Smart city intellectual capital: an emerging view of territorial systems innovation management

Smart City Intellectual Capital: an emerging view of territorial systems innovation management

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Abstract

Purpose – This paper aims to explore whether and how the intellectual capital (IC) approach and concepts could be fruitfully adapted to study the smart city phenomenon from a managerial point of view.
Design/methodology/approach – The compatibility between the smart city and the IC approach is explored thanks to a long-term, in-depth ethnographic exploration of the vast global community, which is created around the smart city movement. Large amounts of information were collected over four years through the in-depth analysis of five representative European case studies. Data gathering methods are diverse and include participant observation, non-participant observation, document collection and action research. In addition, more than 100 further international cases were investigated through website analysis, social network analysis and report analysis. The resulting vast text database was analysed through computer-assisted coding to allow data triangulation and bottom-up identification of emergent concepts.
Findings – The analysis suggests that the smart city and IC views are highly compatible, and the systematic adoption of the IC approach could be very useful to study the managerial implications of the smart city phenomenon. On the other side, in order to effectively analyse a smart city context through the IC lens, the traditional IC framework needs to be extended for: (1) expected outcomes, which should also include sustainability, resilience and quality of life; (2) categories of key resources, which should also include institutional capital and environmental capital; (3) units of analysis, which should also include territorial systems, such as transportation or waste; and (4) key managerial challenges implied, which should include knowledge management, network management and project portfolio management. Thanks to these findings, this paper enlarges the conceptual horizon of IC through cross-fertilization with the smart city approach. As a final result, a smart city intellectual capital (SC-IC) framework is proposed.
Research limitations/implications – Most of the cases analysed in this study are European; therefore, further studies are advisable to better investigate non-European smart city contexts. This work highlights an urgent need from the world of practice, and encourages the birth of a stream of empirical work on the role of knowledge resources in smart city success.
Practical implications – The SC-IC framework provides specific suggestions about how the well-established management tools stemming from the knowledge management, project portfolio management and network management approaches could be adapted to better support practices in smart city management. The concepts developed in this study may be useful for policy makers, investors and public servants.
Originality/value – The SC-IC framework allows for a clear definition of the smart city organisation, as a new knowledge-based, project-oriented, network-shaped type of organisation. According to this view, the mission of a smart city organisation is to leverage SC-IC resources far beyond its own boundaries, in order to strengthen competitiveness, sustainability and the quality of life at the level of city system(s). Therefore, the SC-IC framework provides smart city research with a consistent rooting in management studies and identifies the key management challenges implied in the smart city phenomenon. Further, this paper contributes to the fourth stage of IC research.

Keywords – Smart city, Intellectual capital, Digital city, Knowledge city, Knowledge management, Project portfolio management, Project-based organisation, Knowledge-based organisation.
Paper type – Research paper

1. Introduction

> *'Being smart is not about profit. Mere profit may even be a driver of stupidity. Being smart is about capitalizing on all of our resources to build a better quality of life for all – including the next generations'* (a manager involved in a 'smart' initiative for supporting elderly independent living, 2011).

Recently, the intellectual capital (IC) scholarly community has identified a new and challenging goal for the years to come: to investigate how knowledge resources can be leveraged at the city, regional, or national levels, in order to build strong and sustainable social

ecosystems where healthy organizations can flourish (Dumay, 2013). This has also been labelled as the fourth stage of IC research.

Therefore, the fourth stage of IC research should look at broader fields of interest, linking the role and value of IC to the creation of stronger social, economic, and environmental eco-systems, and be regarded no more as a single organization, but as a network of different actors and subjects rooted in different countries, cities, and communities (Gray, 2006; Yeh-Yun Lin and Edvinsson, 2008). In effect, there is growing awareness that not only is knowledge the crucial resource to achieve firm success, but also, and even more importantly, to address the paramount ecological, social and demographic problems that our societies are facing. Therefore, the knowledge-based approaches to management are called into action, in order to contribute to the sustainability and liveability of social eco-systems.

This study aims to contribute to such an emerging research area. To do so, it explores the ideas and work of a vast global community, which includes researchers, policy-makers, and practitioners, known as the smart city movement.

The smart city approach is vigorously growing worldwide (IDC, 2013) and relies on very relevant funding and institutional support (EU Parliament, 2014). Thus, the smart city idea is resulting in a sort of gigantic natural experiment on a global scale, revealing how technology-enabled innovation by cities' key institutions may trigger virtuous change for the larger good (Shapiro, 2006).

Smart city projects and research are aimed at the sustainability, resilience, quality of life, and competitiveness of city systems (Levin et al., 1998; Rogerson, 1999; Chourabi et al., 2012). The smart city community strongly believes that knowledge is the key to the future, and that the pivotal strategies in the development of 'smart' knowledge are technological innovation, collaborative networking, and participative social interactions (Schaffers et al., 2011).

These ideas are highly compatible with the IC tradition and, especially, with the fourth stage of IC research. Nevertheless, to our knowledge, a bridge between the IC and smart city research communities has yet to be drawn.

This is probably because the two communities have very different disciplinary backgrounds. Whilst the IC tradition is soundly rooted in accounting and management disciplines, the younger smart city movement stems from a fermenting multi-disciplinary ground, which includes urban planning, social and political sciences, regional studies, engineering, and computer science (Ricciardi and Za, 2014).

Consequently, even if the two communities often build upon similar concepts and develop similar goals, they usually attend different events and speak different languages. Thus, although these two research traditions are potentially highly complementary, a laborious and accurate translation effort is required to allow for effective cross-fertilization between them.

We firmly believe that such a cross-fertilization has great potential, and the reasons are twofold.

On the one side, the smart city view may help to go beyond the traditional narrow view, which links IC to the creation of monetary value, to a more ecological and sustainable IC, which focuses on the wealth of nations and cities (Wasiluk, 2013). The IC community has expressed its purpose to start focusing on a wider range of possible IC outcomes, beyond the traditional attention to competitiveness and financial performance (Dumay and Garanina, 2013). The smart city approach, given its links with the literature on public value (Fontana, 2014) and its well-established focus on larger-good goals, such as sustainability, resilience, and quality of life, may provide very useful insights to help broaden the horizon of IC outcomes.

On the other side, thus far, the outcomes of IC research have often been neglected in the context of the innovation of public administration (Dias et al., 2014). However, hundreds of smart city initiatives all over the world do need to be governed, managed, and evaluated. There are many explicit complaints about the poor contribution of smart city research, as it relates to understanding, managing, monitoring, and evaluating the smart city innovation projects in action. In fact, the smart city movement is still poorly rooted in management studies, and this could be a cause of the disappointing outcomes of smart city investments that emerged from the empirical evidence (Dameri, 2012). In other words, there is a pressing demand for sounder conceptual tools to understand and supervise the specific smart city initiatives from a managerial point of view. An ad-hoc version of the IC approach, adapted to the smart city context, could be the best candidate to close this gap, but to do so, a common ground between the smart city and IC views needs to be cultivated.

The basis to cultivate such a common ground already exists. IC scholars have developed special IC models aimed to measure knowledge resources at the national-regional or city level: (i) national intellectual capital (NIC) and (ii) city intellectual capital (CIC).
These frameworks form a very useful basis for the mutual understanding between the IC and smart city communities; in fact, in the NIC and CIC models, the traditional dimensions of IC (human, relational and structural capital) are adapted to evaluate territorial entities, typically for cross-sectional comparisons and ranking. Nevertheless, the main purpose of smart city practitioners is not the comparative evaluation of a territorial system's intangibles; rather, it is to cleverly leverage knowledge resources in order to address specific threats and opportunities in a specific city system (Lombardi, 2011).
In order to pursue this relevant goal, a step beyond NIC and CIC models is required, but, to the best of our knowledge, scholarly research has overlooked this issue thus far. Therefore, this paper aims to explore whether and how the intellectual capital approach and concepts could be further adapted to effectively address the management implications of the smart city phenomenon.
Given the explorative nature of the research question, an in-depth qualitative analysis is conducted, based on case studies, action research, text collection and computer-aided coding (Bryman & Bell, 2011). The cases analysed cover a timespan of four years, and provide an ethnographic understanding of the emerging views of the vast international smart city community.
The results suggest that the smart city and IC views are highly compatible, and the systematic adoption of the IC approach could be very useful to both study and govern the smart city phenomenon. On the other side, this study also suggests that, in order to effectively analyse a smart city context through the IC lens, the traditional smart city framework needs to be extended for (1) expected outcomes, (2) categories of key resources, (3) units of analysis, and (4) key managerial challenges implied.
As a final result, a smart city intellectual capital (SC-IC) framework is proposed. This framework is conceived to be usable by both the IC and smart city communities, and proposes a novel managerial understanding of smart city government bodies.

2. Background: two complementary views on the intelligence of territorial ecosystems

2.1 The smart city view

Smart city is a global stream of research and urban strategies aimed at improving the citizens' quality of life in metropolitan areas and at leveraging innovation and high technologies to solve the hard problems generated by the increasing urbanization (Dameri, 2013). The smart city movement especially originates from the need to face urbanization ills and diseases, such as pollution, land consumption, traffic and congestion, energy needs, difficulties accessing public services, and more generally, the serious urban footprint on the environment and difficulties deriving from high population density.
However, the smart city idea is also grounded in the pivotal role that cities have in creating knowledge, culture, innovation and economic development. A recent OECD report outlines that metropolitan areas in OECD countries contributed on average to over half of the total OECD growth in the 2001–2011 timespan, and in some areas, accounted for more than 70% (OECD, 2013). Also, EU (2013) reports that cities are key to the economic and social development of the European Union, but they should face threats such as demographic change, income disparities, urban sprawl and so on, by turning challenges into opportunities thanks to a sustainable urban development model.
The smart city movement especially developed after 2010, due to some important global waves such as technological progress, the diffusion of smart devices, environmental pressure and the political support of supranational institutions, including the United Nations, European Union and the OECD (Cocchia, 2014). Moreover, cities are acquiring a more central role in territorial government and development. During the latest 10 years, all the most industrialised countries have been changing their administrative organization, applying decentralization and local governance more focused at the city level (Caragliu, Del Bo and Nijkamp, 2011; OECD, 2013b). Metropolitan areas acquire political powers and the role of governing their own territory in a more autonomous way with respect to the central government, even if they are never supported with enough resources. This decentralization qualifies the city as one of the

most important political actors in defining and implementing innovative and qualitative urban strategies for generating a high quality of life in urban areas.
Even if it seems a recent phenomenon, the smart city has ancient roots. The smart city community generally identifies with the experience of the Amsterdam Digital City, the first attempt to use technology, and especially ICT, to integrate people, institutions and social agents in a unique platform conceived to enlarge the city governance to citizens' participation (Van de Besselaar and Beckers, 2005).
The analysis of the international literature about innovation in cities outlines that the present concept of smart city is the result of converging streams of research and the empirical implementation of urban strategies regarding a very large set of topics and goals that we can collect in three main streams:

- the digital city, or "an arena where people can interact and share knowledge and information" (Ishida, 2002) in a digital format, as a result of a physical or virtual ICT infrastructure (Schuler, 2002; Dameri and Cocchia, 2013);
- the green city, or "a city pursuing economic development while reducing greenhouse gas emissions and pollution", safeguarding the environment and biodiversity (OECD, 2010; Batagan, 2011);
- the knowledge city, or "a city that aims at a knowledge-based development" (Ergazakins et al., 2004) resulting from knowledge creation and sharing at both the individual and institutional level (Edvinsson, 2006; Yigitcanlar et al., 2008).

These three approaches are thoroughly investigated in various literature (Dameri, 2014). Even if ICT, knowledge, and environmental preservation are seen as inextricably linked drivers for the implementation of more innovative cities, we can distinguish different city labels, each focusing on a specific range of issues, as shown in Table 1.

[TABLE 1 ABOUT HERE]

The smart city is the result of the merging of these different city concepts, and it distinguishes itself from other innovative city models for an integrated, comprehensive vision on all aspects of urban life, from the economy to government, from social to cultural aspects, from transport to green areas (Caragliu et al., 2011, Dameri, 2013). Giffinger (2007), Nam and Pardo (2011) and Chourabi et al. (2012) are among the most cited authors suggesting a smart city framework that integrates all these aspects in a unique and strategic vision of the city of the future.
Among the most cited smart city definitions, the three founding principles of ICT, environment safeguarding and knowledge creation emerge as core elements of a smart city, inextricably linked with each other (Hollands, 2008; Caragliu et al., 2011; Schaffers et al., 2011). The innovative character of a smart city cannot do without the technology, the knowledge creation and its embedding in urban infrastructures, governance, culture and people.
Knowledge is often conceived as the core component of the smart city, both deriving from the ideas of an intelligent city, information city, knowledge city, learning city, and seen as a specific smart city character consisting in creating and consolidating knowledge and innovation in a veritable intellectual capital, useful for triggering further and better innovative processes in the city.
All the cited city labels (intelligent city, information city, knowledge city, learning city) have commons aspects, but also differences, as each of them focuses on one or a few aspects and not on a comprehensive view of the city. For example, the information city is inextricably linked with the concept of a digital city; it outlines the pivotal role of ICT in collecting, processing, and delivering data and information to all citizens (Ishida, 2002; Rosvall et al., 2005). These processes create intellectual capital embedded in databases, websites and free apps, but they also create a smart community of people connected to each other due to broadband connections and flexible online services linking people, institutions and businesses.
Intelligent city refers to the outperforming city in terms of attractiveness, creativity and liveability (Hollands, 2008). The implementation of smart initiatives increases the quality of life in the city, transforming it into a better place to stay. Urban technologies create a knowledge platform for creating, sharing, using and exploiting both individual and collective knowledge to produce public and economic value.

When the technological policies are merged with cultural policies supporting excellence in museums, theatres, schools and universities, the intelligent city becomes a knowledge city embracing knowledge as the main resource for social and economic development.
All these aspects are absorbed by the smart city idea, but somewhat transformed because they are merged with larger visions including environmental safeguards, energy production and a good style of governance. Knowledge is seen as a resource that can be collected and capitalized both materially and immaterially in the city platform. The concept of urban intellectual capital is explicitly cited by several authors defining smart city as a comprehensive urban strategy based on some core components such as technology, a sustainable economy and environmental safeguards, digitalization of daily life, a good style of governance, and intellectual capital.
Nam and Pardo (2011) consider intellectual capital an intangible, social infrastructure of the smart city, along with the tangible facilities, and composed by people and their relationships. They judge it as the indispensable endowment to generate benefits from smart strategies. Lombardi et al. (2012) describe the role of intellectual capital in smart city especially depicting the triple helix model and the role of universities and research centres in generating innovation and patents supporting smart projects. Also, Leydesdorff and Deakin (2011) connect the triple helix to the knowledge base of the smart city and define intellectual capital as composed by university patents merged with industry wealth and local governance, where knowledge is key to regional innovation systems. Neirotti et al. (2014) outline the role of smart cities to optimise the use and exploitation of both tangible assets and intangible ones, that is, human and intellectual capital. Komninos (2011) identifies intellectual capital in three different architectures of spatial intelligence: (1) orchestration intelligence, that stems from collaboration within a community and integration of people's skills, know-how and collective and machine intelligence; (2) amplification intelligence, based on learning, up-skilling and talent cultivation using open technology platforms and an ICT infrastructure offered by the city; and (3) instrumentation intelligence, based on streams of information generated from the functioning of cities, which enable more informed decisions to be taken by citizens and organizations. He considers, therefore, the smart city as an intelligent city based on all these different architectures of intellectual capital connected with the territorial intelligence of a city. Dameri et al. (2014) study how a smart city strategy can create intellectual capital, empirically sustaining their theoretical work by examining the smart city initiative portfolio of a large Italian city.
This survey reveals that several authors put intellectual capital at the core of the smart city; however, nobody specifically investigates the specific relationships between the nature of a smart city, its core management processes, and the nature of a territorial intellectual capital. Nor are the specific knowledge fluxes and processes examined, arising from smart city initiative implementation and their specific, particular governance.

2.2 The Intellectual capital view
Intellectual Capital scholars are interested in investigating the role of knowledge resources in organizations and business eco-systems.
Broadly speaking, the firm's capital is the whole of business factors of production used in a certain elapse of time. Its value depends not only on the value of each component, but also on the relationships between the capital elements as a whole. The Intellectual Capital of a firm is a subset of its capital, characterised by the immaterial nature of its components; it is therefore composed by intangible elements, especially based on the virtuous cycle of knowledge accumulation both inside the company and across its boundaries (Rumelt, 1987).
The Intellectual Capital has a high potential to contribute to the value creation, especially deriving from two value flows. The first is the capability of Intellectual Capital to employ distinctive intangible assets, deriving from internal processes and able to sustain the competitive advantage of the firm in the long term, thanks to specific characteristics of the intangible assets, such as appropriateness, uniqueness, distinctiveness and protection from imitation. These assets are used to better answer to the customers' needs respect to the competitors and therefore to produce better financial and economic performance in the short time (Winter, 1987). The second is the capability of Intellectual Capital to create more Intellectual Capital, that is, other intangible assets, thanks to a process of assets creation (Grant, 1991). When a company is able to use distinctive assets to offer appropriate and inimitable answers to the customers, it concurrently produces distinctive competences, increasing the consistence and the value of its Intellectual Capital (Collis and Montgomery,

1997).
Therefore the Intellectual Capital of a firm is not a static set of resources, but a dynamic system of competences and capabilities produced by the company itself thanks to specific knowledge flows and the harmonization of intangible assets and core competences in a unique way (Henderson and Clark, 1990).
Intellectual Capital is often described as composed by three main sets of resources of the firm: Human Capital, Organizational Capital (or Structural capital) and Relational Capital (or Social Capital or Customer Capital). (Stewart, 1997; Bontis, 1998).
The IC approach has been extended to analyse also territorial entities (Bounfour and Edvinsson, 2012; Dunleavy and Hood, 1994), such as nations, regions and – even if more rarely – cities. The national level of analysis has been the most investigated so far. Not only did the debate on National Intellectual Capital (NIC) provide novel and interesting frameworks to evaluate nations also beyond the GDP and the other traditional financial indicators; it also refreshed the debate on Intellectual Capital *tout court*, since it implicitly raises reflections on the generalizability of the IC models created by the seminal analyses at the firm's level.
A very recent literature review (Labra and Sanchez, 2013) systematically surveys the publications presenting NIC models. The authors focus on six models (Bontis, 2002; Bounfour, 2003; Lin and Edvinsson, 2004; Andriessen and Stam, 2005; Weziack, 2007; López et al., 2011), selected depending on their completeness as for both definition and measurement of NIC. These NIC models have a macro-economic scope and have been developed to rank nations and to drive policies and investments at the state level.
The dimensions of NIC retrieved in extant literature are similar to those developed for City Intellectual Capital (CIC) models. Uziene (2013) examines five CIC models (Edvinsson and Malone, 1997; Carrillo, 2004; Viedma, 2003; Schiuma and Lerro, 2008; Cabrita and Cabrita, 2010) and all these approaches to city's IC structure are very similar to each other. Even if the labels of each IC component are different, the contents converge towards the classical elements such as Human Capital, Organizational / Structural Capital and Relational / Customer Capital. Sometimes these components are split into subcategories, sometimes are grouped, so that we can have three, four or five CIC main categories.

1. *The knowledge and learning potential embedded in people* is usually labelled as *Human Capital*; it is included as a key knowledge resource in almost all the NIC models (Bontis, 2004; Lin and Edvinsson, 2010; Andriessen and Stam, 2005; Weziack, 2007; López et al., 2011) and in all the CIC models considered (Edvinsson and Malone, 1997; Carrillo, 2004; Viedma, 2005; Schiuma and Lerro, 2008; Cabrita and Cabrita, 2010). Indicators include, for example, numbers of graduated citizens, number of schools per capita, and more generally all the elements useful to measure the capacity to transfer knowledge and education to citizens.
2. *The knowledge and learning potential embedded in intra- and inter-territorial relations* among citizens, firms, etc. is labelled in different ways, but it is considered important in at least four NIC models (Andriessen and Stam, 2005; Weziack, 2007; López et al., 2011; Bontis, 2002, who classifies these resources within market capital) and in all the CIC models considered (Edvinsson and Malone, 1997; Carrillo, 2004; Viedma, 2005; Schiuma and Lerro, 2008; Cabrita and Cabrita, 2010). Indicators include, for example, foreign trade especially export, tourism from abroad, incoming students and workers.
3. *The knowledge and learning potential embedded in territorial institutions, culture, rules*, is labelled in different ways; it is taken into consideration in three NIC models (which tend to include these aspects in the concept of *Market Capital*, since the nation's institutions, culture and rules translate into market institutions: Bontis, 2002; Lin and Edvinsson, 2004; López et al., 2011), and in three CIC models (Edvinsson and Malone, 1997; Schiuma and Lerro, 2008; Cabrita and Cabrita, 2010). Indicators include, for example, measures of trust respect to policemen, politicians, professionals; and measures regarding the norms observance and compliance as a proxy of positive social relationships.
4. *The knowledge and learning potential embedded in innovative products and organizations* is understood as going far beyond patents, licenses and intellectual property rights; these aspects are included in a the much wider concept expressing the territory's innovation capabilities, in most cases labelled as *Renewal Capital*, mentioned in four NIC models (Bontis, 2002; Lin and Edvinsson, 2004; Weziack, 2007; López et al., 2011)) and in two of the CIC models considered (Edvinsson and Malone, 1997; Viedma,

2005). Indicators include, for example, the number of patents, scientific papers published in top ranking journals, innovative start-ups and so on.

5. *The knowledge and learning potential embedded in processes, practices and procedures*, which of course imply software, databases, archives, repositories, etc., is usually labelled as *Process Capital* and is considered a key aspect in all the six NIC models we surveyed (Bontis, 2002; Bounfour, 2003; Lin and Edvinsson, 2004; Andriessen and Stam, 2005; Weziack, 2007; López et al., 2011) and in all the CIC models considered (Edvinsson and Malone, 1997; Carrillo, 2004; Viedma, 2005; Schiuma and Lerro, 2008; Cabrita and Cabrita, 2010). Indicators include, for example digital store per capita, avaialbility and extent of software usage, volumes in libraries per capita.

These models of IC at the national (or regional, or city) level were developed essentially for cross-sectional comparisons and ranking, i.e. for measurement purposes. As a consequence, they do not adopt the "eco-system view" of the fourth stage of IC, advocated by Dumay (2013). However, they are the conceptual basis for understanding how smart city strategies could generate and exploit an urban intellectual capital for creating public value and better quality of life for citizens (Bennington and Moore, 2010).

3. Methodology

Since our research purpose is explorative in nature, a qualitative process of triangulated data collection and analysis (Yin, 2013) has been chosen as the most appropriate for our goals.
A wide-range, in-depth analysis was conducted on how smart city initiatives have evolved in several different and representative contexts, in order to point out the emerging role of knowledge in the world of smart city practice. This research builds upon both non-participant observation and participatory action research (Bryman & Bell, 2011) through long-term direct involvement in smart city initiatives and, therefore, has a large empirical knowledge base.
The data collection process started in 2011, when the 'smart' idea was rapidly spreading following the publication of several seminal papers (Cocchia, 2014) and relevant investments from both the European Union and many leading high-technology firms.
The authors witnessed the rapid growth of the community, which soon started organising conferences, workshops and meetings. The number of publications grew exponentially (Dameri and Cocchia, 2013), along with the number of projects and investments (EU Parliament, 2014). The authors have been studying this community intensively, by exploiting several sources and types of observations over a timespan of four years, as detailed in Table 2.

[TABLE 2 ABOUT HERE]

In the initial phase of our research, we conducted an in-depth analysis of three cases as non-participant observers of some different and interesting "smart initiatives" in three different cities in northern Italy.
The first case focuses on Twiperbole, a Twitter account aimed at information sharing, e.g. information about city events, participation in urban planning, etc., and citizen relationship management initiatives, launched by the municipality of Bologna.
The second case is about a pioneering project exploiting high technologies to enhance independent living, safety and the quality of life of the elderly; this project has been launched by the municipality of Trento.
The third case concerns a complex program involving several technology-enabled innovations, aimed at drastic bureaucratic simplification for the citizens interacting with the municipal administration of Turin.
In addition to classical, non-participant case studies, we also utilized action research and participant observation as key sources of information. One of the authors was directly involved with both political and professional roles, in the activities of PA bodies (the municipalities of Genoa, Italy, and Barcelona, Spain), whilst the other author could witness some of the key meetings where smart city projects were discussed, and pose questions as a participating observer of these two cases. Thanks to reflective practice and discussion of the

experiences, we achieved a direct and in-depth understanding of the concrete opportunities and problems, as implied by smart city initiatives "in action".
A third source of information for this study was participation in several smart city workshops and meetings, which allowed us to take part in interesting discussions on concrete best and worst practices, and provided us with an in-depth understanding of how the international community of smart city practitioners interprets the key challenges for smart city success, as it relates to the concrete implementation of innovative projects.
Fourth, we selected and analysed representative reports by authoritative and important institutional bodies and companies involved in smart city initiatives. The analysis of these institutional reports allowed us to observe how both governments and businesses have been building their respective points of view on the cities of the future. These sources proved very relevant to research triangulation (Yin, 2013).
Fifth, we conducted in-depth content analyses of five important and representative international smart city websites, along with more than 100 Italian city websites. This allowed us to collect information about the portfolios and government frameworks of a significant range of smart city initiatives "in action".
Finally, the analysis of a representative sample of smart city-related Facebook pages allowed us to gain an understanding of the citizens' points of view on typical smart city initiatives. In addition, it also allowed us to observe how the concepts of sustainability, inclusion, participation, quality of life, etc. are socially constructed by the citizens who discuss the smart city projects being launched by their city government.
The authors' long-term engagement allowed for achieving an ethnographic understanding (Schensul et al., 2013) of the smart city community's views. The research activities provided the authors with a multi-faceted experience of smart city phenomenon, as well as a rich and diverse text archive, resulting from institutional and corporate reports, website texts, social network texts, interview recordings, conference/workshop/meeting recordings or notes, and researchers' field notes.
This archive was analysed through a process of systematic text coding with the aid of the ATLAS.ti software. Open coding and, subsequently, axial coding (Corbin & Strauss, 1990) were performed to identify the emergent key concepts defining the smart city view. The results of axial coding led to the identification of four key standpoints from which the smart city approach tends to be described, namely:

(i) key *goals* (expected outcomes of good governance/management), according to the smart city view;
(ii) key intangible *resources* (to pursue the goals), according to the smart city view;
(iii) *units of analysis*, i.e. the typical entities of interest that the smart city initiatives are expected to impact; and
(iv) *typical managerial challenges* implied by the smart city view.

In order to allow structured comparison, about 120 seminal texts from our archive of IC literature, including the literature on NIC and CIC, were coded for similar concepts:

(i) key *goals* according to the IC view;
(ii) key intangible *resources*, according to the IC view;
(iii) key *units of analysis* of the IC approach; and
(iv) *typical managerial challenges* implied by the IC view.

The coding activities were performed independently by the two authors, who recursively discussed and integrated their results in order to achieve a shared interpretation and classification of the observed phenomena.
This in-depth text analysis allowed to systematically compare the views of the smart city community on the one side, with those of the IC community on the other side, on the four issues of (i) goals, (ii) range of key intangible resources, (iii) units of analysis and (iv) typical managerial challenges, respectively implied. The main results of these comparisons are described in the following section, along with some proposals on how the two views could be integrated.

[TABLE 3 ABOUT HERE]

4. Findings and discussion

4.1 Extending the range of key goals

The traditional IC approach relies mainly on the RBV of the firm (Grant, 1996; Kraaijenbrink, Spender, & Groen, 2010; Teece, Pisano, & Shuen, 1997), and then focuses mainly on competitive advantage as the key goal of managerial action. Consistently, the NIC and CIC models, as described above, take the national (or city) GDP as the final indicator of the national wealth, competitiveness, and economic development of a whole country or region, which is understood as a key expected outcome of territorial IC.

The smart city discourse, as well, sometimes mentions efficiency and competitiveness as goals of smart initiatives, but it mainly focuses on other goals, such as the capability to avoid the over-exploitation of critical and strategic resources (i.e. sustainability). Moreover, the smart city approach also mentions, as key expected outcomes, the capability to return to equilibrium after crises (robustness) and the capability to evolve and adapt (agility or adaptability); these can be synthesized by the concept of resilience. Finally, the smart city discourse also includes quality of life as the final expected outcome. This concept considers a wide range of aspects such as security, safety, social inclusion, independent living for the elderly and disabled, environmental quality, leisure offers, quality of mobility, transparency and bureaucratic efficiency of key institutions, and quality of key social services like health care, education, family support, etc. (Andrews and Van de Walle, S., 2013; Ricciardi et al., 2013). In other words, the smart city view takes into consideration a wider range of expected outcomes than the traditional IC approach. These views are revealed by the exemplary extracts collected in Table 3.

On the other hand, the emerging fourth stage of IC seems highly compatible with the extended view of the expected outcomes proposed by the smart city view. In his editorial in the *Journal of Intellectual Capital*, Dumay (2013) claims, 'An analogy, which I have used previously, is that of the 'canary in the coal mine'… If we build strong organizations without also concentrating on building a sustainable environment, surely the canaries will not be able to survive. So on reflection, we need both, in order to progress beyond the crossroads to a new IC-based future' (p. 8).

Thus, we suggest a merge between the traditional IC expected outcomes and the typical smart city goals, as shown in Figure 1. The strategic goals emerged from the analysis can be merged into a list of aims for managerial action, ranging from those closer to the traditional measures of performance (e.g. value creation or competitiveness) to those usually utilized to describe the aims of collective subjects such as value networks, countries and regions, territorial ecosystems (e.g. resilience, sustainability, and quality of life).

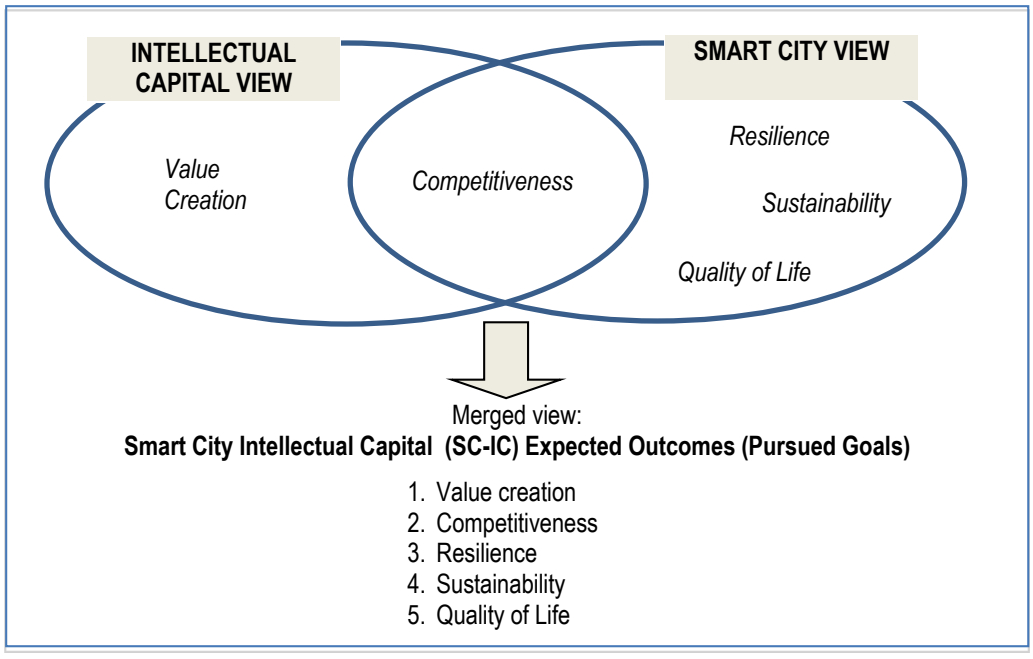

Figure 1. Merge between the typical expected outcomes in the intellectual capital and smart city views

This wide-range view on expected outcomes highlights the complexity of managerial action, since the five strategic goals, synthesized in Figure 1, are quite possibly contradictory to one another. For example, if a firm maximizes competitiveness by concentrating all of its resources on the exploitation of the most successful market niche of the moment, this may imply a severe decrease in the firm's adaptability to future market shifts.
When trade-offs between goals emerge, the goals shaped by short-term pressures may be more likely to prevail than those shaped by long-term, and less harassing, pressures. Thus, we follow the smart city tradition, which tends to encourage those 'smart' actions that, even while pursuing short-term goals, tend to optimize the system for long-term goals as well.
In conclusion, this part of the analysis confirmed that, in order to adapt the intellectual capital approach to the study of smart cities, the expected outcomes should be extended in order to include also resilience, sustainability and quality of life, along with the traditional goals of the IC framework (value creation and competitiveness).

4.2 Extending the range of key intangible resources considered

Both IC and smart city studies identify specific sets of knowledge-based intangible resources that may be leveraged in order to pursue the goals described in Section 4.1.
As the exemplary extracts collected in Table 3 show, there are important similarities, but also some interesting differences between the IC and the smart city views for the categories of key intangible resources considered.
Our analysis revealed that the two discourses, that on IC and that on smart cities, significantly overlap already as for some categories of (knowledge-based) resources.
The smart city community, in fact, already utilizes two key expressions of IC vocabulary (human and relational/social capital) to define some of the most important knowledge resources of a city system.
Conversely, the third component of the traditional IC framework (i.e. organizational or structural capital) remains substantially unmentioned in the smart city discourse. This is easily understandable, since the concept of organizational/structural capital has been specifically developed to understand and evaluate the knowledge resources of a single and specific firm/organization and, thus, is less suitable to support the understanding of complex social ecosystems like cities.
In fact, NIC and CIC models, whilst easily adopting the concepts of human and social/relational capital, replaced the concept of organizational capital with two or three additional concepts that are more suitable to describe the intrinsic intangible resources of the territory being studied. For example, in their NIC model, López et al. (2011) mention *process, renewal*, and *market* capital as complementing human and social capital. These labels are adopted by almost all NIC and CIC research, although there us some nuances in meaning, and, thus, constitute an emerging standard in the IC community, in order to replace the concept of organizational/structural capital when talking about territorial units instead of single firms.
We suggest that these three concepts, after some adaptation, may be suitable to describe the categories of key intangible, knowledge-based resources in smart cities. Moreover, a fourth, novel dimension of intangible capital emerges from the analysis, as follows:

- The NIC/CIC concept of *process capital* is suitable to label the importance of smart practices, based on the exploitation of IT and high technologies. In a smart city context, this label may effectively indicate the smartness embedded in practices, procedures, archives, and software.
- The NIC/CIC concept of *renewal capital* is very similar to the smart city concept of innovation portfolio, and expresses the importance of a continuously renewed pool of ideas, projects, explorations, and initiatives.
- Conversely, we suggest that the NIC/CIC concept of market capital be re-labelled, since it actually includes concepts related to institutional quality, where importance goes beyond competitiveness. Following the smart city interest in institutional smartness, we suggest the new label of *institutional capital*, which may be easily understandable for all management scholars, as well as beyond the IC community (Oliver, 1997). The smart city institutional capital, therefore, can be defined as the smartness embedded in the stock of socially legitimated reward/sanction systems, and related values, stories, rituals, beliefs, roles and rules, which influence: (i) the

people who live, study and/or work in the city, and (ii) the organisations located in the city.

- Finally, the smart city community also utilizes the concept of *environmental capital* to indicate the intelligence potential hidden in the material context around us. The city context is made up of both natural (i.e. trees or rivers) and artificial (i.e. bridges or cell phones) things. This concept is missing in the IC culture, which is traditionally focused on intangible assets. Thus, we suggest that the fourth stage of IC, where the importance of ecosystems finally emerges, could usefully include this dimension in its conceptual horizon. Therefore, we define environmental capital as the smartness embedded in the physical heritage owned, made, used, exchanged, and/or cared for by the city system or sub-system being studied. For example, a building that is accessible by wheelchairs embeds 'smart knowledge' about the problems of disabled people. This knowledge results in enhanced quality of life. From this standpoint, such a building is thus 'smarter' than those that are not accessible by wheelchairs, independent from its economic value.

In conclusion, this part of the analysis confirms that, in order to adapt the intellectual capital approach to the study of smart cities, the range of key intangible resources should include four well-established IC categories, such as human capital, social capital, process capital and renewal capital; moreover, it should also include two further categories, i.e. institutional capital (an extended and revised version of the CIC concept of market capital) and environmental capital (which is a completely novel concept for the IC tradition).
The final results of the merged language on intangible resources that we propose for a possible SC-IC framework are synthesized in Table 4.

[TABLE 4 ABOUT HERE]

4.3 Extending the range of possible units of analysis

The fourth stage of IC (Dumay, 2013) implies a revolution in the choices about the units of analysis. In fact, traditional IC research, given its focus on competitive performance, takes into consideration one entity at a time, with legally and administratively clear boundaries (e.g. the firm or nation).
However, if we choose social ecosystems instead of legal entities, as objects of inquiry, the possible levels of analysis must change consistently. The question is how to do this; our analysis reveals that the smart city community provides a very interesting answer to such a question.
Given its rooting in systems thinking (Fiksel, 2006; Luhmann, 1995; Brondizio et al., 2009) , the smart city approach never considers an organisation in isolation, even in the case where the organization being studied is the core one (i.e. the public body in charge of the city administration). The typical level of analysis of smart city studies is the city sub-system. For example, the city government sub-system includes the key city institutions involved in city government, whether networked or not, and the citizens. The mobility sub-system includes the public transportation organisations and their customers, the privately owned cars (or boats, if in Venice) that circulate in the city and their drivers, the organisations in charge of street maintenance, etc.
Some sub-systems have key relevance in all cities, such as government, mobility, health care, and waste, but some other key sub-systems stem from the specific geographical situation, historical heritage, and economic vocation of each city. For example, the harbour is likely to be considered a key sub-system for Genoa or Marseille, whilst the fashion industry system is likely to be considered a key sub-system for Milan or Paris.
Therefore, the smart city approach views the city as a set of sub-systems, which need to be smartly coordinated and innovated. The analysis can be conducted at the level of one or more sub-systems, or at the level of the city system as a whole, always considering interactions and interconnections as crucial elements on which to focus.
The IC spread in a smart city could be empowered, increased, and renewed by knowledge flows inside a single subject (i.e. inside the municipality), across different subjects (i.e. the use of social networks to involve citizens in planning the Smart Mobility map), or across smart sub-systems (i.e. the Smart Harbor subsystem plans urban logistics together with the Smart Mobility sub-system, to reduce pollution, traffic congestion, and harbour fees).

Therefore, several possible synergies emerge, supporting a wider and deeper penetration of IC creation and use in all smart activities.

4.4 Extending the range of managerial implications

Interestingly, the qualitative analyses of our interviews, field notes and selected documents converge in suggesting that there are growing concerns in the smart city community about the managerial challenges implied in smart city practice. The sources of information listed in Table 2 tend to mention three main groups of problems, which confirm the compatibility and complementarity of the smart city view on the one side, and IC view on the other side.

A first group of managerial issues mentioned in the interviews, field notes and document collections may be labelled as knowledge management implications. Some members of the smart city community under study highlight the difficulties of governing and exploiting the knowledge resources needed for, and resulting from, smart projects and programs:

- Smart projects and programs are usually highly innovative, and thus tend to both attract and generate paramount knowledge flows; however, in most cases, these knowledge flows are considered as mere "side effects" of technological solutions, and are rarely cared for;
- The lack of coordination among smart projects (which often compete for resources) may hinder knowledge sharing and the consolidation of best practices;
- The implementation of smart programs implies intense interactions within and across emergent chaotic communities of practice, well beyond any organisation's boundaries and traditional managerial control;
- Valuable knowledge could be gained at sustainable costs also from failed or abandoned smart city projects, but the investments to pursue such a goal are extremely rare.

In other words, the smart city community, while agreeing upon the knowledge-based nature of the smart city phenomenon, is starting to suspect that instead of catalysing the creation of further value, the bulk of the knowledge generated by smart projects and programs goes to waste because it is very difficult to manage.

This has relevant implications, which in the authors' opinions belong to the area of knowledge management. The knowledge management approach has strong links with the intellectual capital view and the strategic management literature (Choo & Bontis, 2002). Knowledge management is usually defined as the formalized approach of managing the creation, transfer, retention and utilization of a social entity's explicit and tacit knowledge (Cepeda & Vera, 2007). Traditionally, knowledge management studies and practitioners have concentrated on enterprises, but their interest in other social entities, such as the communities of practice, is growing (Wenger, 2004).

We then suggest that the smart city phenomenon be a very interesting and promising subject for developing novel knowledge management studies and practices.

On the other hand, there is also a second group of managerial issues that the smart city community often mentions as relevant.

According to the content databases mentioned in Table 2, in fact, the smart city community tends to describe each specific smart city in terms of its concrete portfolio of smart projects. In other words, according to the smart city community, each concrete smart city setting directly stems from the city's portfolio(s) of smart projects, usually involving several city sub-systems, e.g. transportation, health care, waste disposal, etc., and often implying the development of several and diverse technology-based solutions (EU Parliament, 2014).

More specifically, many sources of information tend to converge in identifying the following key issues for smart city success:

- Smart city projects should be consistently selected on the basis of higher-level smart programs, following an effective strategic vision;
- It is important that smart city projects are effectively coordinated, that possible conflicts between projects are addressed, and possible synergies are exploited;
- Project portfolios should be subject to recurring assessments. For example, if an ongoing smart project proves obsolete, too costly or less useful than expected, it should be possible to switch resources away from it, towards the most strategic or most promising projects;
- Many smart city projects are vendor-driven, i.e. advocated, launched and managed by high-technology vendors; this tends to result in poor coordination and synergies within and across the smart city program(s);

- Some smart project portfolios result almost casually from the stratification of short-sighted choices, political moves, budget constraints, opportunistic actions, local conflicts and bureaucratic inertia;
- Many smart city projects are launched just to seize an opportunity of external funding (particularly from the EU) and do not result from the definition of sound smart city strategies and programs; this tends to result, again, in poor coordination and synergies within and across the smart city program(s).

In other words, this study confirms that many of the issues identified by the smart city community have clear managerial implications, which belong to the areas of project portfolio management and program management (which are often quasi-synonyms in the literature) (De Reyck et al., 2005; Petit, 2012).

The sources of information depict a scenario where poor project portfolio management is perceived as a very frequent issue in smart city contexts. This issue results in harmful resource waste and poor smart city performance, also after relevant investments.

In sum, the analyses suggest that the key managerial challenges confronting the young smart city community imply knowledge management issues on the one side, and project portfolio management issues on the other side.

Are knowledge management and project portfolio management two compatible approaches? As a matter of fact, these two approaches are already complementing each other, as the most recent literature on project-based firms (Prencipe & Tell, 2001) and project management offices (Desouza & Evaristo, 2006) shows.

Therefore, an integrated view on the management issues of the smart city phenomenon, based on both knowledge management and project portfolio management, is probably a promising research goal for the years to come.

Finally, the sources of information also converge in describing the organisational entity that governs the smart city portfolio as a complex network including people from different organisations, such as public administration bodies, universities, municipal utilities, etc. In some cases, there are formal inter-organisational agreements or joint-ventures between the key smart city actors, but in many cases, the most important relationships shaping the smart city governance are fluid and managed informally.

In other words, the smart city phenomenon seems to imply the rise of new, network-shaped forms of organisation, where the organisational boundaries are blurred and new governance, management and coordination needs are emerging. These are the typical challenges of the emerging network forms of organisations, which are at the centre of a viable research stream (Borgatti & Foster, 2003).

The combination of the three management challenges described above implies the development of new and specific organisational solutions in order to effectively implement the smart city strategy. In other words, this study suggests that the successful smart city is likely to imply a novel form of organisation, which needs to be contemporaneously knowledge-based, project-oriented and network-shaped.

4.5 Synthesis of the main outcomes: the SC-IC framework

The analyses described in the paragraphs above were utilised to build an original framework, which mirrors and synthesizes the emerging views of the smart city community through the abstract lens of managerial studies, and IC in particular.

This framework allows for pointing out the crucial role of smart city intellectual capital (SC-IC) in smart city success. By looking at the smart city phenomenon through the lens of an extended IC view (Figure 2), the SC-IC framework proposes that:

1. Each smart city entity should be viewed as a new form of *knowledge-based, project-oriented network organisation*, which in most cases needs to be jointly managed by people from different traditional organisations, such as public administration bodies, universities, public transportation companies, etc.;
2. This novel type of project-based network organisation should be at the centre of a new stream of management studies, in order to investigate which possible business models and organisational designs could be adopted for smart city organisations;
3. The smart city organisation requires development of specific, intertwined knowledge management and project portfolio management approaches, capabilities and tools;
4. City competitiveness, sustainability, resilience and quality of life should be considered the key final goals of smart city management;

5. A peculiarity of this new organisational form is that it can achieve its goals only by leveraging knowledge flows far beyond its organisational boundaries; in fact, city systems and sub-systems, e.g. transportation, health care, security, etc., should be considered the typical levels of analysis of smart city management studies;
6. A city system should be defined as "smart" insomuch as it leverages its knowledge potential to optimize the balance between shorter-term goals/outcomes, such as economic performance and competitiveness, and longer-term goals/outcomes, such as resilience, sustainability and the quality of life;
7. Human capital, social capital, institutional capital, process capital, environmental capital and renewal capital should be considered the key categories of resources to leverage for smart city success.

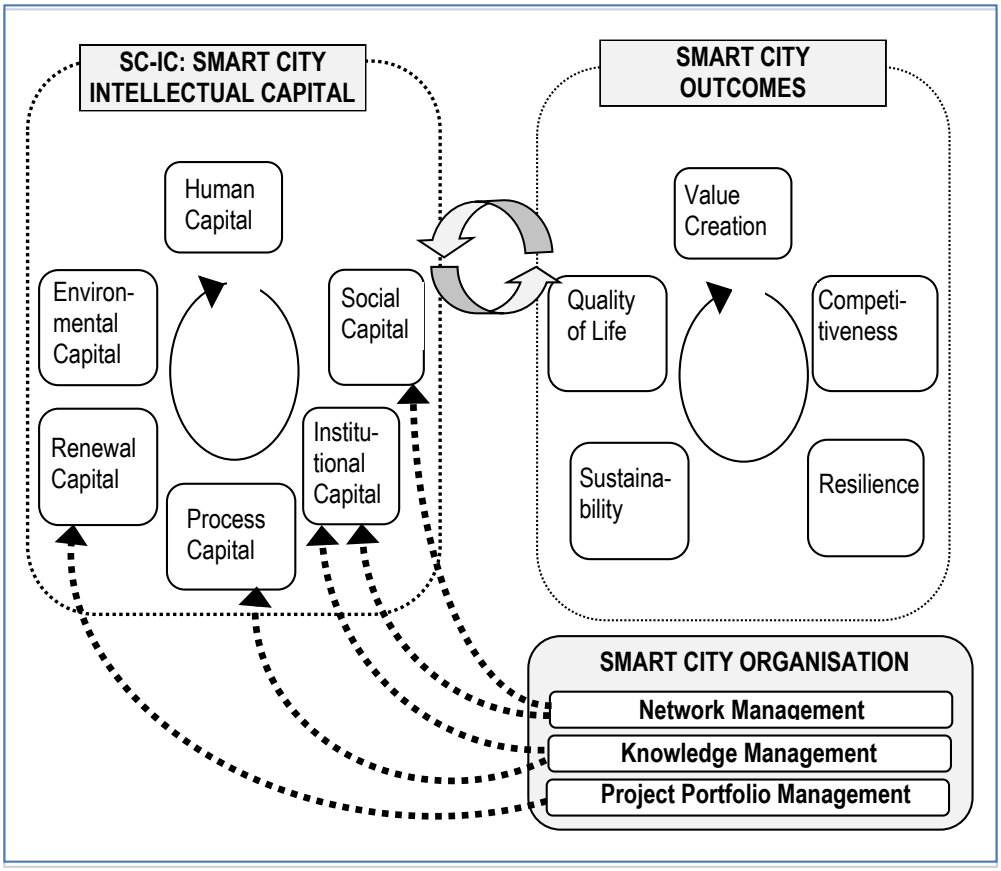

Figure 2. The smart city phenomenon according to the SC-IC view

The findings of this study suggest that the direct impact of smart city project portfolio management is mainly concentrated on the city's renewal capital; conversely, the direct impact of smart city knowledge management is mainly concentrated on the city's process capital and institutional capital; finally, also smart city network management typically impacts on institutional capital, but its main specific target is social capital (Figure 2).
In fact, smart programs, i.e. the portfolios of ongoing smart projects, are a key component of renewal capital, as defined in Section 4.2. On the other hand, the typical managerial tools of knowledge management consist of new software, new procedures, and new values, which directly influence process and institutional capital. Finally, the typical managerial tools of network management are social interactions and the construction of common rules and beliefs, which imply changes in social capital and institutional capital. In other words, the coordinated action of project portfolio management, knowledge management and network management of a smart city organisation can directly change the city's renewal, process, institutional and social capital; by leveraging these changes, in turn, further changes in the other intangibles can be triggered. This domino effect may occur not only at the level of the sub-system where innovation has been introduced (e.g. the waste sub-system), but also at the level of other city sub-systems (e.g. the educational system).
Thus, changes in SC-IC are likely to result in expected, unexpected, or even unintended consequences in at least one city sub-system, in terms of value creation, competitiveness,

resilience, sustainability, and/or quality of life. For example, the introduction of a new project for smart housing aimed at elderly independent living (i.e., a change in renewal capital) may result in safer houses (i.e., a change in environmental capital), increased awareness and empowerment of the elderly and their caregivers (i.e., a change in human capital) and reduced costs for elderly care (i.e., a change in system sustainability).
The SC-IC framework seeks to represent the possible virtuous (and vicious) circles influencing the evolution of IC. The results of the analyses of this study strongly support the idea that important feedback effects influence knowledge-related phenomena in smart cities over time.
Consistently, the SC-IC framework suggest that if a sub-system has already achieved good levels of economic value creation, competitiveness, resilience, sustainability, and quality of life, it is more likely that it will effectively leverage inputs (e.g. financial funds or exogenous shocks) to further improve IC. For this reason, Figure 2 shows two opposite arrows linking smart city IC and smart city outcomes.

5. Conclusions

Cities are the key social engines of societies. Successful cities attract investments, businesses and talent, catalyse ideas and innovation, and trigger growth and prosperity.
On the other hand, cities are being increasingly threatened by paramount demographic, social and ecological challenges. The traditional solutions and approaches are completely insufficient to tackle such challenges; clearly, a dramatic discontinuity is needed for the human capabilities to govern and manage territorial systems. The rise of the fourth stage of IC research (Dumay, 2013) mirrors the importance that more and more management scholars attach to these issues.
The smart city movement is a young, vigorous and extremely dynamic global community, which is struggling to find novel solutions to city problems by leveraging innovation and high technologies. The smart city approach implies dedicating strong attention to sustainability and the quality of life as final goals, and is then particularly promising for its potential of providing good, long-term solutions.
On the other hand, whilst the technological issues associated with the smart city phenomenon have already received intense scholarly attention, the managerial challenges implied by the smart city approach have been critically under-investigated.
This paper contributes to addressing this gap by leveraging the IC approach to yield a management-oriented view of the smart city phenomenon.
In order to pursue this research goal, a four-year vast qualitative research has been conducted. The results confirm that the smart city and IC views are highly compatible, and the systematic adoption of the IC approach could be very useful to investigate the smart city phenomenon from the point of view of management studies. On the other side, the results also reveal that the IC approach needs to be adapted in order to be effectively utilised for smart city studies.
Therefore, this paper proposes that, in order to study the smart city phenomenon, the traditional IC approach should be extended for:

1. Expected outcomes, which should also include sustainability, resilience and the quality of life, along with the traditional IC goals (value creation and competitiveness);
2. Categories of key resources, which should also include institutional capital and environmental capital, along with other four well-established IC and CIC constructs (human capital, social capital, process capital and renewal capital);
3. Units of analysis, which should also include territorial systems, such as transportation or waste; and
4. Key managerial challenges implied; in fact, the emerging problems in smart city practice suggest that specific and intertwined knowledge management, project portfolio management, and network management skills are needed for smart city success.

As a final result, a smart city intellectual capital (SC-IC) framework is proposed.
The SC-IC framework suggests that the smart city entity should be viewed as a new form of knowledge-based, project-oriented, network-shaped organisation, which requires great, specific, and intertwined capabilities of network management, knowledge management and project portfolio management. Thanks to these findings, the SC-IC framework provides smart city research with a consistent rooting in management studies.

On the other side, this paper also enlarges the conceptual horizon of IC through the cross-fertilization with the smart city approach. This study contributes to the fourth stage of IC research by focusing on territorial ecosystems as the key units of analysis, and also by considering territorial system sustainability and long-term quality of life as key final goals of IC research.

Further, this study indicates a path that may have relevant practical implications. The SC-IC framework suggests that the well-established management tools stemming from the network management, knowledge management and project portfolio management approaches could be adapted to support better practices in smart city management. The concepts developed in this study may be useful for policy makers, investors and public servants.

Even if it is based on a vast empirical analysis, this study has clear limitations. Although the smart city phenomenon is booming, it is very recent and turbulent. Thus, we could not build upon a reflective analysis of already concluded, clearly readable and historically settled cases. In addition, most of the cases we analysed are European; hence, further studies would be advisable to check the validity of our results in non-European contexts. Finally, this is an explorative study, aimed at theory-building; therefore, the definition and quantitative testing of specific hypotheses is beyond its scope.

These limitations notwithstanding, this study may play a role as a research trail-blazer, because, to the best of our knowledge, management research lags critically behind the strong need for specific conceptual tools to manage the emerging and turbulent smart city phenomenon.

This paper proposes a clear definition of the smart city from a managerial point of view, viewing the smart city organisation as a new form of knowledge-based, project-oriented, network-shaped organisation with a challenging, crucial mission. This approach points out a route towards the inclusion of the smart city phenomenon in the range of subjects within management studies.

Possible areas for future research, which may benefit from the view provided by the SC-IC framework, may include issues such as:

- Business models of smart city organisations
- Organisational designs for smart city bodies and/or networks
- Knowledge management in smart city organisations
- Project portfolio management in smart city organisations
- Evaluation of smart city initiatives and/or organisations.

Finally, the authors hope that this study will encourage the rise of a systematic collaboration between the IC and smart city scholarly communities, which may yield relevant research results to address the dramatically emergent challenges of territorial eco-systems.

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Tables

City labels	Authors	Main issues
Intelligent city Information city Knowledge city Learning city	Ergazakis, 2004; Komninos, 2008; OECD, 2010; Anthopoulos et al., 2012.	Learning and innovation, information sharing and availability, knowledge creation and sharing, skills and understanding, citizens' awareness, schooling and education
Digital city Wired city Virtual city	Qi et al., 2001; Schuler, 2001; Ishida, 2002; Hollands, 2008.	Data, information, communication, interaction, internet, digital communities, computer and networks, broadband
Green city Sustainable city Eco-city	Roseland, 1997; OECD, 2010; Batagan, 2011.	Green technologies, people's behaviour, green energy, environmental preservation
Smart city	Hall, 2000; Giffinger et al., 2007; Caragliu et al., 2011; Dameri, 2013.	Smart people, smart community, awareness among citizens, sustainable economic growth, high technology, participatory government, quality of life in the city

Table 1.
City labels and typical issues in smart city-related literature

Type of source	Source details
Interviews and document collection in representative case studies	A triangulated multiple case study analysis was conducted on the basis of the following Italian smart initiatives at the city level: Bologna, Twiperbole; Trento, Smart Ageing and Independent Living; and Turin, Torinofacile e-government services (years 2011 – 2013).
Participatory action research - involvement in significant smart city initiatives	One of the authors has conducted participatory action research while serving as a Deputy Mayor for Welfare and Public Dwelling (from May 2012 to November 2013) in Genova, Italy; as a member of the Scientific Committee of Genova Smart City since 2012; as developer of a Smart City Performance Measurement Dashboard for Selex ES from 2012 to 2013; as a consultant of the Municipality of Barcelona to develop a Well-Being Dashboard for smart programs since 2013.
Participant observation at professional/political workshops and meetings	Participant observation (with document collection and field notes) of the smart city community has been conducted at international professional/political workshops and meetings such as the Bologna Smart City Exhibition, Bologna, 2012 and 2013; OECD Roundtable of Mayors and Ministers, Marseille, 2013; OECD Workshop 'How's Life in Your Region? Measuring regional and local well-being for policy making', Paris, 2014 (I and II edition); EU Commission Workshop 'Regional Data and Local Indicators for a Territorial Dimension of EU Policies', Bruxelles, 2014.
Institutional reports	Ten authoritative institutional reports, about smart city and related topics, issued by institutions such as the Italian and UK governments, Italian Municipalities Association, EU Commission, OECD, Territorial Development Directorate, IEEE, and Copenhagen Cleantech Cluster, were selected and analysed.
Corporate reports	Twelve in-depth reports, issued by leading high-technology vendors and consulting firms such as ABB, Cisco, Ericsson, IBM, Apple, Siemens, PWC, Forrester, and McKinsey, were selected and analysed.
Smart city websites	Contents from five representative international smart city websites (Amsterdam, Barcelona, London, New York, and Tokyo) along with 117 Italian smart city websites were selected and analysed in 2013-2014.
Social networks focused on smart city initiatives	A sample of Facebook contents including citizens' opinions and comments about smart city projects involving the cities of Bari, Napoli, Verona (Italy), Memphis (USA), and Amsterdam (Holland), was selected and analysed in 2014.

Table 2.
Sources of qualitative data

	Intellectual capital approach	Smart city approach
Expected outcomes	'Intellectual capital aims to reach some knowledge-based advantages for an organisation'(Bontis, 2002). 'The knowledge-based view of the firm provides strong rationale as to intellectual capital's role in enhancing organizational performance' (Youndt, Subramaniam, and Snell, 2004). 'The intellectual capital statement underpins the development of the future value of the company, and consequently its competitiveness in the knowledge economy' (De Pablos, 2002). 'NIC [National Intellectual Capital] aims at uncovering and managing intangible wealth of a nation' (Nazari and Herremans, 2007). 'Local intellectual capital provides a measure of hidden wealth of the city' (Navarro et al., 2012).	'A smarter city infuses information into its physical infrastructure to improve conveniences, facilitate mobility, add efficiencies, conserve energy, improve the quality of air and water, identify problems and fix them quickly, recover rapidly from disasters, collect data to make better decisions, deploy resources effectively, and share data to enable collaboration across entities and domains' (Nam and Pardo, 2011). 'Amsterdam Smart City aims to create a more sustainable city… through better citizens' behaviour' (Amsterdam Smart City website, 2013). 'Smart City is related with knowledge-based urban development' (a speaker at OECD Forum, 2014). 'A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance' (Caragliu et al., 2009).
Key resources	'Human Capital, Structural capital, Customer capital' (Bontis, 1998). 'All the knowledge elements used to enhance our business and competitiveness' (Entrepreneur, survey about academic spin-off, University of Genova, 2014). 'The main components of city intellectual capital are Human Capital, Structural Capital, Relational Capital' (Area Trieste Science Park, website: www.area.trieste.it). 'City capital is composed by Human capital, Market capital, Process capital, Renewal and development capital' (Viedma, 2005).	'Smart City is the combination of physical infrastructure and urban human, social, and intellectual capital' (Smart City Exhibition, October 2012). 'To implement a smart city, not only the ICT infrastructure is needed, but especially its Intellectual Capital, made by human and social capital, relational capital, innovation, educational institutions, …' (CTI Liguria workshop, April 2014). 'A Smart City is a long term strategy for urban development, based on knowledge, technology, research and aware and involved citizens, aiming at creating human, social, environmental, renewal capital' (Panel of expert, University of Genoa, December, 2013). '[The smart city] requires innovation not just in technology, but also institutional reforms and policies that engage citizens in democratic activities to improve urban competitive advantages and local prosperity' (Paskaleva, 2009).
Units of analysis	'Firm/Organizational Intellectual capital' (Edvinsson and Malone, 1997; European Commission; Sveiby, 1997; Stewart, 1998); 'National Intellectual Capital' (Labra and Sancez, 2013); 'Regional Intellectual Capital' (Bounfour, 2008,); 'City Intellectual Capital' (Viedma, 2006; Uziene, 2013; PriceWaterhouseCoopers, 2013); ICIC - International Conference on Intellectual Capital, talk on City IC; '…the fourth stage [of IC research] concentrates on building strong economic, social and environmental eco-systems, where healthy organisations can flourish' (Dumay, 2013).	'We should work at several levels: the city government, on the one side; the citizens, on the other side; and between these two levels, there are the city sub-systems, such as energy, transportation, education, tourism, and so on' (a speaker at the public debate on Twiperbole, 2012). ' [the six key dimensions of smart cities are] smart economy, smart mobility, a smart environment, smart people, smart living, and smart governance' (EU Commission Open Week, 2014) 'However, infusing intelligence into each subsystem of a city, one by one––transportation, energy, education, health care, buildings, physical infrastructure, food, water, public safety, etc.—is not enough to become a smarter city. A smarter city should be treated as an organic whole––as a network, as a linked system' (Nam and Pardo, 2011).

Table 3. Comparison between the intellectual capital and smart city views on expected outcomes, key resources, and units of analysis

NIC/CIC vocabulary	*Smart city vocabulary*	*New label proposed for SC-IC vocabulary*	*Identifies the intangible/ knowledge resources embedded in:*	*Examples*
Human capital	*Human capital*	**Human capital**	People	Citizens' competences in separating waste for recycling
Social (relational) capital	*Social capital*	**Social capital**	Relationships between people, organisations, networks, and/or systems	Effectiveness and friendliness of the Citizens Relations office, to which people can also report on problems of separated waste collection
Market capital	*Smart institutions*	**Institutional capital**	Roles, rules, hierarchies, policies, shared values and beliefs, reward and sanction systems, and collective identities	Presence of functioning rules for rewarding citizens who effectively separate their waste (e.g. by granting a discount on taxes)
-----	*Environ-mental capital*	**Environmental capital**	All that constitutes the physical environment, including both natural and artificial things such as bridges, trees, and phones	Presence of 'smart' waste bins equipped with sensors and microchips, which monitor the quality and quantity of waste separation by the inhabitants of each building
Process capital	*Smart IT-enabled processes*	**Process capital**	Practices, procedures, databases, archives, and software	Presence of an effective database connecting the data from 'smart' waste bins (see above) and the procedures for taxing citizens (see above)
Renewal capital	*Smart project portfolio*	**Renewal capital**	All of the outcomes of recently conducted or ongoing change, research, and product and/or service development projects	A project for a new high-technology recycling facility

Table 4.
A "Rosetta Stone" providing common smart city-intellectual capital (SC-IC) language on intangible (knowledge-based) resources in city ecosystems