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A knowledge management perspective on the of the role of universities in smart city projects

Abstract

The development of smart cities is becoming more and more based on knowledge management (KM) frameworks. This leads to new managerial challenges, which reflect the complexity of KM governance and processes issues of smart city projects, and the need to manage knowledge that originates both within and beyond projects' boundaries. However, in-depth research on the development of smart cities from a managerial and KM perspective has remained scant. In detail, although universities are deemed to be responsible for the competitiveness and superiority of knowledge-based ecosystems, like smart city projects, the different roles they play in such projects when dealing with KM governance and processes issues are still understudied. Therefore, by conducting an exploratory case study of 20 smart city projects, this paper aims to scrutinize how universities manage the KM governance issue when internal knowledge is used, the KM governance issue when external knowledge is used, the KM processes issue when internal knowledge is used, and the KM processes issue when external knowledge is used. Results reveal that universities act as knowledge intermediaries, knowledge gatekeepers, knowledge providers, and knowledge evaluators.

Keywords: Smart city; Knowledge management; Open innovation; Universities; knowledge-based urban development; Innovation ecosystem

Highlights

- We explore how universities affect the KM mechanisms underlying smart city projects
- We build a conceptual model by combining KM issues and the knowledge origins
- An exploratory case study of 20 smart city projects is conducted
- We propose four roles universities play in smart city projects

1. Introduction

The concept of smart city dates back to about two decades ago (Mahizhnan, 1999). Since then, technology has always been deemed to play the most relevant role in the forward-looking visions about urban futures (Bulu, 2014), in line with the principles of the post-industrial economy. Indeed, technology has been considered the enabler of modern and healthy living conditions, new communication modes, and more effective digital services (Cocchia, 2014; Scuotto et al., 2016).

However, technology, economic, and societal progress have further led to a new economic model, where more knowledge-intensive than labor-intensive activities take place. That is, the knowledge economy, which has recently replaced the post-industrial economy (Powell and Snellman, 2004). Following the knowledge economy principles, the Organization for Economic Cooperation and

Development (OECD) and the European Union (EU), among others, have adopted knowledge management (KM) frameworks in their strategic directions for global and local development (Angelidou, 2015). This paradigm shift in strategic planning has strongly influenced urban development, with the result that knowledge is now conceived as the core component of smart cities, while technology endowment is only a mean supporting their effective implementation (Hollands, 2008; Bakici et al., 2013). In turn, the so-called knowledge-based urban development (KBUD) is becoming a more and more popular approach to design and implement smart city projects (e.g. Yigitcanlar and Velibeyoglu, 2008; Yigitcanlar, 2010).

Despite the emergence of the KBUD approach, there are few examples of successful KM initiatives in smart cities since managing knowledge in smart city projects is not straightforward (Yigitcanlar, 2014). Notably, two main issues to the effective implementation of KM practices within smart city projects can be recognized, namely KM governance and KM processes (e.g. Winden et al., 2007; Lombardi et al., 2012; Anttiroiko et al., 2014). KM governance reflects the complex relationships among the main partners involved in smart city projects - i.e., the government, the private sector, the academia, and, sometimes, the civil society - which represent the four eliches managing knowledge assets in novel urban ecosystems (Selada, 2017). Instead, KM processes refers to the multiple processes to set and implement for managing knowledge in the development of smart cities – e.g. creation, validation, presentation, distribution, and application of knowledge - each of which involves different actors and KM capabilities (Bhatt, 2001; Bresciani et al., 2017). Furthermore, recalling the link between open innovation and KM literatures (Chesbrough, 2003; Natalicchio et al., 2017), we recognize that the knowledge needed for the development and prosecution of smart city projects can reside in different domains, i.e. within or beyond projects' boundaries (Paskaleva, 2011; Pancholi et al., 2015). Thus, the mechanisms to manage the two main KM issues may differ depending on the origin of knowledge, hence highlighting how modern urban planning is a complex task requiring appropriate managerial and KM actions.

Nevertheless, previous studies have mainly focused on the solutions that target the efficiency and technological advancement of a city's hard infrastructure systems rather than delving into the managerial dynamics and KM problems underlying the development of smart city projects. Thereby, a number of questions related to the smart city development from a managerial and KM perspective have remained unanswered. These include inquiries on how to manage the linkage between KM and the smart city strategy, how each actor is involved in the KBUD approach, and how actors interact and share knowledge (e.g. Nam and Pardo, 2011; Paskaleva, 2011). In detail, so far, among the few studies examining network relationships and KM activities in smart city projects (Yigitcanlar, 2009; Yigitcanlar, 2010; Yigitcanlar and Dur, 2013), in-depth analyses on the contributions universities may provide have often been neglected. Except for Grimaldi and Fernandez (2016), most of the attention has been directed towards the strategies and policies set by governments to build smarter cities and their relationships with the private sector and the civil society (e.g. Deakin and Al Waer, 2011; Scuotto et al., 2016). Likewise, while the roles played by governments, firms, and the civil society have mostly been defined (e.g. Yigitcanlar, O'Connor, et al., 2008; Bakici et al., 2013), no specific indication can be identified about universities. These gaps turn particularly relevant if we consider that, first, the literature on innovation ecosystems have widely contended that universities are pivotal entities responsible for the competitiveness and superiority of knowledge-based innovation systems where multiple actors are asked to cooperate, like smart city projects (Etzkowitz and Leydesdorff, 1997; Miller et al., 2016). Second, the presence of universities in the development of almost all successful knowledge-based smart city projects (e.g. Barcelona, Amsterdam, and Tokyo) has been underlined (Winden et al., 2007; Yigitcanlar and Velibeyoglu, 2008; Yigitcanlar, Velibeyoglu, et al., 2008; Letaifa, 2015). In line with this reasoning, we aim to analyse the design and implementation of smart city projects by conducting an exploratory research that answerers the following research question: how do universities affect the KM mechanisms underlying multi-partner, smart city projects?

By combining arguments related to the two KM issues (KM governance and KM processes) and the two knowledge domains (within and beyond a project's boundaries), we come up with a 2x2 matrix highlighting four situations under which a smart city projects can be analysed from a KM perspective, and we study the role played by universities in each situation to identify their specific contributions to a smart city's ecosystem. To this aim, a multiple case study methodology is adopted. Specifically, 20 smart city projects established in different countries and fulfilling five inclusion criteria have been analysed.

Results of our analyses let us propose that universities can play different roles in a smart city's ecosystem respect to KM governance and processes in different KM domains. First, in dealing with the KM governance issue when internal knowledge is managed, universities usually act as knowledge intermediaries, in that they reduce the knowledge distance between public and private partners. Second, they act as knowledge gatekeepers when governance relationships involve external knowledge by connecting and facilitating knowledge pooling and sharing among actors within and beyond a given smart city project. Third, universities directly provide new scientific and technological transdisciplinary knowledge, hence acting as knowledge providers in the process of knowledge creation within the boundaries of smart city projects. Fourth, they have an important role in evaluating knowledge outside projects' boundaries, thus affecting the scanning of the external environment, with the aim of better transferring, applying and exploiting external knowledge.

Overall, this paper discusses the non-technological side of smart city projects, especially analyzing the KM roles played by universities. Thus, we advance the literature on smart cities by providing further insights into the (underdeveloped) area examining smart city projects from a managerial point of view. In turn, we also contribute to the literature on the interplay between KM and open innovation activities since we recognize classical and new tasks universities pursue in a given smart city project that emerge only if the origins of knowledge are taken into account.

The reminder of the paper is structured as follows. Next section presents the theoretical background and the conceptual model used to conduct this study. Section 3 explains the methodology adopted.

Section 4 offers evidence coming from the analyzed smart city projects. Finally, Section 5 outlines main findings, implications, and future research directions.

2. Theoretical background

2.1. The KBUD approach of smart city projects

Over time, the rationale underlying the development of smart city projects has changed in terms of priorities and perspectives. Originally, urban planners have mostly been concerned with the structural organization of cities, as identified in the effective and sustainable planning of land uses, urbanization areas, physical infrastructures, and business districts (Anthopoulos and Vakali, 2012; Cocchia, 2014). Afterward, due to the growing number of people living in urban agglomerations (UN, 2015) and the subsequent need to face more demanding challenges related to energy use, transportation, social inclusion, service provision, etc. (e.g. Caragliu et al., 2011), urban planning has become an extremely complex task requiring multidimensional urban information and strategies that integrate all potential challenges in a well-articulated systemic vision (Wang et al., 2007; Capdevila et al., 2015). As a result, urban planners have started to engage in top-down smart city projects based on infrastructure-oriented strategies, whereby the technological endowment (especially recognized in information and communication technologies) is considered the main driver to shape the future of smart cities (Angelidou, 2014). This rationale finds its roots in the belief that the smartness of cities can be attained by investing in hard infrastructures that make city subsystems highly interconnected and will allow the optimization of actions devoted to better coordinating the issues raised by the rapid urbanization. A relevant example is the extensive adoption of IBM and Cisco technologies in Rio de Janeiro, Dubai, Shenyang (China), and Incheon (South Korea), considered as the primary mean to direct the improvement of environmental and transport systems of those cities (Juan et al., 2011; Angelidou, 2014).

However, the most recent view on smart city development has recognized that the level of technology adoption in urban contexts is no more able to reflect the real smartness of cities (Angelidou, 2015). Nowadays, with the emergence of the knowledge economy, more knowledge-intensive than labor-intensive activities take place in urban areas, which ask smart city planners to develop cities that take advantage of local knowledge and intellectual capital of the population, promote new businesses, and facilitate access to information both locally and internationally (Hollands, 2008; Bakici et al., 2013). Thus, technology no longer represents an end but becomes a component of smart cities. Accordingly, following the EU and OECD KM frameworks for local development, modern urban planning has shifted towards a KBUD approach because of the vital role of knowledge in enabling cities to achieve all main dimensions that may characterize them as smart (e.g. smart economy, smart environment, smart people, and smart living) (Yigitcanlar, O'Connor, et al., 2008; Bakici et al., 2013).

2.2. KM issues in Smart city projects

According to the KUBD approach, smart cities must integrate knowledge about technology, people, and business before actions to create smart economy, smart environment, smart people, and smart living initiatives can be formulated and implemented (e.g. Anttiroiko et al., 2014). Such integration efforts require smart city projects to be composed of public and private players, the academia, and the wider community (de Jong et al., 2013). Notably, this increases the pool of available knowledge and the possibility to address the development of smart city initiatives from multiple, albeit complementary perspectives (Letaifa, 2015). On the other hand, "governmental bodies, universities and firms understand each other only when the social and intellectual soil connecting them is fertile for knowledge flows" (Lombardi et al., 2012:63). But, this is not the common condition in smart city projects since project partners are often driven by conflicting interests and views towards the evolution of an urban area (Angelidou, 2014; Capdevila et al., 2015). Plus, strategic planning and (KM) governance for smart city development have largely remained abstract ideas, hence leading to the "lack of efficient and effective KBUD planning, implementation and management processes"

(Yigitcanlar and Dur, 2013; Yigitcanlar, 2014:5550). As a consequence, it is called for a stronger governance capacity to cope with the complex set of dynamics and conflicts among the various project partners, especially to enable effective cross-organizational knowledge integration and sharing (Yigitcanlar, O'Connor, et al., 2008; Deakin, 2014). In this discourse, Scuotto et al. (2016) revealed that IBM managers consider universities as important in the KM governance of smart city formation, especially to reconcile public-private conflicts. Nevertheless, how universities fully contribute to the KM governance of smart city projects has remained an open line of inquiry.

To realize the smart city development purpose of KBUD, partners of smart city projects should also have a functional understanding of the diverse existing KM processes (i.e. creation, validation, presentation, distribution, and application) (e.g. Bhatt, 2001). Knowledge, in fact, is not a static resource; it entails a continuous, dynamic management of processes of creating, integrating, and applying knowledge out of knowledge (Del Giudice et al., 2017). These processes have different ultimate objectives and are primarily managed by different organizations/actors, which may change over time according to the specificity of related goals (Etzkowitz and Leydesdorff, 1997; Carayannis, 1998). This is also true in the context of smart city projects (Leydesdorff and Deakin, 2011; Selada, 2017). Accordingly, novel knowledge and solutions to address a city's specific needs must be created before initiating a smart city project. Such knowledge creation process may involve all project partners or a subset of them, and these may, or may not engage in knowledge recombination activities during this process. Afterward, the created knowledge requires being presented and shared among the project partners, with the aim of validating the effectiveness of created knowledge for the project goals. Finally, knowledge must be applied to proceed with the development of the smart city project. That is, KM processes help to sustain the development of smart city projects at different points of time and ways (Yigitcanlar, 2009). However, so far, in-depth and systematic analysis of these processes has marginally been presented in some cases studies (Yigitcanlar and Velibeyoglu, 2008; Bakici et al., 2013; Yigitcanlar and Bulu, 2015). Particularly, scant attention has been placed on the actors involved and their contribution to each process, with particular regard to the academic sector.

Indeed, the academia has only been viewed as the creator of scientific knowledge, although it is more and more known that universities may play a crucial role in the validation, transfer and application of knowledge (Leydesdorff and Deakin, 2011; Grimaldi and Fernandez, 2016).

2.3. Knowledge domains in smart city projects

Just like any organization or innovative ecosystem (Campanella et al., 2017), smart city projects include knowledge that resides within and beyond their boundaries. In other words, according to the open innovation paradigm (Chesbrough, 2003; Natalicchio et al., 2017), the development of smart cities can be driven by combining knowledge generated and owned by projects partners with knowledge that originates elsewhere (Paskaleva, 2011; Pancholi et al., 2015). In fact, on the one side, smart cities necessitate that governments and citizens provide the local knowledge to shape cities with respect to local resources, priorities, values, and needs (Angelidou, 2014). Likewise, firms and universities working on smart city projects are asked to contribute with their technical and scientific know-how to the development of smart cities (Leydesdorff and Deakin, 2011; Scuotto et al., 2016). On the other side, the acquisition of best practices from other successful smart city projects may be also beneficial (Wiig, 2016). For instance, the Guangdong province encouraged the cooperation among three smart city projects, namely Tianjin Eco-City, Suzhou Industrial Park, and Guangzhou Knowledge City (de Jong et al., 2013). Moreover, other actions to complement the internal knowledge base of project partners are needed, such as the attraction and retention of skilled human capital (e.g. scientists), the establishment of living labs to involve more citizens, companies, and/or associations, and the adoption of social media and crowdsourcing platforms to acquire new ideas (Zygiaris, 2013; Lee et al., 2014; Pancholi et al., 2015; Voytenko et al., 2016). Of course, managing external knowledge comes with the need to modify or establish novel KM processes that can favor the acquisition, internalization, and retention of knowledge (Natalicchio et al., 2017). Additionally, the KM capabilities asked to project partners may change (e.g. the absorptive capacity) (Cohen and Levinthal, 1990), as well as the acquisition, internalization and retention of external knowledge may

pose further complexities in the project governance. That is, project partners not only have to mitigate and reconcile internal conflicts but also relationships with external actors must be managed.

According to the foregoing discussion, as the knowledge domain changes, we can argue that each KM issue may reflect a different situation that project partners have to cope with. Accordingly, project partners may address KM governance matters in different ways depending on the origin of knowledge; similarly, KM processes change according to the domain of knowledge adopted. This discussion leads us to suggest four different situations under which a smart city can be analyzed from a KM perspective. We represent these situations in a 2x2 matrix that is used as the conceptual model to investigate the role of universities (Fig. 1). Specifically, quadrant I aims to capture KM governance when knowledge of project partners is used; quadrant II aims to capture KM governance when external knowledge is used; quadrant III aims to capture KM processes when knowledge of project partners is used; quadrant IV aims to capture KM processes when external knowledge is used.

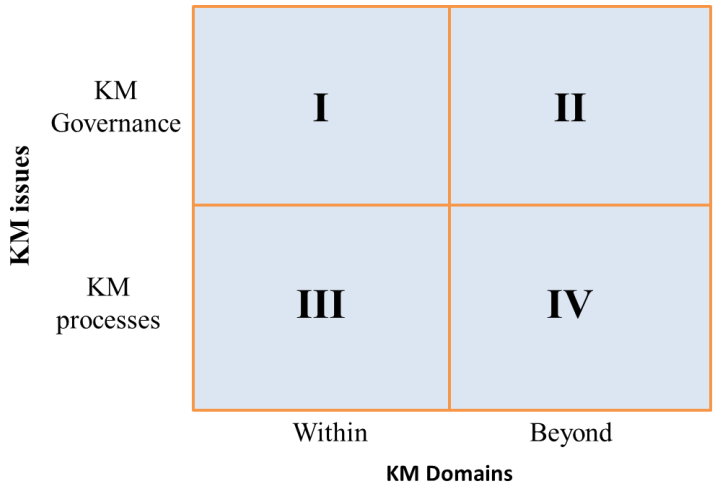

Fig. 1. Conceptual model.

3. Methodology

Due to the lack of adequate empirical evidence on the contributions of universities to smart city projects from a managerial and KM perspective, we carried out an inductive study to address this topic (Eisenhardt, 1989). In this sense, the exploratory case study is considered as an appropriate

research strategy to capture the phenomenon under investigation within its complex context by relying on several sources of evidence (Yin, 2013). Indeed, Eisenhardt (1989) argued that an exploratory case study is a useful approach that exploits different qualitative data collection methods, such as archives, interviews, questionnaires, and observations, with the aim of understanding how organizational dynamics or social processes work (see also Verona and Ravasi, 2003). Specifically, we adopted a multiple case research design because this kind of methodology allows us to retain the complexities and contextual contingencies characterizing KM mechanisms in multi-partner projects, like smart city projects, and use a replication logic to derive new theories (Yin, 2013; D'Ippolito et al., 2014). Moreover, we considered this exploratory methodology an appropriate approach to our goals given the limited existing research on the KM roles of universities in intra- and inter-project contexts simultaneously.

Despite most of the previous studies on smart city adopted the city's or regional's ecosystem as the unit of analysis (e.g. Leydesdorff and Deakin, 2011), we decided to carry out our research from the perspective of the specific smart city project (e.g. Bresciani et al., 2017; Ferraris et al., 2017). The "project", as the unit of analysis, is particularly helpful and was chosen for three main reasons. First, this allows us to comprehend the interaction of universities among different and heterogeneous partners that cooperate within the project (Ferraris et al., 2017). Second, the role of a single actor is better captured if we acknowledge that its role may change within each project since projects differ in terms of partnering team size, budget, breadth and depth. This choice found also confirmation if we look at the established literature on multi-partner R&D projects (e.g. Mishra et al., 2015). Third, through multiple investigators, we improve the creative potential of the study because different team members often have complementary insights and different perspectives that can enrich the data analysis process (Eisenhardt, 1989).

With this choice, we thus seek to propose a novel and fresh perspective on KM at the (smart city) project level by investigating the practical mechanisms underlying multi-partner KM practices.

3.1. Data collection and analysis

Consistent with the case selection procedure proposed by Eisenhardt (1989), we selected our case for theoretical reasons (Wacker, 1998; Messeni Petruzzelli and Savino, 2014) in order to provide a clear picture on the roles of universities in smart city projects. Following previous studies, we selected smart city projects on the basis of five main criteria (Trencher et al., 2014; Bresciani et al., 2017): a) at least one University must be involved in the project; b) both the private sector and the government must be involved; c) a big MNE should be involved; d) the project must have the objective of leading to a socio-technical and sustainable transformation of a specific urban/city location; e) the urban/city transformation must involve knowledge-intensive activities. The sample is constituted of 20 smart city projects. The analysed smart city projects took place in different countries (Italy - 10, UK - 3, USA - 3, Spain – 3, Belgium – 1), hence allowing us to account for differences in national and managerial cultures.

Primary data were gathered through forty semi-structured interviews of different members involved in the projects and belonging to different types of project partners (20 – Smart City managers, 7 – Professors, 6 – CEOs of SMEs, 4 – Top Managers within Universities, 3 – Municipalities). The choice of the different respondents was set to fully analyze the direct and indirect effects of developing smart city projects in multi-stakeholder environments (Bresciani et al., 2017). Moreover, in line with prior studies on the topic (Ferraris et al., 2017b; Sandulli et al., 2017), we decided to interview the Smart City Manager (SCM) of each project. Indeed, SCMs are the people with the responsibility to coordinate smart city projects with external partners, be in strict contact with all project partners, and make decisions with respect to the specific smart city project. Our aim was to have more respondents for each project in order to scrutinize more and diverse information and perspectives in relation to our research question. On average two respondents for each project have been interviewed in order to mitigate threats of bias that might have come up if only one respondent was used to assess each project (Tiwana, 2008). However, in some cases, our analysis is limited to only one respondent due to difficulties in achieving other key members of the project. We decided to keep these projects into

our analysis because the SMC, which is the key respondent within a smart city project, has always been interviewed.

The interview protocol included general questions about the projects, such as the project objectives, the city in which it took place, the partners involved, to what extent they are involved, and the governance of the project (see Table 1). Moreover, the protocol included more specific questions about what and how KM practices and processes were deployed by universities in each project, within and beyond its boundaries. The authors recorded and transcribed all the interviews, which lasted from 60 to 120 minutes. The authors independently analyzed and transcribed interviews by using a lengthy and iterative process to explore similarities among the smart city projects. Only in a second stage the authors discuss and resolve conflicting patterns among each other so as to detect common traits regarding the role of universities in smart city projects. Interviews were our primary source of data. Yet, we also complemented them by using additional data, when possible. Notably, triangulation of multiple data sources is a primary strategy that can be used to improve the reliability of a case study methodology (D'Ippolito et al., 2014). Multiple data collection, in fact, allows providing stronger substantiation of propositions that are helpful for theory building (Eisenhardt, 1989). Moreover, as suggested by Yin (2013), multiple sources of evidence can facilitate the development of converging lines of inquiry. Thus, secondary sourced documents (e.g. smart city projects' websites and reports) were retrieved and content analyzed. Taken together, primary and secondary sources of data provided a richer context to understand KM roles of universities in smart city projects. Table 1 shows general information on the projects.

Table 1
Description of smart city projects and universities roles.

Smart City project	City	Actors involved	Interviews	University roles
ICT platform for assistance to elder people	Turin (IT)	Several SMEs; Local Government; University; Local Community	Smart City Manager; Top Manager of University; CEO of SME	Knowledge intermediary Knowledge provider Knowledge evaluator

ICT technologies for the monitoring of civil city buildings	Genoa (IT)	Several SMEs; Local Government; University; Local Community	Smart City Manager; Municipality	Knowledge intermediary Knowledge provider
Intelligent Connected Buildings	Turin (IT)	Big MNE, several SMEs; Local City Government; 2 Universities; Local Community	Smart City Manager; Top Manager of University; CEO of SME	Knowledge gatekeeper Knowledge provider
Intelligent Connected Buildings	Milan (IT)	Big MNE, several SMEs; Local City Government; 2 Universities; Local Community	Smart City Manager; CEO of SME	Knowledge gatekeeper
ICT platform to scan and manage information of the territory through sensors	Turin (IT)	2 SMEs; International Consortium; Research Center; Local Government; University; Local Community	Smart City Manager; Professor; Municipality	Knowledge provider Knowledge evaluator
Big data analytics on mobile service usage	Trento (IT)	Big MNE; 2 SMEs; Local and international research centers; Local Government; University; Local Community	Smart City Manager; Top Manager of University, Professor	Knowledge intermediary Knowledge gatekeeper Knowledge provider
Home and buildings automation	Trento (IT)	Big MNE; Consortium of several universities and research centers; Local government; 3 SMEs; Local Community	Smart City Manager; Top Manager of University	Knowledge intermediary Knowledge gatekeeper
Smart transportation system for subway	Milan (IT)	2 big MNEs; Local Government; 2 Universities; Local Community	Smart City Manager; Professor	Knowledge evaluator
Smart grids	Genoa (IT)	Big MNE; Local Government; University; Local Community	Smart City Manager; Professor	Knowledge intermediary
Intelligent energy management	Genoa (IT)	Big MNE; Local Government; University; Local Community	Smart City Manager; Professor	Knowledge intermediary
Intelligent energy management	Manchester (UK)	Big MNE; several SMEs; Local Government; University; Local Community	Smart City Manager; CEO of SME	Knowledge provider
Smart transportation system	London (UK)	Big MNE; Local Government; University	Smart City Manager	Knowledge provider
Smart transportation system	Birmingham (UK)	Big MNE; City Council; Research Centre, University	Smart City Manager; Professor	Knowledge evaluator
Violation, notification and adjudication business process and system support	Chicago (USA)	Big MNE; Local Government; several SMEs; University	Smart City Manager	Knowledge gatekeeper Knowledge evaluator

Intelligence dashboard pilot Asset management pilot for street light operations	Boston (USA)	Big MNE; Local Government; University	Smart City Manager	Knowledge gatekeeper Knowledge evaluator
Buildings efficiency	Boston (USA)	Big MNE; Local Government; University; Research Center; SME	Smart City Manager	Knowledge gatekeeper Knowledge provider Knowledge evaluator
Intelligent operations applied to park and beach management	Barcelona (ES)	Big MNE; several SMEs; Local Government; University; Local Community	Smart City Manager; CEO of SME; Municipality	Knowledge provider Knowledge evaluator
Integrated Smart City government platform	La Coruna (ES)	Big MNE; several SMEs; Local Government; University	Smart City Manager; CEO of SME	Knowledge intermediary
Electrical and thermal energy control system	Mons (BE)	Big MNE; Local Government; University; Research Center; SMEs; Local Community	Smart City Manager	Knowledge intermediary Knowledge gatekeeper
Big data analytics on tourism data	Madrid (ES)	Big MNE; Local Government; University	Smart City Manager; Professor	Knowledge evaluator

4. Findings

4.1. KM governance when managing internal knowledge

Universities involved in the analysed smart city projects have a crucial function in reducing the knowledge distance among different project partners, but mainly between the government and the private sector. In this sense, with the regard to the inclusion of universities in the decision-making processes involving the public and private sector, one of our respondents affirmed that "this facilitates the very often problematic collaboration between public and private partners in hybrid multi-partner projects, aligning diverse objectives and reducing cooperation failures". In particular, universities are pivotal in enabling effective cross-organizational knowledge integration and sharing. Accordingly, some key members of universities contribute to the project governance thanks to their expertise and non-adherence/independencies to the firms and to the public government, assuring a more efficient and effective knowledge governance during the planning, implementation and management processes. This makes universities a suited actor that intermediates among the two key smart city stakeholders by reducing cooperation problems and validating the effectiveness of created knowledge

for the project goals. From our interviews, this role has been highlighted as particularly relevant because universities may solve, at least, two main governance problems: a) firms are often reluctant to share knowledge, especially if they perceive the risk to lose control over their knowledge; b) public governments usually do not have the necessary the knowledge base and absorptive capacity to deal with and understand innovative ideas of the public sector. Indeed, on the one hand, universities do not compete against firms; rather, they may be an important source of complementary knowledge and can help firms and public entities to explore and apply relevant opportunities into smart city projects. On the other hand, universities possess the knowledge base to assess firms' knowledge and help the public sector to further understand and evaluate that knowledge, hence reducing the gap posed by the low technological knowledge and skills of public staff. In line with this reasoning, we may contend that:

Proposition 1: Universities act as knowledge intermediaries within smart city projects, especially facilitating the management of knowledge assets between public and private project partners.

4.2. KM governance when managing external knowledge

Our interviews highlighted a very important task related to KM governance that universities perform when knowledge originating beyond projects' boundaries is managed. That is, universities have an important role in connecting ecosystem partners of different smart city projects and other external actors (also from others city ecosystems), thus allowing for an effective sharing and retention of external knowledge within a given smart city project.

Notably, through their established links and relationships with public, private, and research organizations, universities more easily connect project partners with external actors and limit the complexities going along with the formation of inter-organizational, multidisciplinary networks (e.g. reconciling objectives and matching external knowledge with internal problems to solve). Also, universities, as the central actor of such networks, more likely reduce knowledge distance between

project partners and organizations beyond projects' boundaries, which may, otherwise, hinder the codification of knowledge and its transmission within and across the project. Furthermore, besides the connection to third-party organizations, many universities provide project partners with access to local and societal knowledge through the involvement and empowerment of the large local communities (e.g. citizens, students, influence groups), whose knowledge resides within the city's ecosystem but beyond the boundaries of the projects. Through their institutional role and their relationships both in the public and private sphere, universities may ease the involvement of citizens in different phases of the project, providing vital societal knowledge for smart city projects. For instance, universities can promote events in which citizens provide new knowledge through bottom-up innovation processes, helpful to find out new prompts and proposals for social problems characterizing a given smart city initiative. These events include the creation of "context of ideas" for students (the citizens of today and tomorrow), with the aim of proposing new smart city solutions to the city's problems, and the organization of conferences focused on smart cities. Moreover, universities can more easily involve citizens in the knowledge-based urban ecosystem of smart cities through living labs, where multiple types of actors have the possibility to interact and share ideas and information. The foregoing discussion highlights universities as organizations that connect a network of organizations/people, both within and beyond projects' boundaries, that may not interact effectively one with another directly, hence recalling the role knowledge gatekeepers perform in innovation networks (Haas, 2015; Rychen and Zimmermann, 2008). We thus contend that:

Proposition 2: Universities act as knowledge gatekeepers, hence enabling the management of knowledge assets between project partners and external actors.

4.3. KM processes when managing internal knowledge

Universities in our research importantly contribute to the project through transdisciplinary scientific and (cutting-edge) knowledge, especially during the process of knowledge creation. Our findings

reveal that their classical role as knowledge providers is also present in smart city projects. In particular, according to most of our respondents, mainly Polytechnics and IT departments of universities have been strongly included in smart city projects as technical and scientific knowledge creators. This was particularly evident when the projects were initiated by public initiatives because the public body does not usually possess specific knowledge of cutting-edge technologies that are at the core of innovative smart city solutions. Relatedly, universities are pivotal when the funding of the projects is in charge of the public sector (local, national or supranational). Indeed, many projects include universities because they provide relevant knowledge and ideas that can attain national and supranational funds, which are of foremost importance to attract the main financial sources for the generation of knowledge for highly innovative and risky smart city projects. However, also in the opposite case, when funding and smart city initiatives start from the firms, universities are asked to provide new complementary and transdisciplinary knowledge to boost the development of the knowledge-base that will sustain smart city projects. This leads the project leaders to more effective knowledge recombination activities during the process of knowledge creation as well as to the implementation of smart city solutions based on innovative scientific principles. Therefore, we propose that:

Proposition 3: Universities act as providers of internal knowledge during the knowledge creation process, especially favoring the development of knowledge forged in more basic and innovative research activities.

4.4. KM processes when managing external knowledge

Due to their high level of research activity and knowledge interactions with diverse actors, universities usually develop a high level of absorptive capacity. Thus, they can better evaluate external knowledge than others. This role is crucial across boundaries in smart city projects since evaluating which external knowledge better suits the objective of a given project is important for its

effective development and completion. In turn, two main KM processes are influenced by the capability of universities to improve the knowledge validation process when external knowledge is managed, namely knowledge transfer and knowledge exploitation.

Concerning the first process, universities can better enable the transfer knowledge from outside the project thanks to their higher capabilities to evaluate external knowledge, which local actors may not be aware of. Indeed, universities are able to scan and search for best smart city practices and solutions in many different other contexts or countries. This lies in the fact that they are directly involved in smart city projects, possess a high level of absorptive capacity that also positively affect the access to knowledge of local needs and social problems, and have wide networking capabilities thanks to their institutional and personal networks. Furthermore, universities can involve the citizens in smart city projects by asking them to test the validity and the effectiveness of the transferred smart solutions in different stages of the development of a new smart services. Eventually, this provides more reliable knowledge to smart city projects in different steps and help in overcoming some obstacles and critical stages in which they usually stop.

Regarding the second process, the connections outside the city are important not only to complement knowledge within the project but also in the case of knowledge exploitation, increasing the scale and the impact of smart innovations. On the one hand, through their institutional and social relationships, universities can promote the benefits of the new smart technology by influencing the citizens' adoption, as they are the main users of many new smart city solutions, and the projects benefit a lot from a wide-scale adoption. On the other hand, the exploitation process also benefits when new technologies that have been successfully tested and developed within a city area need to be applied to other city contexts in order to be scaled up and generate higher social and economic benefits. Universities' networks, in fact, have been deemed to be used to evaluate external contexts in which knowledge can be better exploited and to provide the necessary connections to implement this faster through the access to the main knowledge partners in other cities. Overall, due to their ability in recognizing and evaluating key knowledge for the projects in which they are directly involved,

universities are especially beneficial in the processes of knowledge validation, transfer, and application, carefully selecting suitable knowledge for each project.

Proposition 4: Universities act as knowledge evaluators between organizations within and beyond smart city projects' boundaries, also enabling effective knowledge transfer and exploitation.

5. Discussion, implications, and future research directions

Developing smart cities is the main goal of current urban development efforts. Thereby, a number of studies have delved into the dynamics favoring the effective completion of smart city projects (Scuotto et al., 2016; Bresciani et al., 2017). Although, in the past, the implementation of information and communication technologies has been the primary concern of such projects (Bulu, 2014), more recent urban planning theories attempt to boost urban development based on a KM perspective, according to the KBUD approach (Yigitcanlar and Velibeyoglu, 2008). However, this poses new managerial challenges in smart city projects, and the extant research falls short of a clear understanding of efficient and effective KBUD management procedures (Yigitcanlar and Dur, 2013; Yigitcanlar, 2014). In detail, this calls for more careful attention in untangling the complexity of KM governance and processes issues of smart city projects, especially resulting from the adoption of knowledge originating both within and beyond projects' boundaries. In response, we conducted a qualitative study that provides new and fresh viewpoints of the roles of universities in the development of knowledge-based smart city projects.

Our findings propose significant new insights, useful to rethink the role of universities but, at the same time, confirm some of their more established roles. Specifically, our theoretical discussion moves the focus of prior research toward an original perspective that captures the complexity of KM mechanisms in smart city projects by highlighting four situations under which these projects may be analysed from a KM perspective. On the basis of our analysis, for each situation, we identified the main role of universities in the attempt to elucidate their contribution to smart city ecosystems from

a KM perspective. That is, universities may be considered as: 1) knowledge intermediaries in dealing with the KM governance issue when internal knowledge is managed; 2) knowledge gatekeepers when governance issues also require the management of external knowledge; 3) knowledge providers in the process of knowledge creation when internal knowledge is managed; 4) knowledge evaluators, with the aim of better transferring and applying external knowledge. Fig. 2 summarizes our findings. Table 1 also reports the roles played by universities in each of the analyzed smart city projects.

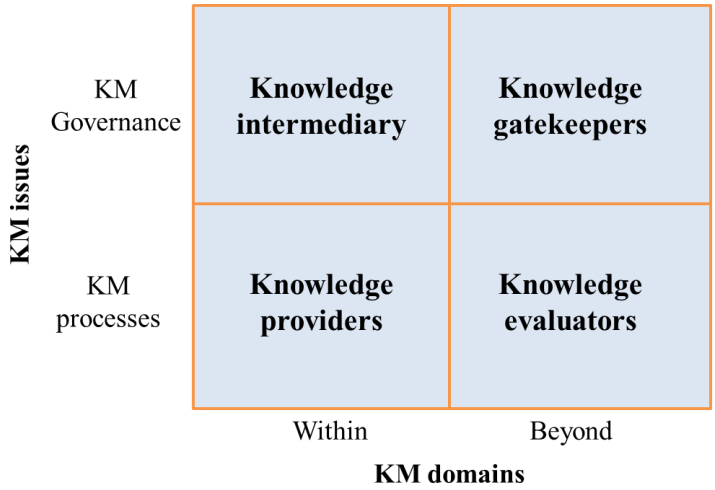

Fig. 2. Summary of findings.

Overall, we have found that some tasks (e.g., providing scientific knowledge and attempting to reconcile public and private project partners) universities perform are similar to those highlighted in previous models (e.g., Kaba and Ramaiah, 2017; Romano et al., 2014) but are adapted to the peculiarities of smart city knowledge-based ecosystems. Conversely, other traditional roles could not be identified, e.g. the active "director" role in research projects; in fact, no university in the analyzed smart city projects have a leadership position. This does not imply a less relevant role of universities because, in the specific context of smart city projects, other novel roles emerge and are needed to effectively address the KM issues in the development of smart cities. The most original and relevant ones are recognized when external knowledge is managed. In fact, this study highlights that

universities are critical in managing knowledge assets across a city's stakeholders and across different city's ecosystems by acting as knowledge gatekeepers and evaluators.

Our findings have theoretical and practical implications. While much has been said on the technologies and hard infrastructures needed to develop smart cities, there is a pressing demand for sounder conceptual perspectives to understand and examine smart city initiatives from a managerial point of view (Hollands, 2008; Angelidou, 2015; Dameri and Ricciardi, 2015). Indeed, there is a significant gap because smart city is still a relatively new concept in the management field. Therefore, this research addresses this gap and contribute to the literature on smart cities by embracing a KM perspective to study the managerial influences of universities in smart city projects. Relatedly, this study offers evidence of new and original tasks related to the management of knowledge not only within the boundary of smart city projects but also across different actors and projects. Thus, we may also add to the literature stream discussing the interplay between KM and open innovation activities in the specific context of smart city projects. In fact, this research lies at the intersection of three main topics, namely KM, open innovation, and smart cities. With this regard, we highlight that universities are particularly relevant for inbound open innovation processes in smart cities, in that they act as a central actor in the evaluation, transfer, and application of external knowledge.

From a practical point of view, this study also proposes some implications to leading partners of smart city projects. It suggests that universities can be at the core of the building of smart city ecosystems and can be active in developing and maintaining key relationships within and across a city's ecosystem. This means that universities may take a leading role in building external relationships in smart city initiatives. This sensibly requires a change in the mindset of the top management of smart city projects, and more efforts are needed in involving academics in these projects. This, in turn, has direct and indirect effects on the development of a city's ecosystem, stimulating new entrepreneurial opportunities to firms and helping public governments in the implementation and delivery of new smart services (Del Giudice et al., 2013).

Of course, this study presents some limitations that may open the doors to further interesting lines of inquiry. First, additional projects may be explored, and these projects may include more respondents for a further refinement of our findings. Second, the external validity of the findings deserves particular attention. They should be tested and refined with empirical considerations or, at least complemented with quantitative data. For instance, simulation models based on the theory of complexity (Mol, 2002) may be set to further study the intertwined relationship of the four main project actors in managing knowledge assets. Third, the types of knowledge exchanged between partners (e.g. tacit vs. codified, local vs. international, nascent vs. mature) have scantly been analyzed. Yet, differences in knowledge characteristics are important to better understand how KM practices are managed and influence the relationships among actors. Therefore, future studies may place more attention to this matter.

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