basic tenets of complex adaptive system theory applied to the emerging field of smart city and its participatory, community-centered, and self-regulation dynamics, providing some exemplars with the cities of Barcelona and Medellin, second to explore what kind of "complexity-enabled" process could be adapted to experiment participatory and deliberative democracy principles (Calzada 2018) on a "socially smart" emerging community system. As we choose to focus on the "*socially smart cities*" (Durose et al. 2019) part of using the lens of "*generative emergence*" (Chiles et al. 2004; Lichtenstein 2009; Plowman et al. 2007) and its underlying mechanisms, as applied to the transformation of a territory, a smart city or a community, "*from the ground up*" (Bria 2019).

How Smart Were the Cities of the Past?

The seminal book *The City in History* by Lewis Mumford (1968) tells us cities of the past were self-evolving ecosystems obeying the laws of organic planning. Organic planning, as analyzed by Mumford, has no preconceived objectives. It is a self-adaptive system which reinforces its coherence along time. The resulting pattern has not been foreseen beforehand but is strongly coherent and harmonious.

This evolution was made possible by a shared common sense of beauty and life purpose in the city. One of the most salient traits of these towns is that they were free merchant cities ruled by various forms of democracy, drawing from direct democracy – for example, Veliki Novgorod in eleventh-century Russia – to complex mix

regimes to preserve the equilibrium of powers among the few powerful and the many of citizens – for example, Florence, Venice (Rochet 2018). The sense of the Common good and the sense of harmony as constitutive elements made these cities working as a continuous problem solving and learning system, which reinforced its coherence along time (Ibid.).

As Mumford put it, the coherence of these cities was reinforced by the wall that we could call, in the contemporary system language, the perimeter of the system which defines what is inside and outside the system (Mumford 1968). The relationships between the city and its periphery were organized as described at the beginning of the nineteenth century by Von Thünen, by concentric circles (Rosenberg 2020). But what made the success of the medieval town turned out to lead to its downfall. While the wall was fixed, the city evolved over time, increasingly becoming an open evolutionary system, especially with the advent of the "death of distance," first with more secure roads and with the revolution of transportation by the middle of the nineteenth century. With the appearance of networks of infrastructure technologies and the spread of the telegraph that transformed the government of the city, critical obstacles to the growth of cities were removed making the wall senseless. Today digital technologies amplify this move, providing new tools such as smart phones that became a "digital Swiss army knife" (e.g., see The smartphone is the Swiss Army knife of gadgets (2013)) that allows inhabitants to be active actors in the city life, communicating and coordinating with each other, using and feeding databases (Khatoun and Zeadally 2016).

Cities as Far from Equilibrium Adaptive Systems

Growing cities began to be considered a system in the practice of urban planning that appeared formally in the 1950s to solve the problem of transportation between workplaces and housing, under the banner of "*social physics*," the utilitarian approach propelled by Stanley Jevons at the end of the nineteenth century (Jevons 1871, 1970) who considered economy ruled by the general laws of mechanics. These key ideas assumed the system was in equilibrium and might be regulated by single feedback loops according to the principles of first order cybernetics. This kind of model relied on spatial interaction for testing, for example, how people might shift from one mode of transportation to another, as decided to solve the congestion in London in 2003 by charging car traffic, and predict the effect on global pollution, the growing density of the city to shorten the traffic between workplace and habitation (Beevers and Carslaw 2005).

But in the recent decades, since the 1980s, the paradigm has changed fundamentally. In first order cybernetics, the system is centrally organized, in equilibrium, being able to return to its state of equilibrium after a perturbation – an equilibrium slightly different but not questioning the dominant pattern of the city (Rochet 2018). This kind of system is viewed as centrally organized and structured from the top down, as exemplified by Rio do Janeiro central control system built by IBM (see *IBM takes smart cities concept to Rio de Janeiro* 2012).

The development of second order cybernetics in the 1980s moved the structures and behaviors of the city toward a system being organized from the bottom-up. These systems are in dynamic disequilibrium, notwithstanding that disequilibrium is not permanent since the system is undergoing to one state of equilibrium to another (Rochet 2018). Michael Batty has coined the expression "*far from equilibrium*" to describe this phenomenon (2012), initially studied in thermodynamics (e.g., the work of Prigogine and his colleagues (Prigogine 1955; Nicolis and Prigogine 1989)), and later, in complex social systems (Meyer et al. 2005). In this theoretical framework, organizing far-from-equilibrium is what leads to "... *emergence and ongoing, perpetual novelty*" (Meyer et al. 2005, p. 450b), explaining the origin of systemic state change.

These systems are *adaptive* (Arthur 1997) meaning that equilibrium is renewed from within through unanticipated innovations reacting unanticipated events. This is an *endogenous* evolutionary process, compared to the *exogenous* command and control process of the first order cybernetics. Here we find this kind of "*architecture without architects*" as described by Mumford (1968), in the case of the Middle-age city, with cities growing organically from the bottom-up. Christopher Alexander, in his seminal book on system architecture of cities, *A Timeless Way of Building* (1980) has given an iconic definition of organic growth, putting that "*quality in buildings and towns cannot be made, but only generated, indirectly, by the ordinary actions of the people, just as flower cannot be made but only generated from the seed*."

This supposes some sort of genetic code, like in biology, that made the system self-regulating. In that case, asserts Alexander, this code is "*replaced by people conscientiousness of the larger scale patterns, which provides the rules of growth. If people have agreements about these larger scale patterns, then they can use their knowledge of the patterns, and the degree to which these patterns have been attained, or not, to guide the growth and the assembly of the smaller patterns. Slowly, under the impact of this guidance, the sequence of small-scale transformations will, of its own accord, create the larger patterns, piece by piece: without any individual person necessarily knowing how or where these larger patterns will be in the finished town*" (Alexander 1979).

To sum it up, the more the city as a system is confronted to as well endogenous as exogenous changes, the more it accumulates this "people consciousness" that allows new patterns to emerge. **The smartness of the city consists of this continuous learning process** that relies on interactions between basic cells and actors of the city. If the lessons of the middle-age city as an archetype of organic development that produced the smart city of that time, its failure was it was conceived as a closed system locked in behind the wall.

In the nineteenth century, intents to reinvent such self-contained cities were made by utopians such as Ebenezer Howard (1898, 1985) in reaction to the unhealthy sprawling of industrial revolution cities. He thought of the smart city as an ideal city conceived from scratch as a mix of country and city. His insight was to conceive the city as an interaction between a city with jobs and opportunity, but with pollution, and the countryside with fresh air and cheap land, but with fewer opportunities, each one acting as magnets attracting and repelling people. He invented a third magnet,

The Garden City, which combined the most attractive elements of both city and countryside (Howard 1898, 1985). Garden city was the Songdo of its day (Townsend 2013) that galvanized architects, engineers, and social planners in search of a rational and comprehensive approach to building city. Howard's approach was excoriated by Jane Jacobs in her *Death and Life of Great American Cities* (1992, 1985) for not giving room to real life: "*He conceived of good planning as a series of static acts; in each case the plan must anticipate all the needed... He was uninterested in the aspects of the city that could not be abstracted to serve his utopia*." As Dennis Hardy (1991) put it, Howard's garden cities were a quasi-utopia of a perfect city in an imperfect world (while communist and fascist utopias have dreamed of the city as a perfect city in a perfect world). Unable to evolve, the garden city dream, not relying on a global systemic architecture, has degenerated in the banal reality of suburban sprawl.

The same risk exists today with digital technologies, which could revive the ideal city dream, under the impulse of the big technology vendors who have an interest in a top-down and deterministic approach that reduce smart cities to the adoption of their intelligent technology (e.g., Calzada 2018; Calzada and Cowie 2017; Rochet 2018).

What Makes a City Smart?

In their analysis of present smart cities initiative, Neirotti et al. (2014) notice that there is no practice that encompasses all the domains, hard and soft, of the cities. The most covered domains are hard ones: transportation and mobility, natural resources, and energy. Government is the domain in which the cities report the lowest number of initiatives. More, in the present smart cities research program, there is an inverse correlation between investment in hard and soft domains, smart government being still the poor relative in smart cities initiatives, while cities that have invested in hard domains are not necessarily more livable cities. In fact, two models emerge from Neirotti and colleagues' survey: one focused on technology (with a strong impetus for technology vendors) and another focused on soft aspects (e.g., related to welfare and social inclusion policies – such as assistance of disabled citizens, culture and education), the hard model being dominant (Neirotti et al. 2014). The problem is there are no vendors for soft domains apart from the citizens themselves whereas systemic integration relies on soft domains, mainly taking into account the context and valuing social capital.

These approaches are dead ends, as analyzed by Adam Greenfield in his pamphlet *Against the Smart City* (2013). Promoted by vendors of technology, the ideology of the smart city is a techno-centric approach that relies on top down methodology that has produced the nonhabitable cities of Songdo, Masdar, Plan IT valley... The pamphleteer and digital philosopher Evgueny Morozov has excoriated this mood in his *To Save the World Click Here* (2013) as "*solutionism*," a term that Morozov draws from urban planning and architecture studies, referring to situations when someone (i) invents a problem, (ii) misrepresents this fiction as a genuine and urgent

dilemma, and (iii) advocates using technology to fix it. Morozov has further argued that the economics of these giant technology vendors' data extraction are creating a world in which they build addictive services to gather citizens' data to develop artificial intelligence (AI) and machine learning solutions for the very addiction problem they created (Morozov and Bria 2018).

The metaphor of the "*Cyborg City*" has often been used (Gandy 2005) to describe the dominant type of Smart City initiatives "*that seeks to optimize (the city's) operations through the capacity and speed of algorithms and artificial intelligence (Computing City) to handle the huge amounts of Big Data constantly collected by a network of sensors in the physical city and online*" (UNESCO and Netexplo 2019, p. 349). Coined by Antoine Picon (1998), the term appeared a year later as the title of a movie, where Michael Burke, director of *Cyborg City* (Burke 1998) "*describes how beneath the 'glass and concrete' of the future city there will be a 'humming mass of technology' acting as a central nervous system, 'constantly monitoring and controlling both its own functions and those of its citizens'*" (Burke 1998, cited by Gandy 2005, p. 29).

Netexplo study (2018) also observed an alternative model of "*Community City*" that could be defined by its social innovations as a priority response to the real life needs of citizens. Smart cities as "smart communities" (Granier and Hiroko 2016), or Community Cities as opposed to a Cyborg City (UNESCO and Netexplo 2019), are a type of Smart Inclusive Cities that aims to improve urban sociology through relations, mutual assistance, and the collective identity of the population with all its components, including Inclusive City aspects (UNESCO and Netexplo 2019). What some authors term "Smart community" (e.g., Granier and Kudo 2016; Gurstein 2014; Mellouli et al. 2014; Meijer 2016) corresponds, to smart cities where public participation is considered as an end in itself, with technologies being used for a "*distributed intelligence*," allowing to steer the diversity of actors more effectively and eventually leading to more integrated services and better policies (Meijer 2016).

In the same vein, Francis Pisani (2015), considers that the challenge for the future our cities is to overcome the discord between two extremes, between "*Datapolis*," the city completely managed using data collected by the technological infrastructure, and "*Participolis*," the city in which citizens participate in the design and management of the space in which they live. He recognizes though that "*Participolis remains more an aspiration than a reality, a multitude of active points throughout the world which are struggling to connect with each other*" (p. 193).

Considering the city evolution as a fluid, ongoing and "*always in the making*" product (Guy 2009) of a collective and recursive learning process that resonates with ideas of participatory, deliberative or direct democracy (Karvonen and van Heur 2014), we might look at the smart city as a smart *"autopoietic social system*" (Luhmann 1986).

A social system considered to be autopoietic is a "network of events which produces itself . . . the reproduction of events by events" (Luhmann 1986, p. 175).

Following Luhmann's definition, the smart city as an autopoietic system is never made once and for all but is continuously co-constituted by its actants, humans, and

nonhumans (Dainow 2017) and therefore is able to continuously reframe itself to adapt to an ever changing environment, along the urban life cycle (Rochet 2018).

Autopoiesis is a property of living dissipative systems: strong entropy and correlative capabilities to reproduce itself permanently thanks to its internal interactions (Maturana 1981; Varela et al. 1981). This property makes the system able to face with the rapid changes of the environment: "*This generalized view of autopoiesis considers systems as self-producing not in terms of their physical components, but in terms of its organization, which can be measured in terms of information and complexity. In other words, we can describe autopoietic systems as those producing more of their own complexity than the one produced by their environment*" (Gershenson 2015).

As a result, urban system scales from local actions and interactions that lead to global patterns which can only be predicted from the bottom-up (Miller and Page 2007). In this new view of the city being the result of emergent patterns, we need to focus on the role of citizens and direct or deliberative democracy at play in a "*city in the making*" (Guy 2009).

Why Do We Need Strong Citizen-Based Interactions Within the Urban System?

In urban planning expert-based, hierarchically organized policy making and governance have led in the postwar years to an erosion of process and output legitimacy due to the increased complexity of societies and their institutional fabric (Anttiroiko 2016). Wagenaar (2007) argues that participatory and deliberative models of governance are effective in harnessing complexity because they increase interaction within systems and thereby both enhance and utilize their diversity and creativity.

What emanates from this is a collective intelligence, be it aggregation of opinions or the wisdom of crowds (Surowiecki 2005), that translates into a participatory culture that supports, guides, and controls such development (Foth et al. 2011).

The social side of such intelligence assumes that a heterogeneous group of people is generally able to provide smarter solutions than an individual expert, that is, diversity trumps expertise (Howe 2009; Surowiecki 2005). This connects the smart city discourse to inclusive, open, and user-driven innovations as critical elements of smart urban development (Anttiroiko 2015; Antikainen et al. 2010).

Some cities and regions in Europe and globally are already being self-organized by following what is called "city-as-a platform" (Anttiroiko 2016), or "urban laboratories" (Karvonen and van Heur 2014), through the emergence of new tacit communities and relational spaces (Peña-López 2019), and more broadly through transformative alliances among the public sector, private sector, academia, and civic society allowing to democratize the smart city concept (Calzada and Cowie 2017) but also to experiment across institutional boundaries in search of the urban commons (Oström 2010).

By squaring the circle of the Stakeholders involved in the development of communities in cities or regions, which has been coined as "Helix Strategies"

(Deakin 2014; Etzkowitz and Leydesdorff 2000; Satyam and Calzada 2017), what is at stake is allowing territorial communities to find their own way through the assembling of stakeholders' present interests and future visions (Calzada and Cowie 2017).

A good illustration of the above perspective can be found in the rebuilding of Christchurch by its inhabitants. After the city of Christchurch (NZ) has been destroyed by an earthquake in 2011, the government of NZ proposed to rebuild the city based on a traditional top-down approach. The answer of Lianne Dalziel, the newly elected mayor, was to rely on citizens' intelligence initiatives insisting on the fact that a resilient city able to withstand a shock as an earthquake needed to be built bottom-up mobilizing empirical mundane knowledge and creating the conditions to appropriate scientific knowledge (see https://www.rnz.co.nz/news/national/401725/lianne-dalziel-reiterates-commitment-to-rebuilding-christchurch "Lianne Dalziel reiterates commitment to rebuilding Christchurch").

The second reason to plead for bottom-up approaches is the economy. To generalize, in the rapidly changing world, there is a need to smarten up economic renewal, which involves urban-regional functions that are based on the reflexivity of the urban actors involved, those who can learn, repair, and redesign their smart-city sub-systems in a wider regional context (Anttiroiko 2016). The smoothness and success of such a systemic whole and level of synergies depends to a large extent on the collective intelligence generated by the collaborating actors (Anttiroiko 2015; Herrschel 2013; Innes and Booher 2002).

An economic structure based on synergies on economic activities is the condition to wealth creation which reinforces itself through interaction of a political power based on the Common Good (Reinert 2008; Rochet 2012).

In the case of FFF (Failed, Fragile and Failing states), Kattel et al. (2009) note that "*State failure and fragility are often preceded, or at least accompanied, by failure and fragility of cities.*" When a city sprawls out of control, it produces negative externalities without positive synergies. "*The missing link in the economics is related to the lack of increasing returns based on "coopetitive" diffusion of means in a predictable and conducive environment. (. . .) productive governance often enforces the development sustainable productive structures based usually on a participatory system. The more the participatory system is closed to democracy and shared economic growth with special focus on health, education and communication infrastructure building, more quickly the divergence between countries narrow down*" (Kattel et al. 2009).

The third reason is the technological intensity of smart cities. To generalize, such factors as connectedness, sharing, and interdependence have given impetus to the rise of the platform economy (Evans and Gawer 2016), and analogously there is a gradual transition towards platform cities (Anttiroiko 2016), which facilitate interaction, exchange, and transactions through physical and virtual platforms or real-virtual hybrids. Emerging interconnectedness and multilayeredness have a connection to both the increased dynamism of economic and social processes as well as increased flexibility in territorial governance (Somerville 2011). Such developments also have a potential to increase local choices, ad hoc social formations,

virtual nomadism, and individualism, as platforms can reduce gatekeeper functions and facilitate self-expression and interactive processes, allowing dynamic and context-sensitive aggregation of individuals' interests. This creates a natural connection with such tendencies as the democratization of innovation and the participatory turn in public governance.

The power of these technical systems requires strong political control to be both fully efficient and not becoming the level of a totalitarian system (Simondon 1958). The current debate about the suitability of a participatory and representative democracy is timely in the evolution of smart city citizenship and inevitably reflects on "*citizens' awareness of (big) data and (big) data's techno-political and psycho-political implications*" (Calzada 2018, p. 47). These implications include transparency as "*no longer just a desirable virtue in politics but an imperative tactic if the aim is to stay clear of disrepute*" (Castells 2018, p. 101). The city of Barcelona can be seen as a good illustration and laboratory for the implementation of a transformative, democratic innovation project, starting from real citizens' needs, and leveraging digital technology to devolve more power to citizens and residents (Bria 2019; Morozov and Bria 2018). Critiquing the "*solutionist, technocratic smart city agenda previously promoted*," which was "*top-down and technology first*," Francesca Bria, the Chief Technology and Innovation Officer of the Barcelona City Council, advocates for a political and pragmatic approach (Bria 2019, p. 86). The key questions that must be posed, she adds, are "*why technology is actually needed, what kind of urban problems we should solve, who manages them, who owns what, and, most importantly, how we govern technology to implement policies.*" The key issue, she says, is that "*in order to change the existing smart city model, technology must be aligned with the city's politics, and not the other way around*" (Bria 2019, p. 86).

Indeed, the ethos behind putting the citizen at the center is the ethos of the Information Age as described by Himanen (2001), which reflects the distributed way that collective production has been working since the digital revolution (Raymond 1999). This new ethos is what leads the transformation of social production (Benkler 2006), in the political arena, with more horizontal and democratic approach to decision-making, or, digitally speaking, to a "*wiki mode of government*" (Noveck 2009).

Rethinking the Smart City Concept from the Perspective of Citizens' Bottom-Up Involvement: The Cases of Barcelona (Spain) and Medellin (Colombia)

In response to the techno-centric smart city, the citizen-centric, or experimental, city is emerging through several experiments that demonstrate nuanced democratic and co-operative service provision models for cities (Anastasiu 2019; Goldsmith and Keliman 2017; Gupta 2014). We provide here two exemplars of community and citizen-driven approach to smart city in two different geographies associated to very different local contexts: Barcelona and Medellin. Those two cases have been

thoroughly documented as being a success along a significant period of time, both for Barcelona (e.g., Calzada 2018; Peña-López 2019) and Medellin (e.g., Corburn et al. 2019; Dávila 2013).

The Case of Barcelona: Decidim.Barcelona

Barcelona is currently undergoing a citizens' democratic revolution from below, promoting networks of rebel cities which innovate public policy and challenge the status quo (Morozov and Bria 2018). The Barcelona strategy consists of engaging the city's ecosystem through a series of co-creation workshops where they can provide solid inputs to the City's strategy, evolving from a top-down to a bottom-up process, promoting the collective intelligence of citizens, and involving all players (p. 28).

In February 2016, Barcelona began initiated a participatory democracy project, decidim.barcelona ("*Barcelona, we decide,*" in Catalan), to enable participatory strategic planning for the municipality from the ground up (Bria 2019), which was clearly a "reversal of city management habits (making), the transition from top down technological priorities to citizen defined priorities" (Francesca Bria in UNESCO and Netexplo 2019, p. 209).

Decidim.barcelona has been used as a supporting tool to draft the strategic plan of the city for 2016–2019, with the ambition that the platform becomes the axis of all decision making of the city, where the citizen will have a personal profile through which they can propose, engage with, and monitor all the activities, topics, etc., that they might be interested in Peña-López (2019).

Barcelona Smart City Approach: A Citizens' Democratic Revolution from Below
Decidim.barcelona has 27,000 registered users presenting over 11,700 proposals, with 11 participatory processes running in parallel. One of the best use cases regarding participation in Barcelona has been the participatory urban planning process. Here, the city involves neighborhood groups and citizens in the planning process through offline citizens' assemblies and the online platform decidim. Together with its citizens, the city drafted an ambitious mobility plan to curb excessive air pollution, lower noise levels, and reduce traffic by 21%. The plan is based around the idea of superilles (superblocks) – mini-neighborhoods around which traffic will flow, and in which spaces will be repurposed into green space for citizens, freeing up 60% of streets currently used by cars (Morozov and Bria 2018, p. 51).

The abundance of open documentation (Ajuntament de Barcelona 2015, 2016) available demonstrates that decidim.barcelona has increased the amount of information in the hands of citizens, created momentum around key issues, and has led to an increase in citizen participation.

This improved participatory culture has had a positive impact on democratic processes, especially in creating legitimacy around decision making, which can be summarized in four key points (Peña-López 2019):

- Deliberation becomes the new democracy standard.
- Openness as the prerequisite for deliberation.
- Accountability and legislative footprint as an important by-product to achieve legitimacy.
- Participation leads to more pluralism and stronger social capital, which fosters deliberation, thus closing the (virtuous) circle of deliberative democracy (Dryzek 2010; Elstub 2018).

What we are witnessing with Barcelona is the ongoing transition between (techno-centric) smart cities and (citizen-centric) experimental cities (Calzada 2018). Not only the participatory process of early 2016 has been widely put into practice, but it's been technically designed and integrated into the core of policy making in sustainable and replicable ways, with a widespread adoption of the model across other Spanish cities and also by supra-municipal entities (Peña-López 2019).

The Case of Medellín: "City for Life"

Much has been said and written about the transformation of Medellín, Colombia, over the past 20 or more years (e.g., Fukuyama and Colby 2011; Kimmelman 2012; Vulliamy 2013; Brodzinsky 2014; Martin 2014). Once the most violent city in the world, famous for its drug lord Pablo Escobar (Warnock-Smith 2016), Medellín was recognized in 2013 as the most innovative city in the world by the Wall Street Journal and the Urban Land Institute and received the Lee Kuan Yew World City Prize in 2016. In the 2000s, when many Latin American cities were struggling with growing levels of urban violence and inequality, Medellín was celebrated as an impressive case of urban transformation and a model of successful public initiatives that reduced not only gun violence but also poverty, segregation, and inequality (The Economist 2014). "*City for Life*" was the slogan of the Medellín municipal government from 2011 to 2015 and the title used for the City when it hosted the 2014 World Urban Forum (UN Habitat 2014).

In a direct continuation with the abovementioned "*socially smart*" city (e.g., Durose et al. 2019), Medellín's strategy of progress in its "*smart-community-city*" transformation roadmap was clearly citizen-centric actions, targeting the human community of residents, to improve both their material conditions of life and also the mixing of populations, to improve their self-image and that of the city, and further an incentive to collaborative participation (UNESCO and Netexplo 2019). In Medellín, the focus is on "*citizen-centric . . . and collective psychology, overcoming the feeling of exclusion, rebuilding solidarity among the population in 'a city that belongs to us all, for us all' . . . This is how Medellin defined work for recovery of the sick ecosystem of a 'Community City'*" (p. 150).

In the wake of social urbanism (Dávila 2013) and the PUI projects (Integrated Urban projects), the Medellín government began actively engaging residents through "*imagination workshops,*" co-facilitated by the Urban Development Agency (or EDU), which is a municipal agency that helps design, manage, and implement strategic neighborhood upgrading projects (Corburn et al. 2019). EDU planners focused on developing strong community-based relationships by dedicating hundreds of hours to participatory planning activities and negotiating small truces between the municipality, local leaders, and youth gangs (Sotomayor and Daniere 2017).

Medellín is also one of the largest cities in the world engaged in participatory budgeting (Uran 2009). With paramilitary groups controlling most local institutions and a state with limited credibility, participatory budgeting became one way to re-engage citizens and build trust by allowing communities to discuss their priorities and vote on how municipal resources ought to be allocated in their neighborhood (Hajdarowicz 2018). Participatory budgeting can also be a way for citizens to understand how government can work for, not against, their interests: the allocation of the participatory funds for community driven projects is managed by a group of popularly elected neighborhood planning representatives called Juntas Administradoras Locales (JALs) (Guerrero 2011).

In the research conducted by Jason Corburn and colleagues (2019), it's been highlighted that Medellín's transformation has focused on both processes (i.e., who is included and how are decisions made) as well as products (i.e., the plan, programs and built form) of healthy city planning and development. The authors found seven interrelated factors that together have contributed to the successful transformation of this city from a place characterized as greatly unequal and violent, to one of increasing prosperity for all and a City for Life, including: (i) Governance continuity and transparency – successive leaders implementing long-range plans and strategies; (ii) Planning a "city for life" – centering the social determinants of health in redevelopment; (iii) Adaptation and innovation – adjusting programs as you learn what is and is not effective; (iv) Sustained civic engagement – committing to on-going civil society involvement in generating and implementing solutions; (v) Integrated projects that include public-private partnerships – working across sectors and spatially integrating services that promote wellbeing (Corburn et al. 2019, p. 1).

Metrocables, a "Jewel in Medellín's Social Urbanism Crown"

Like all "social urbanism" projects, the Metrocables (aerial cable-cars) were implemented with close involvement and participation of local communities. The Metrocables improved access to what were previously considered dangerous areas and opened them up to local, national, and international tourism, a significant means to "make poor neighborhoods visible" to the rest of the city.

(continued)

This type of understanding developed by the city's inhabitants, those that live in the communes and those using the Metrocables, contributes to major processes of community organization, participation, and local management.

This project and others related to the "City for life" transformation have been aided by the practice of participatory budgeting and is articulated to wider consultations leading to the joint formulation and implementation of local development plans by residents and local authorities (Dávila 2013; Dávila and Brand 2013).

The bottom line in these two exemplars of citizen-centric, bottom-up, and socially focused vision of smart cities is that such cities are "*always in the making, on the move and fluid*" (Guy 2009), championing process over product (Karvonen and van Heur 2014), with a large variety of direct and/or collaborative democracy practices often hybrid, combining online and offline interaction, with the emergence of new organizational models involving citizens and collective intelligence in the policy-making process (Morozov and Bria 2018; Satyam and Calzada 2017; Saunders and Mulgan 2017).

Such dynamics cannot be steered and controlled through data levers or top-down policies, and they constitute social emergences, involving complex, interdependent systems that influence each other in often unpredictable ways (Innes and Booher 2000).

This complexity, and the fact that there are still few cities or territories that call on citizens to design collective solutions to their most pressing problems (Unesco and Netexplo 2019), leads some authors to the following question: "*Is the bottom-up innovation perspective simply wishful thinking?*" (Satyam and Calzada 2017).

Social Emergence as a Proposed Lens for a Finer Grained Understanding of How Bottom-Up Dynamics Within Smart Cities Initiate and Bring New "Social Orders"

As we have seen previously, existing experimentations of smart human cities as an alternative paradigm to the dominant technocentric conception of smart cities are the result of complex human interactions, often leading to unexpected and emergent social phenomena. In what follows, we propose to further analyze what actually initiates the emergence of new order creation within social communities.

Complexity sciences provide a structure for gaining insight into the phenomenon of emergence, a means for exploring what emergence is and how it occurs. As defined by Lichtenstein (2014), who has conducted a very comprehensive review of the notion of emergence in social complexity sciences, "*emergence is the creation of order, the formation of new properties and structures in complex systems... when emergence happens, something new and unexpected arises, with outcomes that*

cannot be predicted even from knowing everything about the parts of the system . . .emergence is present at every level of reality" (Lichtenstein 2014, pp. 1–2).

Emergence is at the heart of complexity science with more and more scholars seeking to understand patterns of collective social behavior (e.g., Chiles et al. 2004; Epstein and Axtell 1996; Goldstein et al. 2010; Lichtenstein 2009, 2014; Macy 1991; Schelling 1978; Sawyer 2005). Most studies of complexity examine the "bottom-up" emergence of agents into higher order entities that is the creation of order solely through local interactions with no external influence or top-down control. (e.g., Lichtenstein 2014 in his broad literature review).

One might ask the following question: "*do emergent (social) systems always act 'of their own accord,' spontaneously?*" (Lichtenstein 2014, p. 12). This question is at the core of the very notion of smart city governance when considering the place of citizens in the very conception and functioning of their city (Unesco and Netexplo 2019). The Netexplo Observatory has spotted a "*trend toward rebalancing the urban progress approach between top-down dirigisme and bottom-up openness. . . based on mobilization of citizen-actors?*" (Unesco and Netexplo 2019, p. 216), recognizing that there is still a great deal to be done in our understanding of such emerging processes.

Recent studies on emergence in complexity science have been exploring this issue of spontaneity by investigating how agency can catalyze social innovations and emergents in ways that are both spontaneous and planned, emergent, and constructive (Goldstein et al. 2010; Lichtenstein 2009, 2014).

The Case of Branson

One of the best studies on the emergence of real social urban systems is the dissertation research of Todd Chiles (Chiles et al. 2004), who pursued a 100-year study of emergence in Branson (Missouri), now one of the most visited tourist areas in the United States. Using dissipative structures theory as a framework, their analysis explored the dynamics underlying the "punctuated emergences" that transformed the region from a small town to a thriving organizational collective. In the context of social emergence, their study showed how emergences in the region generated more capacity for growth, leading to further emergences over time in a long series of positive feedback processes. The findings reflect organizing and emergence at multiple levels, including individual entrepreneurs, key families, organizations and businesses, community-wide associations, and regional and national effects, showing how emergence was generative at each level, leading to greater capacity in future eras.

Chiles and colleagues (2004), for instance, described how the emergence of the Branson Mall was usefully kept in check by a strong set of common cultural values, long-standing pro-business policies, and a coordination of marketing efforts, through the actions of collective organizations in the area.

(continued)

Collective action played a significant role in the emergences at Branson, primarily through a number of influential organizational collectives around the region. By the 1920s, two such collectives were already helping draw tourists to the Ozarks by promoting the "Land of A Million Smiles." Increasing tourism was one of the critical resources that fueled Branson's astounding growth. Moreover, Branson's first theater started as a collective organization, back in 1955. In more recent years, the Ozark Marketing Council has attracted increasing waves of tourists to the area, "channeling and accelerating" the resources necessary for emergence. Even more broadly, the collective organizing of entrepreneurs, financers, and community leaders created a context for the ongoing transformations of the region (Chiles et al. 2004).

These findings, combined with those demonstrating the importance of individual agency, the pivotal role of specific organizations, and the interplay of the broader social system, suggest that a rich theory of organizational evolution must adopt a multilevel approach: focusing from the individual and organization, through the organizational form and population, to the organizational community and social system (Chiles et al. 2004, p. 515). By explaining how microprocesses generate macro-order, complexity theory is therefore ideally suited to such a multilevel approach, providing scholars with a fuller understanding of the dynamics of change that allows for emergence and surprise (Tsoukas and Chia 2002, p. 568).

The Generative Emergence Model, as a Promising Way to Study Processes of Emergence in Socially Smart Communities

Complexity and emergence scholars have identified three catalysts of emergent order: far-from-equilibrium dynamics (e.g., Meyer et al. 2005), adaptive tension (e.g., McKelvey 2004) and opportunity tension (e.g., Lichtenstein 2009) that overall converge and complement each other (Lichtenstein and Plowman 2009).

When grounded in social and environmental sustainability, a dynamic creation approach, driven by cycles of opportunity tension (Lichtenstein 2009), can explain the process of emergence and development of human societies (Carniero 1970, 1987), of cities (Dyke 1988), and of expanding order in society (Adams 1988; Coren 1998).

Lichtenstein and colleagues' work on generative emergence (Lichtenstein 2009, 2014; Lichtenstein and Plowman 2009) led to the identification of five key processes that lead to emergence and two outcomes of the process (emergence or dissolution). This has led to the conceptualization of an emergence cycle around five key processes or phases, as shown in the following idealized diagram of one cycle of emergence, that are a direct analogy to the microprocesses of order creation in dissipative structures (Fig. 1).

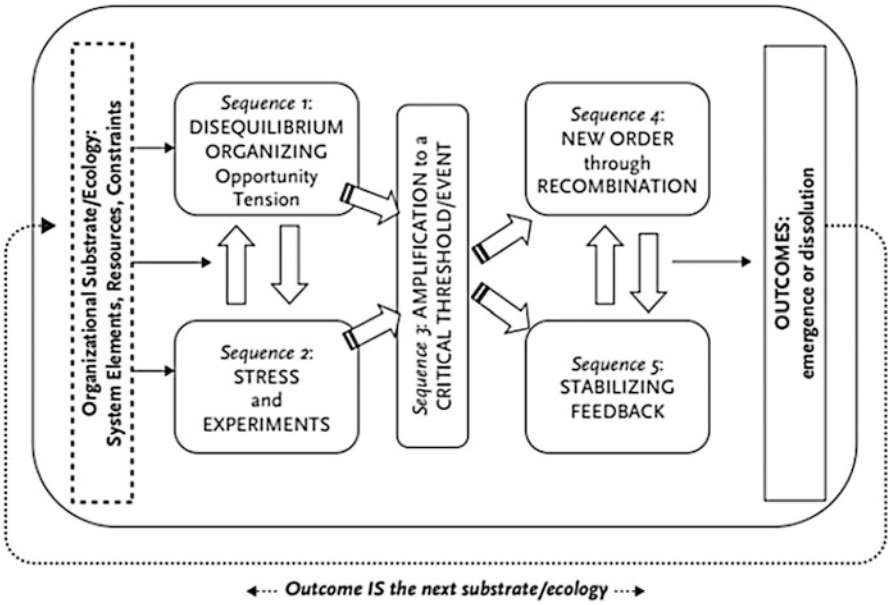

Fig. 1 One cycle of emergence – idealized diagram of five-phase emergence sequence (Lichtenstein 2014, p. 326)

These phases have long been identified by management scholars studying organizational emergence and transformation (Lichtenstein 2014): four- or five-phase models are found in Smith (1986), Smith and Gemmill (1991), Browning et al. (1995), Chiles et al. (2004), and Plowman et al. (2007). What the studies conducted by Lichtenstein and colleagues show is that these five phases operate sequentially, as a cycle of emergence (Lichtenstein 2009, 2014; Lichtenstein and Plowman 2009). The entire process within a cycle can be summarized as follows (Lichtenstein 2014, p. 325): (i) A cycle of generative emergence is initiated by an opportunity tension that generates disequilibrium organizing, which gives rise to stress and experiments; (ii) if these qualities continue to increase, the system will reinforce and amplify experiments and other energy, toward a critical event – the system reaches a tipping point; (iii) on the other side of this threshold, new order will emerge, through a recombination of components. In virtually every successful case, this emergent order results in a more adaptive system; (iv) if the emergence is successful, the system will produce stabilizing feedbacks that institutionalize the changes into a sustainable dynamic state; (v) this whole process eventually leads to dissolution or stabilization of a new (emergent) order.

To illustrate this processual view of social emergence, we provide an example of bottom-up emerging development of a rural village in Morocco, Tizi N'Oucheg ("Tizi") in which one of the authors has been associated as a researcher (Amine Belemlih). Although it may seem far from the classical exemplars of smart cities development, this case is very enlightening for the availability of its longitudinal

data over a period of 10 years, which made possible the documentation of its process of social emergence "along the way." (The research has been conducted with the collaboration with the chairman and founder of the "Open village" association that has played the role of facilitator and catalyst over a 10-year period, see www.open-village.org) The "Tizi" case is at the counterpoint to the dominant smart cities approach and discourse, focusing almost exclusively on urban and techno-centered initiatives, as seen previously. But it is in line with recent and growing number of studies on smart-city-regions perspectives (e.g., Calzada 2017), smart rurality, and lagging regions (e.g., Oliva 2019). What is mostly considered here, that has been the foci of many cited studies, is the human-citizen-centered and bottom-up dynamics of collective initiatives (e.g., Calzada and Cowie 2017; Corburn et al. 2019; Durose et al. 2019; Karvonen and van Heur 2014; Peña-López 2019).

The Tizi village has been through an impressive transformation "from the ground up," starting 10 years ago as one of many examples of socially depriving community, suffering an accumulation of socio-economic handicaps (severe poverty, rural exodus to name a few).

The first phase of "*Disequilibrium organizing*" has started with the creation of a "*Jam'ia*" (local association) of young and proactive villagers, seeking to "do something about the poverty and education flaws," alongside the traditional popular assembly that we find in most Berber villages, the "*Jama'a*" (the "assembly," in Arabic). While they started a visioning process, with the diagnostic of "all that the village needs to succeed in the next 10 years," and a first purpose to "*make do with what we have,*" which eventually led to an objective of economic empowerment. This initiative has brought a lot of resistance within the *Jama'a*: while the elders continued to tell the association – *Jam'ia* – members "*you'll never succeeded*" both circles agreed on one wicked issue: 100% of the pupils in primary school failing to move up to high school. One important fact to mention here is the previous negative experience with a Luxembourgian association that tried to impulse the culture of quinoa "*in a top down manner without involving the villagers,*" only dealing with local authorities (which led to a strong push back from the villagers, left aside the process).

In sequence 2 ("*Stress and experiments*"), several experimental initiatives have gradually led to a significant increase of the "entrepreneurial and action-oriented energy" of an increasing number of villagers, eventually building trust which further enhanced collective action in a recursive way. For instance, a dialog between one of the village sympathizers, KB (KB is one of the co-founders of the Open Village association, that has been created to document and spread the self-organized approach to development adopted by the Tizi village), has led to the set-up of a local production of blackberry jam, which managed to value the presence in large quantities of blackberry that is endemic to the Tizi territory (surrounded by the Atlas mountains, close to Marrakech). In parallel, a working group performed a diagnostic of the educational situation, in conjunction education experts and led to a series of small steps, like building a small house for the local teacher, designing a preschool education program to teach Arabic to the pupils as a communication language (the whole village is primarily Amazigh-Berber speaking) which has managed to address

the primary cause of failure in primary school (the official program is designed only for Arabic speakers as a mother tongue). These experiments, among others, have yielded over time encouraging results, which led to further reinforce the "opportunity tension" related to emerging opportunities perceived, leading to new initiatives, etc.

In sequence 3 ("*Amplification to a critical threshold/event*"), the virtuous cycle of actions/positive results/new actions or extension of actions led to some initiatives that had a profound impact on the village's self-perception and level of confidence, all of which went on reinforcing each other further on. One first threshold has been reached when 100% of the primary pupils succeeded making the transition to secondary school, with the best grades in the region. Another threshold has been crossed when the villagers succeeded in designing and building by themselves their own water system, including water storage, purification, and supply systems providing drinking water to each house.

In sequence 4 ("*New order through recombination*"), the Tizi village managed to disseminate their approach to extended circles villages within their surrounding territories, first by building a road proving access to the national road, with the support of four neighbor villages. The encouraging and rather unprecedented actions performed by themselves led more and more funders and experts to proactively propose their support to the village, leading to a redefined set of resources available, not exclusively limited to the local resources at hand. In the same line, a 100 villages that heard of the Tizi experience formed a federation of villages and started studying with the help of Tizi ways to roll out adapted version of the self-organized development process, joined by several public and research institutions seeking to understand "*how Tizi made it.*"

In sequence 5 ("*Stabilizing feedback*"), the new governance and collective action scheme reached a plateau, with all of the key development objectives drafted in the "vision statement" largely over-achieved before their due dates. Furthermore, the jama'a and the jam'ia reached a firm foundation of trust which contributes to amplify and accelerate collective action and amplify the momentum.

We must draw the attention on the many limits of this case study given its nonstandard features (focusing on a rural community) when compared to the smart city perspective, although our intention here was to illustrate how community bottom-up dynamics unfold over time as it is the case in socially smart cities. One caveat is related to the need to better understand the nature and behaviors of the exogenous factors that helped "*catalyze collective action*" (Lichtenstein 2014, p. 399), apart from top down supervision that was not at play in this case. Another caveat is related to the fact that it is still to be proven that the generative emergence model is applicable to large social change, beyond the scale of organizations or small collectives, or in the case of "*macro-emergence*" (Lichtenstein 2014). Although previous empirical research studies in the case of cities and large communities (e.g., Chiles et al. 2004) are suggestive that the five-phase model may be applicable at larger scales (Lichtenstein 2014), we believe there is an opportunity to further conduct processual and empirical based studies on the emergence bottom-up dynamics of socially smart cities in the future.

Conclusion

In this chapter, we have analyzed the smart cities dynamics through the lens of complex systems architecture, stating that the smartness of a city consists of this continuous learning process that relies on interactions between basic cells and actors of the city.

In this new view of the city as the result of emergent patterns, we have focused on the role of citizens, proposing an original perspective of the dynamics underpinning bottom-up initiatives.

To further explore this perspective, we have proposed to use the generative emergence model as a lens to get to finer grained understanding of the citizen-centered and self-organized dynamics, at play in smart cities, regions, and rurality, which remain scarce and unusual situations that are expected to expand in the future.

References

Adams, R. N. (1988). *The eighth day: Social evolution as the self-organization of energy.* Austin: University of Texas.

Ajuntament de Barcelona. (2015). *Mesura de govern. Procés participatiu per a l'elaboració del Programa d'Actuació Municipal (PAM) i dels Programes d'Actuació dels Districtes (PAD) 2016–2019*. Barcelona: Ajuntament de Barcelona.

Ajuntament de Barcelona. (2016). *73 Barris, una Barcelona. Cap a la ciutat dels drets i les oportunitats. Programa d'Actuació Municipal 2016–2019*. Barcelona: Ajuntament de Barcelona.

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology, 22*(1), 3–21.

Alexander, C. (1979). *A pattern language, town, buildings, constructions, with Sarah Ishikawa et Murray Silverstein*. New York: Oxford University Press.

Alexander, C. (1980). *The timeless way of building* (Center for Environmental Structure series). New York: Oxford University Press.

Anastasiu, I. 2019. Unpacking the smart city through the lens of the right to the city: A taxonomy as a way forward in participatory city-making, in De Lange M. & Wall M. (Eds) The hackable city: Digital media and collaborative city-making in the network society. Singapore: Springer.

Antikainen, M., Mäkipää, M., & Ahonen, M. (2010). Motivating and supporting collaboration in open innovation. *European Journal of Innovation Management, 13*, 100–119.

Anttiroiko, A.-V. (2015). Smart planning: The potential of web 2.0 for enhancing collective intelligence in urban planning. In C. N. Silva (Ed.), *Emerging issues, challenges, and opportunities in urban e-planning* (pp. 1–32). Hershey: IGI Global.

Anttiroiko, A. V. (2016). City-as-a-platform: Towards citizen-centre platform governance. In *RSA winter conference 2016 on new pressures on cities and regions*, London, pp. 1–27.

Arthur, B. (1997). In S. Durlauf & D. Lane (Eds.), *The economy as an evolving complex system II*. Reading: Addison-Wesley.

Bak, P. (1996). *How nature works: The science of self-organized criticality.* New York: Springer-Verlag.

Batty, M. (2012). Cities as complex systems: Scaling, interaction, networks, dynamics, and urban morphologies. Centre for Advanced Spatial Analysis, University College London working papers, pp. 1–62.

Batty, M. (2013). *The new science of cities*. Cambridge, MA: The MIT Press.

Batty, M. (2015). Does big data lead to smarter cities? Problems, pitfalls, and opportunities. *I/S: A Journal of Law and Policy for the Information Society, 11*(1), 127–151.
Beevers, S. D., & Carslaw, D. C. (2005). The impact of congestion charging on vehicle emissions in London. *Atmospheric Environment, 39*(1), 1–5.
Benkler, Y. (2006). *The wealth of networks: How social production transforms markets and freedom*. New Haven: Yale University Press.
Bria, F. (2019). Building digital cities from the ground up based around data sovereignty and participatory democracy: The case of Barcelona. *Monografias, 73*, 83–91.
Brodzinsky, S. (2014). From murder capital to model city: Is Medellín's miracle show or substance? *Guardian*. Available from: http://www.theguardian.com/cities/2014/apr/17/medellin-murder-capital-tomodel-city-miracle-un-worldurban-forum
Browning, L., Beyer, J., & Shetler, J. (1995). Building cooperation in a competitive industry: SEMATECH and the semiconductor industry. *Academy of Management Journal, 38*, 113–151.
Burke, M. (1998). Cyborg city. Film notes listed at www.yle.fi/d-projekti/arkisto/saa/99kyber.html
Calzada, I. (2017). The techno-politics of data and smart devolution in city-regions: Comparing Glasgow, Bristol, Barcelona, and Bilbao. *Systems, 5*(1), 18.
Calzada, I. (2018). (Smart) citizens from data providers to decision-makers? The case study of Barcelona. *Sustainability, 10*(9), 32–52.
Calzada, I., & Cobo, C. (2015). Unplugging: Deconstructing the Smart City. *Journal of Urban Technology, 22*(1), 23–43.
Calzada, I., & Cowie, P. (2017). Beyond smart and data-driven city-regions? Rethinking stakeholder-helixes strategies. *Regions, 308*, 25–29.
Carniero, R. (1970). A theory of the origin of the state. *Science, 169*, 733–738.
Carniero, R. (1987). The evolution of complexity in human societies and its mathematical expression. *International Journal of Comparative Sociology, 28*, 111–128.
Castells, M. (2018). Democracy in the age of the internet. Retrieved from https://llull.cat/IMAGES_175/transfer06-not01.pdf
Chiles, T. H., Meyer, A. D., & Hench, T. J. (2004). Organizational emergence: The origin and transformation of Branson, Missouri's musical theaters. *Organization Science, 15*(5), 499–519.
Corburn, J., Asari, M. R., Jamarillo, J. P., & Gaviria, A. (2019). The transformation of Medellin into a "City for Life": Insights for healthy cities. *Cities & Health, 8*, 1–12.
Coren, R. (1998). *The evolutionary trajectory: The growth of information in the history and future of the Earth*. Amsterdam: Gordon and Breach Publishers.
Dainow, B. (2017). Smart City transcendent – Understanding the smart city by transcending ontology. *Orbit*. https://www.orbit-rri.org
Dávila, J. D. (2013). Urban mobility and poverty: Lessons from Medellin and Soacha, Colombia. Published by Development Planning Unit, UCL & Faculty of Architecture, Universidad Nacional de Colombia (Medellín campus).
Dávila, J. D., & Brand, P. (2013). La gobernanza del transporte público urbano: Indagaciones alrededor de los Metrocables de Medellín. *Revista Bitácora, 21*(2), 85–96.
Deakin, M. (2014). Smart cities: The state-of the-art and governance challenge. *Triple Helix, 1*(1), 1–16.
Dryzek, J. S. (2010). *Foundations and frontiers of deliberative governance*. Oxford: Oxford University Press.
Durose, C., Escobar, O., Gilchrist, A., Agger, A., Henderson, J., van Hulst, M., & van Ostaijen, M. (2019). *Socially smart cities: Making a difference in urban neighbourhoods* (pp. 1–47). Edinburgh: University of Edinburgh.
Dyke, C. (1988). Cities as dissipative structures. In B. Weber, D. Depew, & J. Smith (Eds.), *Entropy, information and evolution: New perspectives on physical and biological evolution* (pp. 355–368). Cambridge, MA: MIT Press.
Elstub, S. (2018). Deliberation and participatory democracy. In A. Bächtiger, J. S. Dryzek, J. Mansbridge, & M. Warren (Eds.), *The Oxford handbook of deliberative democracy*. Oxford: Oxford University Press.

Epstein, J. M., & Axtell, R. (1996). *Growing artificial societies: Social science from the bottom up*. Cambridge, MA: MIT Press.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy, 29*, 109–123.

Evans, P. C., & Gawer, A. (2016). *The rise of the platform enterprise: A global survey*. New York: The Center for Global Enterprise. Available online: http://thecge.net/wpcontent/uploads/2016/01/PDF-WEB-Platform-Survey_01_12.pdf

Foth, M., Choi, J. H.-J., & Satchell, C. (2011). Urban informatics. In *ACM conference on Computer Supported Cooperative Work (CSCW), Hangzhou, China, 19–23 Mar 2011* (pp. 1–8). New York: ACM. Available online: http://eprints.qut.edu.au/39159/1/39159.pdf

Fukuyama, F., & Colby, S. (2011). Half a miracle. Foreign policy, April 25, 2011, p. 1–5. Available at: https://foreignpolicy.com/2011/04/25/half-a-miracle/

Gandy, M. (2005). Cyborg urbanization: Complexity and monstrosity in the contemporary city. *International Journal of Urban and Regional Research, 29*(1), 26–49.

Gershenson, C. (2015). Requisite variety, autopoiesis, and self-organization. *Kybernetes*, *44*(6/7), 866–873. Available at http://cepa.info/2627

Giffinger R. & Haindl G. (2010). Smart cities ranking: An effective instrument for the positioning of the cities. Journal of the Centre of Land Policy and Valuations. University of Catalonia. Thematic network "Architecture, City and Environment". Available at: https://core.ac.uk/download/pdf/41793309.pdf

Goldsmith, S., & Keliman, N. (2017). *A new city O/S: The power of open, collaborative, and distributed governance*. Washington, DC: Brookings.

Goldstein, J., Hazy, J., & Lichtenstein, B. (2010). *Complexity and the nexus of leadership: Leveraging nonlinear science to create ecologies of innovation*. New York: Palgrave Macmillan.

Granier, B., & Hiroko, K. (2016). How are citizens involved in smart cities? Analysing citizen participation in Japanese "smart communities". *Information Polity, 21*(1), 61–76.

Greenfield, A. & Nurri, K. (2013). Against the Smart City. Ed. Do Projects. 147 p.

Guerrero, A. (2011). *Rebuilding trust in government via service delivery: The case of Medellín, Colombia* (pp. 1–28). Washington, DC: World Bank.

Gupta, C. (2014). The co-operative model as a "living experiment in democracy". *Journal of Co-operative Organization and Management, 2*(2), 98–107.

Gurstein, M. (2014). Smart cities vs. smart communities: Empowering citizens not market economics. *The Journal of Community Informatics*, *10*(3). Retrieved at: http://ci-journal.net/index.php/ciej/article/view/1172/1117

Guy, S. (2009). Fluid architectures. In D. White & C. Wilbert (Eds.), *Technonatures*. Waterloo: Wilfred Laurier University Press.

Hajdarowicz, I. (2018). Does participation empower? The example of women involved in participatory budgeting in Medellin. *Journal of Urban Affairs*, 1–16.

Hardy, D. (1991). *From garden cities to new towns: Campaigning for town and country planning, 1899–1946* (Studies in history, planning and the environment) (p. xii, 340). New York: Routledge/Chapman & Hall.

Herrschel, T. (2013). Competitiveness and sustainability: Can "smart city regionalism" square the circle? *Urban Studies, 50*, 2332–2348.

Heylighen, F. (1992). Distinction dynamics: From mechanical to self-organizing evolution. In E. Gindev (Ed.), *Proceedings of the international workshop "analysis and control of dynamical systems"*. Sofia: CLCS, Bulgarian Academy of Sciences.

Heylighen, F., Joslyn, C., & Turchin, V. (1991). A short introduction to the Principia Cybernetica project. *Journal of Ideas, 2*(1), 26–29.

Himanen, P. (2001). *The hacker ethic and the spirit of the information age*. New York: Random House Trade Publishers.

Holland, J. (1995). *Hidden order*. Redwood City: Addison-Wesley.

Holland, J. H. (1998). Emergence: From Chaos to Order. Redwood City, California: Addison-Wesley. 272 p.

Howard, E. (1985). Garden cities of tomorrow. Attic books, 1985. First published in 1898 under the title "*Tomorrow. A peaceful path to real reform.*"

Howe, J. (2009). *Crowdsourcing: Why the power of the crowd is driving the future of business*. New York: Three Rivers Press.

IBM takes smart cities concept to Rio de Janeiro. *New York Times*, Mar 2012, link retrieved from: https://www.nytimes.com/2012/03/04/business/ibm-takes-smarter-cities-concept-to-rio-de-janeiro.html

Innes, J. E., & Booher, D. E. (1999). Metropolitan development as a complex system: A new approach to sustainability. *Economic Development Quarterly, 13*(2), 141–156.

Innes, J. E., & Booher, D. E. (2000). Indicators for sustainable communities: A strategy building on complexity theory and distributed intelligence. *Planning Theory and Practice, 1*, 173–186.

Innes, J. E., & Booher, D. E. (2002). Metropolitan development as a complex system: A new approach to sustainability. In A. Madanipour, A. Hull, & P. Healey (Eds.), *The governance of place: Space and planning processes* (pp. 239–264). Aldershot: Ashgate.

Jacobs, J. (1985). *Cities and the wealth of nations*. New York: Random House.

Jacobs, J. (1992). The Death and Life of Great American Cities. Vintage; Reissue edition (first edition, 1961). 458 p.

Jevons, W. S. (1970). In R. D. C. Black (Ed.), *The theory of political economy*. London: Penguin. (Originally published 1871).

Karvonen, A., & van Heur, B. (2014). Urban laboratories: Experiments in reworking cities. *International Journal of Urban and Regional Research, 38*, 379–392.

Kattel, R., Kregel, J. A., & Reinert, E. S. (2009). In R. Kattel, J. A. Kregel, & E. S. Reinert (Eds.), *Ragnar Nurkse (1907–2007). Classical development economics and its relevance for today* (The Anthem other canon series). London: Anthem Press.

Keeton, R. (2015). When smart cities are stupid. International New Town Institute, link retrieved from http://www.newtowninstitute.org/spip.php?article1078

Khatoun, R., & Zeadally, S. (2016). Smart cities: Concepts, architectures, research opportunities. *Communications of the ACM, 59*(8), 46–57.

Kimmelman, M. (2012). A city rises, along with its hopes. *New York Times*. Available from: http://www.nytimes.com/2012/05/20/arts/design/fighting-crime-witharchitecture-in-medellin-colombia.html

Lichtenstein, B. B. (2009). Moving far from-far-from-equilibrium: Opportunity tension as the catalyst of emergence. *Emergence: Complexity and Organization, 11*(4), 15–25.

Lichtenstein, B. B. (2014). *Generative emergence: A new discipline of organizational, entrepreneurial, and social innovation*. Oxford: Oxford University Press.

Lichtenstein, B., & Plowman, D. A. (2009). The leadership of emergence: A complex systems leadership theory of emergence at successive organizational levels. *The Leadership Quarterly, 20*, 617–630.

Lizaroiu, G. C., & Roscia, M. (2012). Definition methodology for the smart cities model. *Energy, 47*, 326–332.

Luhmann, N. (1986). The autopoiesis of social systems. In *Sociocybernetic paradoxes* (pp. 172–192). London: Sage.

Macy, M. (1991). Chains of cooperation: Threshold effects in collective action. *American Sociological Review, 56*, 730–747.

Martin, G. (2014). *Medellín. Tragedia y Resurreccion. Mafia, Ciudad, Estado. 1975–2012*. Colombia: Promolibro.

Maturana, H. R. (1981). The organization of the living: A theory of the living organization. *Cybernetics Forum, X*(2–3), 14–23.

McKelvey, B. (2004). Toward a complexity science of entrepreneurship. *Journal of Business Venturing, 19*, 313–342.

Meijer, A. (2016). Smart city governance: A local emergent perspective. In J. A. Gil-Garcia, T. A. Pardo, & T. Nam (Eds.), *Smarter as the new urban agenda: A comprehensive view of the 21st century city*. New York: Springer.

Mellouli, S., Luna-Reyes, L. F., & Zhang, J. (2014). Smart government, citizen participation and open data. *Information Policy, 19*(1–2), 1–4.
Meyer, A., Gaba, V., & Colwell, K. (2005). Organizing far from equilibrium: Nonlinear change in organizational fields. *Organization Science, 16*, 456–473.
Miller, J. H., & Page, S. E. (2007). *Complex adaptive systems: An introduction to computational models of social life*. Princeton: Princeton University Press.
Morozov, E. (2013). *To save everything, click here: The folly of technological solutionism* (p. 432). New York: Public Affairs.
Morozov, E., & Bria, F. (2018). *Rethinking the smart city: Democratizing urban technology*. New York: Rosa Luxemburg Stiftung.
Mumford, L. (1968). *The city in history* (p. 255). New York: Harcourt, Brace & World.
Neirotti, P., De Marco, A., Corinna Cagliano, A., Mangano, G., & Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylized facts. *Cities, 38*, 25–36.
Netexplo. (2018). Smart Cities Accelerator. Netexplo Global Obersvatory. Available at https://netexplo.com/static/media/uploads/uploads/pdf/guidebook_smart_cities_trilingue_pdf_.pdf
Nicolis, G., & Prigogine, I. (1989). *Exploring complexity*. New York: W. H. Freeman.
Noveck, B. S. (2009). *Wiki government: How technology can make government better, democracy stronger, and citizens more powerful*. Washington, DC: Brookings Institution Press.
Oliva, J. (2019). *Lagging regions, smart ruralities and empty peripheries: A discussion on the post-crisis futures of Spanish countryside*. Navarre: Public University of Navarre.
Oström, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *Transnational Corporations Review, 2*(2), 1–12.
Peña-López, I. (2019). *Shifting participation into sovereignty: The case of decidim.barcelona*. Barcelona: Huygens Editorial.
Picon, A. (1998). *La ville territoire des cyborgs*. Paris: Les Éditions de L'Imprimeur.
Pisani, F. (2015). A Journey through Smart Cities: Between Datapolis and Participolis, ed. UNESCO/Netexplo, 2015. Available at: https://unesdoc.unesco.org/ark:/48223/pf0000234422
Plowman, D. A., Solanksy, S., Beck, T., Baker, L., Kulkarni, M., & Travis, D. (2007). The role of leadership in emergent, self-organization. *The Leadership Quarterly, 18*(4), 341–356.
Prigogine, I. (1955). *Introduction to the thermodynamics of irreversible processes*. New York: Wiley.
Raymond, E. S. (1999). *The Cathedral & the Bazaar*. Sebastopol: O'Reilly.
Reinert, E. S. (2008). *How rich countries got rich . . . and why poor countries stay poor* (p. 400). New York: Public Affairs.
Rochet, C. (2012). Le défi d'une stratégie d'influence: Bâtir un référentiel managérial public commun et un bassin élargi de compétences au sein des administrations publiques francophones. Forum mondial de la langue française, juillet 2012, Québec.
Rochet, C. (2018). *Smart cities: Reality or fiction*. New York: Wiley.
Rosenberg, M. (2020). Learn about the Von Thunen model. Retrieved from: https://www.thoughtco.com/von-thunen-model-1435806
Satyam, A., & Calzada, I. (2017). *The Smart City transformations: The revolutions of the 21st century*. Bloomsbury, London.
Saunders, T., & Mulgan, G. (2017). *Governing with collective intelligence* (pp. 1–29). London: Nesta.
Sawyer, K. (2005). *Social emergence: Societies as complex systems*. New York: Cambridge University Press.
Schelling, T. (1978). *Micromotives and macrobehavior*. New York: W. W. Norton.
Simondon, G. (1958). *Du mode d'existence des objets techniques*. Paris: Aubier Montaigne.
Smith, C. (1986). Transformation and regeneration in social systems: A dissipative structure perspective. *Systems Research, 3*, 203–213.
Smith, C., & Gemmill, G. (1991). Self-organization in small groups: A study of group effectiveness within non-equilibrium conditions. *Human Relations, 44*, 697–716.
Somerville, P. (2011). Multiscalarity and neighborhood governance. *Public Policy and Administration, 26*, 81–105.

Sotomayor, L., & Daniere, A. (2017). The dilemmas of equity planning in the Global South: A comparative view from Bangkok and Medellín. *Journal of Planning Education and Research, 38*(2), 273–288.

Surowiecki, J. (2005). *The wisdom of crowds*. New York: Anchor Books.

The Economist. (2014). The trouble with miracles: The transformation of Colombia's second city will be hard to copy. Available from: https://www.economist.com/the-americas/2014/06/07/the-trouble-with-miracles

The smartphone is the Swiss Army knife of gadgets. *Time*, Nov 2013, link retrieved from: https://techland.time.com/2013/11/18/the-smartphone-is-the-swiss-army-knife-of-gadgets/

Townsend, A. M. (2013). *Smart cities: Big data, civic hackers, and the quest for a New Utopia*. New York: W. W. Norton.

Tsoukas, H., & Chia, R. (2002). On organizational becoming: Rethinking organizational change. *Organization Science, 13*, 567–583.

UN Habitat. (2014). *Cities for life concept paper. World urban forum*. Nairobi: UN Habitat. Available from: https://unhabitat.org/7th-world-urban-forum-medellin-declaration/

UNESCO and Netexplo. (2019). *Smart cities: Shaping the society of 2030*. UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000367762.locale=fr

University of Catalonia. Thematic network "Architecture, City and Environment". Available at : https://core.ac.uk/download/pdf/41793309.pdf

Uran, O. A. (2009). Participacion ciudadana y tranformacion democratica del conflict urbano: notas a proposito de programa de presupuesto participativo en la ciudad deMedellin, Colombia [Citizen participation and democratic transformation of urban conflict: notes on the purpose of participatory budgeting in the city of Medellin, Colombia]. Cadernos Intituto de Pesquisa e Planejamento Urbano e Regional de Universidad Federal de Rio de Janeiro, 23, 175–200.

Varela, F. G., Maturana, H. R., & Uribe, R. (1981). Autopoiesis: The organization of living systems, its characterization, and a model. *Cybernetics Forum, X*(2–3), 7–13.

Volk, R., Stengel, J., & Schultmann, F. (2014). Building Information Models (BIM) for existing buildings – Literature review and future needs. *Automation in Construction, 38*, 109–127.

Vulliamy, E. (2013). Reinventing the world's most dangerous city. *The Observer Magazine*, 9 June.

Wagenaar, H. (2007). Governance, complexity, and democratic participation: How citizens and public officials harness the complexities of neighborhood decline. *The American Review of Public Administration, 37*, 17–50.

Warnock-Smith, A. (2016). Story of cities #42: Medellín escapes grip of drug lord to embrace radical urbanism. Available from: https://www.theguardian.com/cities/2016/may/13/story-cities-pablo-escobar-inclusiveurbanism-medellin-colombia

Weick, K. E. (1987). Organizational culture as a source of high reliability. *California Management Review, 29*, 112–127.

Weick, K. E. (1995). *Sensemaking in organizations*. Thousand Oaks: Sage.