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Smart city or smart citizens? The Barcelona case

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Abstract

Purpose – In recent years, the term “smart city” has attracted a lot of attention from policy makers, business leaders and citizenship in general. Although there is not a unique definition of what a smart city is, it is generally accepted that “smart” urban policies refer to local governments’ initiatives that use information and communication technologies in order to increase the quality of life of their inhabitants while contributing to a sustainable development. So far, “smart city” approaches have generally been related to top-down processes of technology diffusion. The purpose of this paper is to present a broader view on “smart” initiatives to analyze both top-down and bottom-up dynamics in a smart city. The authors argue that these two perspectives are complementary and its combination can reinforce the collaboration between different city stakeholders. Top-down and bottom-up initiatives are not opposed forces but, on the contrary, can have a synergistic effect on the innovation capacity of the city. Both perspectives are illustrated by providing examples of different “smart” aspects in the city of Barcelona: smart districts, open collaborative spaces, infrastructures and open data.

Design/methodology/approach – To illustrate the arguments, the authors analyze the case of the city of Barcelona providing examples of top-down and bottom-up initiatives in four different smart city aspects: smart districts, open collaborative spaces, infrastructures and open data. The research method is based on a case study (Yin, 1984). The primary data consisted on interviews to city council representatives as well as managers of local public institutions, like economic development offices, and local organizations like for instance coworking spaces. The authors interviewed also specialists on the innovation history of the city in order to validate the data. In addition, the authors used secondary data such as reports on the 22@, and documentation on the Barcelona innovation policies, as well as doing a compilation of press articles and the online content of the institutional webpages. All together, the authors have followed a data triangulation strategy to seek data validation based on the cross-verification of the analyzed data sources.

Findings – The analysis suggests that the top-down and bottom-up perspectives are complementary and their combination can reinforce the collaboration between different city stakeholders. Top-down and bottom-up initiatives are not opposed forces but, on the contrary, can have a synergistic effect on the innovation capacity of the city. Both perspectives are illustrated by providing examples of different “smart” aspects in the city of Barcelona: smart districts, open collaborative spaces, infrastructures and open data.

Research limitations/implications – Nevertheless, the analysis has its limitations. Even if the authors have emphasized the importance of the bottom-up initiatives, citizens do not have often the resources to act without governmental intervention. This is the case of services that require high-cost infrastructures or regulatory changes. Also, as it usually happens in the case of disruptive technology, it is hard for citizens to understand the possibilities of its use. In these cases, firms and institutions must play an important role in the first phases of the diffusion of innovations, by informing and incentivizing its use. It is also important to note that some of the emerging usages of technology are confronted to legal or regulatory issues. For instance, distributed and shared Wi-Fi networks might be in opposition to economic interests of internet providers, that often difficult its expansion. It is also the case of services of the sharing economy that represent a menace to established institutions (like the tensions between Uber and taxi companies, or Airbnb and hotels). In these cases, city halls like it is the case in Barcelona, tend to respond to these emergent uses of technology by regulating to ensure protection to existing corporate services.



Practical implications – In conclusion, the transformational process that leads a city to become a smart city has to take in consideration the complexity and the plurality of the urban reality. Beyond considering citizens as being users, testers or consumers of technology, local administrations that are able to identify, nourish and integrate the emerging citizens' initiatives would contribute to the reinforcement of a smart city reality.

Originality/value – The contribution of the paper is to go beyond the generalized technologic discourse around smart cities by adding the layer of the citizens' initiatives.

Keywords Top-down, Open data, Smart city, Bottom-up, Open collaborative spaces, Smart citizens, Smart districts

Paper type Research paper

Introduction

More than half of the world's population live currently in urban agglomerations. This figure is expected to grow to 66 percent by 2050 (United Nations, 2014). Cities face challenging issues related to economic development, social inclusion, security, sustainability, infrastructures, transport, housing, etc. At the same time, the advent of the new information and communication technologies has allowed an increased democratization of the production capacity of citizens and has empowered them to participate in the innovation dynamics of their cities.

Cities can be conceptualized as complex ecosystems, where different stakeholders with diverse (and potentially opposed) interests are forced to collaborate to ensure a sustainable environment and an adequate quality of life. In this context, new technologies can allow the interaction between the different stakeholders in order to co-develop solutions to the most important challenges that cities are facing.

In recent years, the term "smart city" has attracted a lot of attention from policy makers, business leaders and citizenship in general. Although there is not a unique definition of what a smart city is, the concept could be briefly described as cities that use information and communication technologies in order to increase the quality of life of their inhabitants while contributing to a sustainable development.

While all the smart city approaches intend to have a positive impact on the everyday life of their citizens, "smart" policies have usually been focussed on top-down initiatives. The smart city concept has been popularized in political discourses that, even if taking in consideration the citizens, are usually translated into policies designed and implemented by institutions. Citizens are often considered as users, testers or consumers rather than producers and sources of creativity and innovation.

The aim of this paper is to analyze the concept of smart city by differentiating two different types of initiatives. From one side, the ones designed and implemented by public and private organizations in a top-down approach. From the other side, other types of initiatives that have their origin at the individual and local community level, and that emerge in a bottom-up manner.

The paper argues that both types of approaches are complementary and that their combination reinforces the "smart" side of a city, by allowing a two-direction circulation of knowledge and by contributing to the collaboration between local public administration, firms, universities and citizens. The contribution of the paper is to go beyond the generalized technologic discourse around smart cities by adding the layer of the citizens' initiatives. To illustrate our arguments, we analyze the case of the city of Barcelona providing examples of top-down and bottom-up initiatives in four different smart city aspects: smart districts, open collaborative spaces, infrastructures and open data.

The smart city concept

The concept of the smart city itself is blurry and eludes a clear definition (Hollands, 2008; Lee *et al.*, 2014). Nevertheless, taking a general definition, a city is considered to be smart “when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance” (Caragliu *et al.*, 2009).

The smart city concept is related to several other concepts like the “intelligent city” (Komninos, 2002), “information city” (Castells, 1996), “wired city” (Dutton, 1987), “knowledge city” (Carrillo *et al.*, 2008; Edvinsson, 2006; Ergazakis *et al.*, 2007; Yigitcanlar *et al.*, 2008; Dvir and Pasher, 2004), “digital city” (Yovanof and Hazapis, 2009) or “ubiquitous city” (Lee *et al.*, 2008). These different concepts share some similarities but focus on a particular aspect of the use of technology in urban environments.

Some of these concepts (as “information city,” “ubiquitous city” or “digital city”) tend to take a technologic perspective, putting ICT at the center. A digital city can be defined as “a connected community that combines broadband communications infrastructure, a flexible, service-oriented computing infrastructure based on open industry standards; and innovative services to meet the needs of governments and their employees, citizens and businesses” (Yovanof and Hazapis, 2009). The digital city approach has mainly focussed on the use of online services for different city actors, including institutions, firms and citizens. As in the “ubiquitous city” approach, the digital city focus considers the need to make data ubiquitously available regardless of time and location to local actors through a distributed infrastructure while providing citizens with services and contents, including those for energy and environmental monitoring (Lee *et al.*, 2008). According to this view, the provided services improve the quality of life of citizens and the city’s competitiveness. Nevertheless, the ubiquitous/digital/information notions put more stress on the technologic aspects than on the social uses of infrastructures from a more human and social capital perspective (Lee *et al.*, 2014).

The concept of “intelligent city” suggests that a city is smarter by enhancing its citizens’ inventiveness and creativity. To capture the distributed collective intelligence, ICT providers participate in the design of services that are interrelated with technologic infrastructures like sensors and interactive devices (Komninos, 2002; Komninos and Tsarchopoulos, 2013). The notion of “intelligent city” is intimately related to the knowledge economy and the changing spatial agglomeration of knowledge-based urban development (Carrillo *et al.*, 2008).

The discourse on smart cities, initially strongly centered on ICT topics, has evolved into conceptual variations that tend to progressively take a more holistic view by considering three core factors: technology (infrastructures of hardware and software), people (creativity, diversity, education) and institutions (governance and policy) (Nam and Pardo, 2011; Lee *et al.*, 2014). Giffinger *et al.* (2007) propose a ranking of “smart cities” of European medium-size cities based on an analytical framework composed of six characteristics: smart economy, smart people, smart governance, smart mobility, smart environment and smart living (Giffinger *et al.*, 2007; Lombardi *et al.*, 2012). A smart city would consequently be a city being able to perform well in those six characteristics, “built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens” (Giffinger *et al.*, 2007).

This paper focusses on how cities are progressively becoming “smart cities,” from one side by implementing top-down strategies based on decisions of the public governmental

bodies and from the other side, responding to bottom-up initiatives lead by citizens and social local movements. Before illustrating our arguments with the case of Barcelona, the next section clarifies the notions of top-down and bottom-up.

Top-down and bottom-up approaches

A top-down approach refers to a process that is fostered or lead by actors of an organizational upper level in a hierarchical structure and that is progressively diffused and implemented by involving actors of lower levels. Such an approach is likely to be based on a central authority and control. The process management is orchestrated by an actor with authority and this risks to not take into account the plurality of all involved stakeholders (Sabatier, 1986).

In contrast to a top-down perspective, a bottom-up approach considers initiatives that organically emerge out of actors from lower levels of the hierarchical structure or by actors outside organizational structures. These community (or grassroots) movements are thus initiated at the base of the power structures and developed gradually by the progressive involvement of higher hierarchical levels.

From an organizational point of view, a top-down approach is linked to the hierarchical character of organizations that bases the structure on power, chain of command, bureaucracy and authority (Fayol, 1916; Weber, 1947). In the case of cities, the two concepts refer to the relationship between the higher and the lower levels of complex organizational systems (Simon, 1962) rather than referring to organizational hierarchies.

In this paper, the differentiation between top-down and bottom-up is relative to the actors that are at the origin of the smart innovation processes and to the actors to which the initiative is directed. Smart city policies are consequently considered as top-down whereas citizens' initiatives using technology to solve urban problems are considered as being bottom-up.

The case of Barcelona

In 2014, Barcelona was awarded the European Capital of Innovation (“iCapital”) prize of Europe (European Commission, 2014). Four years before, Barcelona’s city council launched the “Barcelona as a people city” project by using new technologies to promote economic growth and the welfare of its inhabitants. The city project was structured around five axes: first, open data initiatives; second, sustainable city growth initiatives (smart lighting, electric-vehicle mobility and residual energy; third, social innovation; fourth, promotion of alliances between research centers, universities, private and public partners; and fifth, providing “smart services” based on ICT (Barcelona City Council, 2014). Barcelona’s sustainable innovation ecosystem labeled as iCapital is supported by public institutions (including public services as well as universities and research centers), the private sector (from global corporations to start-ups), and the citizenship and it is grounded on the city’s infrastructures (Barcelona City Council, 2014).

Barcelona has been acknowledged as being able to successfully develop an ecosystem where urban development, business opportunities and quality of life have improved in the last decades. Even though the current global crisis has particularly affected Spain, Barcelona has been able to pursue policies that benefit the local dynamics of innovation. The global visibility of Barcelona as a tourist hub, has been reinforced by the fact of becoming a knowledge-intensive city, reaching the fifth position in the 2010 ranking of Europe’s best cities for hosting new business (Cushman and Wakefield, 2010). Barcelona has also been able to capitalize their experience of being one of the first cities developing an innovative district, the 22@Barcelona (Oliva, 2004).

This paper intends to analyze the different “smart” initiatives that take place in Barcelona in order to better understand the intertwined character of the innovation dynamics that constitutes a smart city. The goal of this research is to illustrate the complexity and the complementarities of different strategies, some of them planned and others emerging, that configure the reality of a smart city, beyond institutional discourses and city branding initiatives. To do so, the paper focusses on one single case in order to provide a deeper level of detail. The case of Barcelona is especially illustrative due to the interest of the city council and local governmental bodies to develop policies regarding urban planning, economic development and increasing the quality of life of their inhabitants while building on the global visibility and branding of the city.

Methodology

The methodological approach used in our research was qualitative, based on a case study (Yin, 1984). The data collection was done considering mainly two sources: first, semi-structured and in-depth interviews; and second, an analysis of public documents related to government projects (such as the case of the 22@) and cultural institutions.

The primary data were interviews that were done in two rounds. The first round consisted of 50 semi-structured interviews undertaken with social actors belonging to the artistic sector, the neighborhood sector (neighbors and neighborhood associations) and the administrative sector (staff of the Barcelona’s City Council related to the creation and development of the 22@ project). Through a second round, we gathered 29 more interviews that were conducted with other city council representatives as well as managers of local public institutions, like economic development offices, as well as local organizations like for instance coworking spaces, Fab Labs and artists’ workshops. We also interviewed specialists on the innovation history of the city in order to validate our data. All conversations were conducted in a manner as open and informal as possible. Interlocutors brought up topics themselves, without or with only few general directions from the researcher (Whyte and Whyte, 1984). Thus, the gathered material reflects the topics and notions particularly important for interviewees, and is not intended to fit into any prior theoretical framework. All field material was analyzed and interpreted through categorizations, following the principles of grounded theory (Glaser and Strauss, 1967).

In addition, we used secondary data such as reports on the 22@, and documentation on the Barcelona innovation policies. We also compiled press articles and the online content of the institutional webpages.

Triangulation of data, researchers and methods was used to increase the richness of data, as well as to draw on other perspectives within the study (Fetterman, 1989). Data triangulation was based on using data from different organizations (public institutions, firms and social agents). Researcher triangulation involved two independent scholars gathering data for about two years, with one of the researchers mainly studying the development of the 22@ project and the artistic urban environment and the other mainly researching on community-based projects in Barcelona. Methodological triangulation was based on using several methods, as above described. All together, we have followed a data triangulation strategy to seek data validation based on the cross-verification of the analyzed data sources. Even being aware of the current critique of triangulation (Blaikie, 1991; Denzin and Lincoln, 2003; Kleine, 1990), we considered convenient to widen the picture, even at the cost of occasional incongruence.

Smart districts: 22@Barcelona

22@Barcelona is the city's innovation district (22@, 2006). The project officially began in 2000 and was promoted by the city council together with other local actors. The 22@ is part of the strategic plan aiming to an industrial renewal of the old manufacturing district of Poblenou (Marti-Costa and Pradel, 2011). Poblenou was an old industrial zone named the "Catalan Manchester" in the beginning of the twentieth century due to its intensive manufacturing life (Oliva, 2004). In the late 1980's the district was in a run-down situation. The municipal government planned to develop an urban cluster with the intention of developing projects linked with the new economy (Gdaniec, 2000). To do so, the city council identified different strategic economic fields that they defined as "clusters": information and communication technologies, energy, medical technologies, media and design (Barcelona City Council, 2010). The companies that are dedicated to these fields represent over 56 percent of the total amount of businesses located in the district.

Top-down initiatives. Despite being an industrial renewal operation was developed using a top-down approach, the 22@ management has tried to generate cross-industrial dynamics between co-localized companies to encourage collaboration and innovation. To this end, the 22@network was an initiative to bring together the local firms in search of synergies and the creation of networking dynamics (Oliva, 2004). New firms have decided to locate in the district to profit from the positive spillovers of clustering (Breschi and Lissoni, 2009).

The 22@ has given support to initiatives that add value to the business located in the district and to the city. Among these projects, Barcelona Urban Innovation Lab & Dev illustrates the public-private partnership to implement innovative projects that benefit both firms and the city. This project aims to facilitate the involvement of the private sector in the development of innovative solutions to current urban problems (Bakici *et al.*, 2013). The city council provides human and technical resources as well as giving access to the urban infrastructures while firms profit of having first-hand access to real-life testbeds for their new products while contributing to the innovative capacity of the city. The urban space serves as an experimentation sandbox and a field for urban research, creating synergies between public and private institutions.

Bottom-up initiatives. In the process of the 22@ project development, the relationship with the former social, industrial and urban environment tended rather toward substitution rather than integration (Zarlenga *et al.*, 2013). There was an absence of social interaction with the people outside the cluster and a limited involvement in the district social daily life. In this sense, the 22@ initiative led by the city council encountered considerable opposition from local actors representing the district inhabitants that have accused the municipality of taking a top-down approach to benefit the private interests neglecting the citizens' concerns (Cruz i Gallach and Martí Costa, 2010). To illustrate this fact, the urban development of the 22@ represented the disappearance of most to the local artists workshops, leading to a certain loss of the local artistic and social identity of the district (Marti-Costa and Pradel, 2011).

Contrarily to how it was initially conceived in the early 2000's, the implementation of the 22@ has partially failed in the integration of the citizenship in the local creative and innovative processes (Cruz i Gallach and Martí Costa, 2010; Marti-Costa and Pradel, 2011). In the last years some initiatives have emerged to counteract the commercial and corporate side of the district. Bottom-up initiatives such as the "Poblenou Urban District" or "Mapa creatiu del Poblenou" (Poblenou Creative Map) are platforms that have contributed to bring together the different artists located in the district. Some artists' workshops like La

Escocesa, Palo Alto or Hangar have also been able to survive the gentrification effect of the real estate urban operation by dealing their status with the city council. Furthermore, periodic events like the “Tallers oberts del Poblenou” (Poblenou Open Workshops) and the “22@outside” events contribute to diffuse the artistic production of the district to the neighbors and outside visitors. Overall, the 22@ continues to be a lively place that nurtures the emergence of art, creativity and innovation.

Open collaborative spaces

The democratization of technology that we have witnessed in the last decades has allowed the empowerment of citizens that can now easily become producers of technologic solutions rather than being mere consumers or users. Technology has also facilitated the knowledge sharing and the collaboration of individuals with the same interest and hobbies. Communities of innovative users have emerged co-developing innovative endeavors while sharing knowledge and best-practices. The increasing use of digital social networks and online platforms has facilitated the interaction between members of those communities. In parallel, some communities have organized themselves around localized spaces like Fab labs, Living Labs, maker spaces or hacker spaces. These are open collaborative spaces where individuals develop their personal and collective projects using shared resources. Co-location facilitates the sharing of physical resources (3D printers, laser cutters and other prototyping devices) as well as the transmission of tacit knowledge.

Top-down initiatives. The democratization of technology and the increasing complexity of the competitive environment has forced firms to rapidly adapt to market trends by constantly innovate. To accelerate the innovation pace and to launch products that better correspond to the users’ needs, organizations seek to tap on external sources of creativity by adopting an open innovation approach (Chesbrough and Appleyard, 2007). The open innovation principles advocate for the openness of firms to external ideas. To do so, firms have to put in place the means to capture the distributed creativity of their environment. Open innovation intermediaries provide firms with the resources to be able to capture, filter, analyze and use the ideas and innovations that might be enrich their innovation processes. In many cases, these intermediaries consist on online digital platforms (Dodgson *et al.*, 2006). However, in recent years there has been an increasing interest in using physical spaces as environments of experimentation where different stakeholders, from developers to citizens, engage in the co-creation of innovative endeavors (Almirall and Wareham, 2008). Examples of this kind of spaces are Living Labs. Most Living Labs are public-private partnerships which provide services both to the local community and to the businesses that contribute to their funding (ENoLL, n.d.).

Barcelona is one of the European cities with the highest number of Living Labs. Apart from the 22@Urban Lab described in the previous section, there are other Living Labs in the Barcelona metropolitan area such as LIVE, BDigital Cluster TIC Living Lab, i2Cat Living Lab, Hangar, Citilab-Cornellà, Fab Lab Barcelona, BCNLAB, Guifi.net and Barcelona Laboratori.

The Barcelona Laboratori initiative deserves a further explanation. This initiative was developed by the city council to encourage innovation through public and private collaboration between the arts, science and technology. What distinguishes this project from previous ones is that, as they claim:

For the first time, the City is adopting a peer to peer attitude towards civil society, no trying to patronize the innovation communities [...] For the first time, peer to peer relations between City council and citizens is the main principle that is helping to Barcelona Laboratori to

involve users [...] This is the first time in the last decades that City council “descend to the arena” and meet the different urban innovative tribes of the city, allowing the creation of a new kind of peer to peer relationship (Barcelona Laboratori, 2012).

Bottom-up initiatives. The social collaboration and association movements are rooted in the historic Catalan tradition. Spaces for meeting, socializing and sharing have an historical base. Current collaborative spaces such as coworking spaces or maker spaces also represent the natural evolution of the local tradition of associativity and collectivism that characterizes the social-economic substrate of the Catalan society.

In the last years, Barcelona has experienced the emergence of a great amount of collaborative spaces of different kind. Most of these spaces are initiatives of private actors that, in some cases, are driven by a non-for-profit objective. This is the case of local communities of artists and hobbyists that have launched some of the artists’ workshops, maker spaces and hacker spaces in the Barcelona districts of Poblenou, Ciutat Vella, Raval or Gràcia.

In other cases, collaborative spaces are opened by local communities that are driven by a for-profit objective. That is the case of coworking spaces, initiated by entrepreneurs to help other entrepreneurs and freelancers to develop their professional project by sharing resources and collaborating (Capdevila, 2014). There are currently more than 100 spaces in Barcelona that define themselves using the term “coworking.” Barcelona is the European city with the highest density of coworking spaces per inhabitant and one of the main hubs for coworking in Europe. New coworking spaces are being inaugurated in a regular basis, while many others are still almost half empty. As a space manager put it: “Currently, there are more coworking spaces than coworkers.” One of the main reasons of the coworking explosion in the city can be attributed to the economic crisis that Spain has suffered in the last years. From one side, many companies were forced to reduce their workforce and their office surface. To monetize the empty workspaces, some of them decided to rent out part of their offices publicizing them as coworking spaces. Another reason is linked to the increase of unemployment due to the economic crisis. Consequently, many jobless professionals decided to start their own business as freelancers, entrepreneurs and autonomous workers and to join a coworking space to reduce costs and increase their networking. Coworking spaces represent third places (Oldenburg, 2002) where members can work, socialize while avoiding the high costs related to renting an office.

Barcelona has also become a European coworking hub due to its attractiveness for foreigners (Leon, 2008). Many professionals have moved for short or long periods to work in the city and coworking spaces have offered them the possibility to have a flexible work environment and the opportunity to get in contact with local social and professional networks.

Infrastructures

Infrastructures play an important role in the implementation of a smart city as they represent the ground to the development of technologic services. Capital-intensive investments are often required in the construction of technologic infrastructures, like for instance in the case of cable networks or energy grids. In such cases, the involvement of governments is required not only to contribute to the funding but also to clear the administrative work to modify the urban hard infrastructures. Nevertheless, in some other cases, the accessibility to technology allow private actors to develop low-cost ICT infrastructures, as it is illustrated below through the Guifi.net case.

Top-down initiatives. Since the 1990s, Barcelona City Council has been planning and investing in the modernization of its infrastructures to adapt them to the current citizens' needs, mainly in terms of integrating the ICTs. For instance, this involves expanding the optic fiber network, providing Wi-Fi connection in public spaces or developing sensor networks configured to be accessible for different purposes and providers.

Nevertheless in specific districts of Barcelona, like in the 22@, the city council has especially invested in the development of new infrastructures through a Special Infrastructure Plan. The 22@ used to be a zone with a deficit of infrastructures in the 1980s. Through its renewal for the Olympic Games and the latter 22@ project, the district has experienced the more important change in terms of infrastructures. The goal of the City council was twofold. On the one hand, the plan aimed to develop infrastructures that became a differential element of the district quite above the standards. The objective was to attract big firms dedicated to the knowledge and technology-based industries. On the other hand, the plan intended to put in place an innovative approach by improving the quality of public spaces. To do so, the network was designed to differentiate the public and the private networks (Oliva, 2004). The new infrastructures involved the following systems: telecommunications, water system, selective waste collection, energy and mobility in public spaces. The total cost of the plan was funded by landowners (60 percent), the city's public-service operators (30 percent) and city council (10 percent). A public-owned company (called 22@) was created by the city council in order to manage the planning, the execution of the infrastructures as well as the relationship between the town-planning authority and the developers (Oliva, 2004).

Bottom-up initiatives. In some cases, the deployment of technologic infrastructures does not necessarily require large investments or to modify physical structures as they have a limited impact on the physical environment. In such cases, infrastructures can be deployed in a more organic manner using limited resources. For instance, as it is the case of Guifi.net, local wireless Wi-Fi networks represent a type of infrastructure needed to the development of online services that can be spread out incrementally by the organic involvement of citizens who add connection nodes.

Guifi.net is an open network infrastructure that started in Catalonia and has progressively been extended to other regions. The network structure is completely distributed. Anyone is able to extend it by adding a Wi-Fi access node after accepting an interconnection agreement that ensures the respect of the project principles. Currently, Guifi.net is the largest free network in the world (Vega *et al.*, 2012). In 2008, the project was labeled by the ENoLL as a Living Lab, providing more visibility and legitimacy to the initiative. The internationalization of the open network infrastructure allows providing a free Wi-Fi connection to a larger amount of people at a very low cost and at the same time reinforces the innovative and creative capacities, diffusing the knowledge on technology and its applications.

Guifi.net is a bottom-up initiative created by engaged citizens without initial institutional support, created by citizens which has become the biggest free network in the world. The administration of the network is completely distributed. Everyone can extend it by accepting an interconnection agreement which guarantees the preservation of its principles. The project was inspired in the free software movement (Stallman, 1985/2009) that promotes the free circulation of knowledge and applies the principles of the open hardware (Powell, 2012).

Open data

Open data allows the analysis of complex problems by gathering large quantities of data sets and involving different actors (Arzberger *et al.*, 2004). It can be valuable for public organizations in order to improve their services or for private firms (e.g. in the case of apps developers using public traffic information).

Open data can be defined as “non-privacy-restricted and non-confidential data which is produced with public money and is made available without any restrictions on its usage or distribution” (Janssen *et al.*, 2012). This definition only considers open data from governmental public sources. In this perspective, citizens passively (and often unconsciously) generate data that are afterwards compiled and shared openly by governmental bodies. In this paper, we refer to these initiatives as top-down initiatives. However, in some cases citizens themselves have taken the initiative of generating, compiling and diffusing the data in a free mode through a bottom-up initiative.

Top-down initiatives. The Barcelona City Council has started to implement projects related to the open governance (Barcelona City Council, 2014). One of them focusses on open data, as a way of sharing data sets that are collected at the city level. The open data project does not only provide free availability to the data but also contributes to the integration of the data as inputs to usages from external actors. To facilitate the integration in other platforms, the data are provided in standard, comprehensive, open and digital formats, with a clear structure and support information. The data included in the open data project have been compiled or generated by the city council, and it only excludes the data related to privacy, property or personal data protection or related to security, as well as the data that are contrary to government regulations.

The main goals of the open data project are fourfold. First, the aim is to increase the transparency of the city council toward citizens, business and public administration. Second, the intention is to detect the needs for open data of other actors and try to satisfy them. Third, the project aims to reinforce the open data movement and foster the reuse of the available data. Fourth, it focusses on reinforcing the economic sector providing new business opportunities (Barcelona City Council, n.d.). In short, this top-down initiative pretends to increase the open database by including new data sets and creating new data sets according to the needs of users.

Bottom-up initiatives. As has been argued above, current definitions of open data generally refer to data compiled by public institutions. Nevertheless, there are initiatives that emerge from other kind of actors that also openly share data. Engaging citizens to collect data by themselves solves the difficulties that public actors have due to their limited resources. Considering the easy access to technology, citizens can in many cases collectively generate the data that they require, without governmental intervention.

The Smart Citizen project serves as an illustrative example of how a grassroots initiative can be gradually adopted by citizens and by public institutions. The Smart Citizen project has been developed by some of the members of the Fab Lab Barcelona. The goal is to allow individuals to easily collect and share data about different environmental variables such as the measure of the air composition (CO and NO₂), temperature, light intensity, sound levels and humidity (Smart Citizen, n.d.). This project is an open-source (open hardware and open software) environmental monitoring platform that consists of an Arduino-compatible hardware, a data visualization web API and a mobile app. The device is able to stream the measures by the different sensors over a Wi-Fi connection and share the data over internet in real time. The obtained open data can be freely used by public or private actors to develop applications or services. For

instance, data on air quality can be used to create local maps of humidity, air quality or sound levels in order to report to local city governments or to raise awareness of issues that matter to the local community (Smart Citizen, n.d.).

After being partially financed through a peer-to-peer funding platform, the project is currently in pre-production phase with over 1,000 kits functioning. Several European cities have shown interest on the project and tests are currently being made in Barcelona, Amsterdam and Manchester, supported by local administrations. The project is also enriched by an active online community that supports the project, by sharing experiences, usages and technical improvements. In 2013, the Smart Citizen Kit project won the World Smart Cities Awards.

Discussion and conclusion

The smart city concept is strongly dependent on the adoption of technology. The literature on smart cities and other related approaches (digital city, intelligent city, information city, etc.) has focussed on the importance of the deployment and accessibility of technological infrastructures. The concept of smart city has been related (often almost uniquely) to this aspect, as the following definition suggests: “The use of Smart Computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient.” (Washburn *et al.*, 2010). In this paper, we have showed that technology and infrastructures are pre-requisites for a smart city, but not enough. They represent the first layer that will serve as a base to implement the smart city services (Al-Hader *et al.*, 2009). However, infrastructures and technology will be useless if the citizens that are supposed to benefit from them do not use them. The contribution of this paper is to enlarge the current use of the concept of smart city to include a citizen-driven innovation perspective into the picture. From the theoretical point of view, the smart city literature has captured the innovative changes introduced by new technologies in urban areas but has often failed to recognize the crucial role that citizens play in the development, implementation and acceptance of technology in their cities.

According to several critiques, the smart city concept reinforces the idea of urban spaces seen from a neo-liberal perspective, where business-friendly cities would aim to attract new businesses while having an “underlying emphasis on business-led urban development” (Caragliu *et al.*, 2009). So far, policy makers have used the smart city approach to provide more efficient and innovative services and to approach technology to citizens. Firms have also seen a huge opportunity in developing technology and infrastructures for cities embracing the concept. Big technologic firms, such as IBM, Orange or Schneider electric, just to cite a few, have identified the huge business opportunities that providing services to cities can represent and consequently, they are dedicating vast resources in order to strength their commercial relationships with urban decision makers. Smart city policies might provide technologic solutions to urban problems, but they also risk to be responding to commercial pressures from the private sector. Consequently, a potential problem of smart city policies is that they risk to be more focussed on technology-push than on demand-pull (Nemet, 2009), being more porous to private firms’ interests of commercializing their services rather than to the citizens real concerns. Local governments are also under a great pressure to embrace the smart city approach, in order to reinforce their image in front of their citizens, to improve their city branding and international visibility (Begg, 1999; Giffinger *et al.*, 2007). City rankings have become double-edge swords that, by simplifying concepts and compiling statistics, compare cities in aspects that might be hardly comparable (Giffinger *et al.*, 2007). City

administrations are confronted to the global competition between cities and risk to introduce measures that respond to private interests rather than public. Furthermore, as it is the case in the “Creative City” concept (Landry, 2000; Florida, 2008), the concept of “smart city” risks to be converted into a “urban labeling” phenomenon (Hollands, 2008) that is used more with a city branding intention rather than as a real improvement to empower citizens by the use of technology. From this perspective, the bottom-up initiatives provided in this paper exemplify how citizens can actively contribute technologically in the city and how their intervention can impact their daily reality.

The smart city concept involves the development of the technological infrastructures of the city that allow the development of new businesses to emerge. Consequently, by investing in being “smarter,” cities supposedly attract talented individuals, companies, and the creation of universities and research centers, and thus contribute to develop an entrepreneurial character. In line with these arguments, the creative class approach advocates that urban environments that encourage technology, talent and tolerance will improve social and economic local environment (Florida, 2002). This represents a more human perspective that goes beyond the focus on technology. Following this line of arguments, the current problems associated to cities can be solved by means of the distributed creativity and the collaboration between different local actors. In this sense, the concept smart city is in consonance with the concept of smart citizens. This view underlines the importance of creativity, social integration, education and tolerance while resonating with the vision of Jane Jacobs (1961) about the richness of urban diversity and cultural mix. Nevertheless, we argue that the social/community/human aspect of the smart city has not been sufficiently integrated in the smart city policies and subsequent research. For instance, only one criteria of the smart city ranking (out of six) concerns directly smart citizens (Giffinger *et al.*, 2007).

A smart city is related to the learning capacity of their citizens and institutions, dealing with the relationships between local communities that advanced in the solution of their common problems. Consequently, we suggest that policies aiming to the reinforcement of the smart city approach should give more importance to emergent phenomena of citizens’ technologic appropriation. Policies aiming to the detection, identification and support of citizens’ initiatives would reinforce other top-down policies and overall contribute to build more consistent and perdurable smart city practices. The role played by local governmental bodies is a crucial ingredient in the smart city approach. Public institutions are often an intermediary between the citizens and the firms that propose their technologic solutions. The role of the administration as broker makes institutions essential in the design, implementation and final success of a smart city strategy. Government agencies are necessary to create an administrative environment that supports the different private or public smart city initiatives. The role of intermediation is also important to deal with opposed priorities of the different stakeholders and to contribute to the coordination of actions. Therefore, smart cities do need smart governments (Gil-Garcia *et al.*, 2013) and transparent smart governance (Willke, 2007) that includes the participation of all involved agents to interconnect effectively and dynamically citizens, firms, universities and administration.

In the context of the smart city concept, the implementation of “smart” policies has generally referred to initiatives conceived and implemented by top-down governmental institutions and involving citizens in a second step. Comparing organizational and urban innovation, many of the current smart city policies can be assimilated to the open innovation projects applied in firms (Chesbrough, 2003). They both are designed by organizations (public or private) to incorporate the input from external actors. The aim of this paper is to widen the concept of smart city by considering other initiatives that are originated by citizens rather than by organizations. Continuing with the analogy, we suggest that the

literature on smart cities should consider the citizens' innovations in the same way that the literature on innovation in organizations has studied the user-driven innovation (von Hippel, 2005). Smart city policies prioritizing private firms' interests risk to neglect the innovative capacity of citizens thus offering services based on technologies that are not adapted to citizens current needs. Actually in some cases, the citizens' needs in terms of green and sustainable environment are sometimes in opposition with economic and commercial logics.

A smart city will be a city whose community has learned to learn, adapt and innovate (Coe *et al.*, 2001). People need to be able to use the technology in order to benefit from it (Caragliu *et al.*, 2009). A "smart city" (top-down) and a "smart citizens" (bottom-up) perspective can coexist providing a fruitful environment to innovation. For instance, as it has been analyzed in this paper, city councils can pro-actively develop initiatives to include citizens' voices in their smart projects. For instance, the Barcelona Laboratori initiative is a clear example of the will of the local administration to empower emerging community initiatives.

Nevertheless, our analysis has its limitations. Even if we have emphasized the importance of the bottom-up initiatives, citizens do not have often the resources to act without governmental intervention. This is the case of services that require high-cost infrastructures or regulatory changes. Also, as it usually happens in the case of disruptive technology, it is hard for citizens to understand the possibilities of its use. In these cases, firms and institutions must play an important role in the first phases of the diffusion of innovations, by informing and incentivizing its use. It is also important to note that some of the emerging usages of technology are confronted to legal or regulatory issues. For instance, distributed and shared Wi-Fi networks might be in opposition to economic interests of internet providers, that often difficult its expansion. It is also the case of services of the sharing economy that represent a menace to established institutions (like the tensions between Uber and taxi companies, or Airbnb and hotels). In these cases, city halls like it is the case in Barcelona, tend to respond to these emergent uses of technology by regulating to ensure protection to existing corporate services.

This paper intends to have a broad view on "smart" initiatives to analyze both top-down and bottom-up dynamics in a city. We argue that these two perspectives are complementary and its combination can reinforce the collaboration between different city stakeholders. Top-down and bottom-up approaches are not opposed forces but, on the contrary, can have a synergistic effect on the innovation capacity of the city as the Barcelona case has shown. By empowering the citizenship and distributing the technologic resources to different actors, territories also increase their resilience as both central actors as well as peripheral actors have access to knowledge and resources to develop creative and innovative solutions.

In conclusion, the transformational process that leads a city to become a smart city has to take in consideration the complexity and the plurality of the urban reality. Beyond considering citizens as being users, testers or consumers of technology, local administrations that are able to identify, nourish and integrate the emerging citizens' initiatives would contribute to the reinforcement of a smart city reality.

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