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An emergent taxonomy of boundary spanning in the smart city context – The case of smart Dublin

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ABSTRACT

Smart cities emphasize the use of advanced technology to deliver better services to and improve the well-being of their residents. Since the administrative authorities that manage cities often lack the knowledge and skills needed to transform their operations in this way, smart city initiatives usually involve a complex set of actors, from local urban authorities and their technical departments to small and large IT firms, academics, and civic organizations, as well as individual citizens. Mediating organizations are often set up to coordinate and manage such interactions. However, little is known about the roles and activities of such bodies. Using data from the Dublin smart city projects, this study draws on the concept of boundary spanning to develop a taxonomy of the work of such intermediaries. Divided into technical, political, social, and cultural domains, the study demonstrates the critical role of the work done by such bodies in enhancing collaboration among and the participation of a diverse group of citizens, IT and digital strategy departments of local authorities, universities and local/international IT companies (e.g., Google, Facebook or Airbnb), leading to a bottom-up governance style of leading smart city initiatives and projects.

1. Introduction

A relatively extensive literature has focused on the leading role played by both global IT firms (such as IBM, General Electric, Siemens, and Cisco) and governments in developing and deploying specific smart city technologies and initiatives in existing and new cities (Anthopoulos et al., 2016; Hollands, 2008; McNeill, 2015; Söderström et al., 2014; Paroutis et al., 2014; Yigitcanlar et al., 2018): for example, IBM's policy consultation role in Philadelphia, USA, and Rio de Janeiro, Brazil, and the role of the national and local governments in Songdo, Republic of Korea (Shwayri, 2013; Wiig, 2016). Their roles have received two important critiques. First, global IT companies are granted extraordinary power and freedom to exploit city assets to produce marketable technologies (Kummitha and Crutzen, 2017). This means that a majority of systems and data gathering tools have surveillance issues and suffer from lack of transparency and privacy (Angelidou, 2014; Townsend, 2013). Second, city governments' efforts reflect a restricted view of the social, technological, cultural, and political potential of their cities to accommodate technological innovations, so as to promote a coherent and integrated response to urban problems (Coletta et al., 2019; Yigitcanlar et al., 2018).

As smart city initiatives mature from a bottom-up governance perspective, city governments, instead of being the primary driver of these projects, need to coordinate the actions of a broad range of citizens and communities as well as national and/or international IT, corporate, governmental, and academic actors (Kitchin, 2015; Lin, 2018; Lin and Geertman, 2015). But despite abundant efforts, collaboration is problematic to shape through the innovation process and, in the face of

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increasing complexity, is often abandoned (Mills et al., 2021; Zuzul, 2019). This complexity is due to many factors (Carvalho, 2015; Carvalho and Campos, 2013). Firstly, from the perspective of municipal governance, a key issue is the tendency of local authorities (LAs) to have siloed internal structures and functions, which can be detrimental to the joint coordination of project initiatives within and between governmental entities (Emerson et al., 2012; Broccardo et al., 2019). This lack of cross-functional and cross-organizational integration is especially pertinent in the case of the IT departments of local authorities (Höjer and Wangel, 2015; Maccani et al., 2020; Townsend, 2013). Secondly, even after relationships have been built, ethical, legal, and regulatory issues may conspire to impede the flow of a project (Coletta et al., 2019; Van Geenhuizen, 2016). Moreover, collaborative activities are often compromised by conflicts resulting from differential knowledge, divergent interests and motivations, and asymmetries in power relations (Guldemond and Van Geenhuizen, 2012; Ranga and Etzkowitz, 2013; Zuzul, 2019). Thirdly, most smart cities are governed "entrepreneurially", whereby citizens are positioned as passive consumers, meaning that their potential as co-designers and co-producers of smart products and services is not fulfilled (Bjögvinsson et al., 2012; Cardullo and Kitchin, 2019; Le Dantec and DiSalvo, 2013; Perng, 2017).

In response to these issues, some cities have begun to experiment with mediating governance structures which effectively act as "boundary-spanning" organizations. Examples of such organizations are Barcelona Urban Lab in Barcelona, Spain; Laboratorio para la Ciudad in Mexico City, Mexico; Smart Dubai in Dubai, UAE, and Seoul Institute in Seoul, Republic of Korea (Acuto et al., 2019; Anthopoulos, 2017; Mills et al., 2021). These mediating structures create information and innovation ecosystems among all actors and citizens, and aim at deploying smart project prototypes, adapting smart technologies to unique local needs, and standardizing and spreading cross-fertilized innovations (Acuto et al., 2019; Ferraris et al., 2019; Townsend, 2013). However, the role that these organizations play in the cities where they informally govern city projects and infrastructures, especially through a citizen-centric approach, has been overlooked. Despite the increased use of such organizations (Coletta et al., 2019), the smart city literature has yet to provide any detailed empirical accounts of the strategies, processes, and behaviors used by mediating organizations to create collaborative ecosystems. Drawing on the boundary-spanning perspective, this study asks: *How can a top-down governance approach transform to a bottom-up approach through activities a mediating organization carries out?* The research question is investigated through a case study of Smart Dublin created by the city of Dublin in Ireland to develop multi-actor collaboration and promote both technical and social innovation.

Smart cities are still obsessed with technology-driven innovation (Mora et al., 2017; Mu et al., 2022). This obsession reflects traditional assumptions: merely neoliberal forms of urban development, top-down urban planning and decision-making, and policies focused only on ICT disciplines (Myeong et al., 2020; Yigitcanlar et al., 2018; Yigitcanlar and Lee, 2014). This research is important because it challenges these traditional assumptions to reexamine better ways to advocate for citizens' rights and ideas and to work in concert with primary sectoral and governmental organizations in order to co-design, co-produce, and test ICT-enabled services and infrastructures. This study shows how boundary-spanning roles and activities are associated with the different ways Smart Dublin seeks to take the lead in facilitating actor collaboration and citizen participation. Rather than contributing to the smart city concept, this study unpacks case studies and best governance practices in smart city innovations at a local level, examining actors' experimentation with an assortment of digital or ICT-driven solutions.

The next section sets the stage for the paper by providing an overview of issues that hinder collaboration and components that constitute smart governance. Following that, we carry out a careful review of the literature on boundary spanning in varying contexts and settings. Next, we describe the characteristics of the research's case study as well as taxonomy-making processes. Finally, the findings are elaborated on, and the theoretical and practical contributions of this study are summarized and discussed.

2. Literature review

2.1. Smart city collaboration

The term "smart city" has come to be regarded in the literature as something inherently positive. Its proponents claim that networked, data-driven technologies can operate both instrumentally and normatively to deliver technical, social, and political improvements in urban administration (Janowski, 2015; Meijer and Thaens, 2018; Misuraca et al., 2012). Smart city collaboration portrays a bottom-up approach that involves citizens and multiple actors from sectors utilized by a city government to solve urban problems that have not been resolved through traditional hierarchical relationships or top-down approaches (Mills et al., 2021; Mora et al., 2019; Townsend, 2013). However, the literature has identified barriers that may restrict a smart city from delivering on its potential to support transparent and evidence-based decision-making and foster a citizen-centric model of development prioritizing social justice, participation, and democracy (Hollands, 2008; Kitchin, 2016).

First, city governments have limited capacity to understand and apply technical knowledge or to capture value through commercialization (Ferraris et al., 2019). This is often because IT functions are under-resourced, leading to a deficit of technical knowledge and digital skills (Sancino and Hudson, 2020). As a consequence, IT departments struggle to plan and govern new technical arrangements or evaluate new solutions from external partners (Höjer and Wangel, 2015; Mills et al., 2021); examples are the former internal IT departments of New York, Chicago and Amsterdam, which were incapable of reusing government data and reforming software projects to explore urban problems (Mills et al., 2021; Townsend, 2013). In turn, this has led to an increased reliance on universities and private sector entities – for example, telecommunication companies, start-ups, and/or ICT companies (Cardullo and Kitchin, 2019; Coletta et al., 2019; Kitchin, 2014; Höjer and Wangel, 2015).

Second, unless they are tightly coordinated, collaborations between city governments and external IT stakeholders can result in infrastructure being assembled piecemeal, with new systems poorly integrated with legacy technologies, the built environment, and governance structures (Coletta et al., 2019; Shelton et al., 2015; Yigitcanlar et al., 2018). Such infrastructure may also be resisted by internal departments, both technical (e.g., IT and digital strategy functions) and non-technical, which may have limited scope to incorporate new business and information handling practices into business-as-usual activities (Kitchin and McArdle, 2016; Perng, 2017). Alawadhi et al. (2012) point out that interdepartmental collaboration and cooperation was essential in the success of smart city initiatives in four North American cities: Philadelphia and Seattle in the United States, Quebec City in Canada, and Mexico City in Mexico. However, Coletta et al. (2019) note that in a local authority context, structures are often characterized as uncooperative and non-interoperable and arise from weak governance and an absence of directed leadership. As a result, local authorities are frequently unable to share technical and non-technical knowledge, skills, and expertise internally, as well as with international/national IT companies (Broccardo et al., 2019; Mu et al., 2022). Therefore, operational isolation may lead to local authorities iteratively developing their own innovation and procurement processes (Coletta et al., 2019).

Third, once projects are initiated, the need to accommodate legal, regulatory, and ethical imperatives introduces additional layers of complexity to the innovation process (Carvalho and Campos, 2013; Yigitcanlar and Lee, 2014). For example, ensuring compliance with environmental protection directives, data protection rules such as GDPR (the European Union's General Data Protection Regulation), and procurement requirements can make project development challenging, as

can enrolling citizens in the decision-making process (Coletta et al., 2019). The smart city literature has witnessed complex ecosystems in existing cities, where the implementation of a smart city strategy has been susceptible to a lack of political, moral, and ethical balance (Angelidou, 2014). For example, analysis of the city of Rio de Janeiro and its cooperation with IBM has shown a few failures related to the digital divide, transparency, privacy, and security.

Fourth, effective collaboration means creating a mutual understanding between diverse actors who may have differing cognitive representations (Zuzul, 2019), divergent interests and motivations (Broccardo et al., 2019; Emerson et al., 2012; Meijer and Thaens, 2018), and differential access to decision makers (Broccardo et al., 2019; Van Geenhuizen, 2016). Zuzul (2019) found that contrasting knowledge domains and expertise shape different and often incompatible preferences about important choices when IT and non-IT actors are working together to develop smart projects. The dominance of a large actor may deter smaller actors from participating, resulting in a lack of representation or conflict during decision-making (Guldemond and Van Geenhuizen, 2012). The case of the Cyberjaya city in Malaysia has shown how the power and control of political coalitions deform the direction of smart city projects, causing them to diverge from the smart city vision (Nordin, 2012; Yusof and Van Loon, 2012). These issues have raised concerns about the extent to which city management should be delegated to national and/or international IT firms or government bodies involved in smart city planning and execution (Bunnell, 2015; Kummitha and Crutzen, 2017).

Finally, smart cities have tended to focus on promoting technologically-led entrepreneurship among businesses such as start-ups and SMEs (Cardullo and Kitchin, 2019). However, besides economic value, smart cities also need to realize social value from their investments, and doing so requires innovation processes in which citizens play a constructive and active role (Cardullo and Kitchin, 2019; Hollands, 2008; Wiig, 2015). Several smart cities, such as Songdo in the Republic of Korea and Cyberjaya in Malaysia, have received negative attention for having insufficient planning to foreground engagement with citizens (Brooker, 2008; Nordin, 2012; Shwayri, 2013; Yigitcanlar et al., 2018; Yusof and Van Loon, 2012). Moreover, recent research on smart citizenship reveals that innovation is frequently characterized by paternalism, stewardship, and the promotion of passive consumption, with technology production and design bearing the hallmark of top-down autocracy (Shelton and Clark, 2016; Malek et al., 2021). Cardullo and Kitchin (2019) note that citizen participation within the smart city paradigm typically ranges from non-existent to tokenistic, with individuals essentially positioned as “users” and reduced to experiencing algorithmically-mediated services. As a result, citizens are typically relegated to providing feedback on smart initiatives through ICTs rather than co-creating innovative and sustainable solutions with other actors (Lin, 2018). In practice, their role is often limited to consumers or testers of online applications or software, or as sources of data which may contribute to new products or services (Batty et al., 2012; Myeong et al., 2020; Nesti, 2020; Wang, 2018). There is a growing consensus that, in order to address these issues, smart cities need to improve their collaborative practices so that they are governed in an inclusive and responsible manner (Carvalho, 2015; Nam and Pardo, 2014).

2.2. Smart governance

The connection between collaboration and governance in the smart city context has received a substantial amount of attention from scholars (Lazaroiu and Roscia, 2012; Lin, 2018; Lombardi et al., 2012; Torfing et al., 2012). Governance is defined as a way to make decisions and administer public services through the engagement of various actors (Albino et al., 2015). Good administration, policies, and decision-making are based on effective collaboration, and these components are mutually constitutive (Meijer and Bolívar, 2016; Ruhlandt, 2018). Building on these conceptualizations of governance, this study postulates that effective collaboration influences and is influenced by administrative cultures, decision-making processes, and differentiated policies occurring across government departments (internal collaboration), between various actors' organizations (external collaboration), and between government and citizens (Alhusban, 2015a, 2015b; Mills et al., 2021; Nam and Pardo, 2011, 2014; Pereira et al., 2017). A comprehensive literature review on smart governance and its components indicates that the transformation of a governance approach towards smartness occurs when government considers smart public service design around citizen needs, when government promotes entrepreneurship and innovation by bringing various sectors and stakeholders together, and when government manages project activities around discourses of accountability and transparency (Anthopoulos et al., 2022; Meijer, 2016). Applying these perspectives highlights a need for a shift from traditional modes of municipal governance to a more proactive, consensus-building, and citizen-centric orientation. In response, several scholars have suggested forming new organizational bodies to promote smart city development with diverse roles and skills to face challenges on behalf of each actor (Lee et al., 2014). Höjer and Wangel (2015) also proposed that entities like this would have the potential to negotiate challenges associated with knowledge sharing, project and program management, procurement, resource allocation, conflict resolution, and policy compliance (see also Van Geenhuizen, 2016).

2.3. Theoretical perspective of boundary spanning

Boundary spanning is a function that disseminates information inside and between actors' organizations and helps them to integrate interrelated tasks and processes (Ancona and Caldwell, 1992; Faraj and Yan, 2009; Paraponaris et al., 2015). Boundary-spanning activities have been undertaken by individuals, teams, and organizations to implement processes, strategies, or behaviors in order to improve decision-making (Cummings, 2004), conflict resolution (Fleming and Waguespack, 2007), learning (Akkerman and Bakker, 2011), and innovation (Howells et al., 2004). To date, a number of researchers have studied the occurrence of boundary spanning in a variety of settings (Marrone, 2010). Mitchell (2006) focused on inter-individual boundary spanning: for example, a CIO sharing new knowledge about technology and its impact and implementation with his/her IT professionals. Levina and Vaast (2008) presented inter-team boundary spanning, which focused on outsourced IT teams aligning project plans and costs with captive business teams through formal and informal communication channels or bespoke systems or websites. Birkinshaw et al. (2017) looked at inter-organizational boundary spanning between software development headquarters and their spatially dispersed subsidiaries to increase the effectiveness of the internal and external networks. In addition to these settings, a disparate set of boundary-spanning activities has been identified, aimed at creating information and innovative environments in different contexts: for example, in marketing (Ancona and Caldwell, 1992), information systems (IS) (Levina and Vaast, 2005; Pawlowski and Robey, 2004), open source software (Fleming and Waguespack, 2007; O'Mahony and Bechky, 2008), a multinational corporation (MNC) (Birkinshaw et al., 2017), and service activity and service innovation (Howells et al., 2004). Overall, this body of research has shown that boundary-spanning activities facilitate building trust-based relationships, sharing knowledge and expertise, regulating inflows and outflows of information, and reconciling contrasting interests to direct joined-up, collaborative activities between various actors (Birkinshaw et al., 2017; Fisk et al., 2010; Marrone, 2010; Marks et al., 2001; Sawyer et al., 2010).

Integral to these boundary-spanning activities is the successful management of three primary boundary types, which have been identified through previous empirical research (Carlile, 2002, 2004). First, syntactic boundaries are primarily technical and are characterized by a mutually understood information processing orientation that is used to match incompatible codes, routines, or protocols (Henderson and Clark,

1990; Kellogg et al., 2006). In these circumstances, boundary-spanning functions enable knowledge transfer through the creation and use of a common lexicon or set of standard operating procedures (Carlile, 2004). The syntactic boundary is associated with low levels of novelty and complexity, in which boundary spanners share information through invoking information artifacts such as repositories, specifications, and standards (Adler, 1995; Hansen, 1999; Leonard-Barton, 1992; Nicolini et al., 2012; Nonaka, 1994; Teece, 1998). Second, semantic boundaries are culturally different and present cognitive and value divergences in meanings, assumptions, and contexts between actors that make coordination difficult (Carlile, 2002, 2004; Kellogg et al., 2006). In order to resolve these incompatibilities, boundary-spanning functions negotiate these differences through knowledge translation using shared languages (Bechky, 2003; Roberts and Beamish, 2017), common artifacts (Akkerman and Bakker, 2011; Ferraris et al., 2019; Gopal and Gosain, 2010), collective stories, or communities of practice (Boland and Tenkasi, 1995; Schotter and Beamish, 2011). Finally, pragmatic boundaries are regarded as highly political and contingent on the composition of actors in terms of power, status, and opaque decision-making structures (Carlile, 2002, 2004; Kellogg et al., 2006). The political perspective emphasizes differences in interests and actions in a specific context in which boundary-spanning functions engage in a process of knowledge transformation, resulting in the creation of new knowledge and practices (Tippmann et al., 2017).

Recently, the concept of boundary spanning has received attention from researchers in the smart city context (Acuto et al., 2019; Ferraris et al., 2019). Given that a smart city is a multidisciplinary ecosystem that encompasses a broad spectrum of actors and a range of beneficiaries of smart technologies, a multiplicity of boundaries has emerged that makes the coordination of smart project activities challenging.

2.3.1. *Boundary spanning in the smart city*

To facilitate the flow of information, knowledge, and practice necessary for smart project implementation, scholars have recommended different types of activities. Broccardo et al. (2019), for instance, suggested a set of political activities and defined it as the rules and assignments of specific roles played by certain actors in order to align interests with practice. They also identified the importance of cultural activities that involve constructing networks with organizations and creating a shared motivation and understanding of what has to be done, resulting in changes in organizational norms and the development of collaborative dynamics between multiple actors. Bergvall-Kåreborn et al. (2009) noted the significance of technical activities and the need for skilled actors who can contribute to high quality products and system acceptance. As previously noted, the smart city literature has also begun to highlight the need for interventions that encourage cooperation between key actors throughout their activities, and, more importantly, that promote coherent and integrated engagement with citizens (Harvey et al., 2014; Höjer and Wangel, 2015; Mørk et al., 2012).

From the macro-scale perspective of boundary spanning, some researchers have examined a host in the form of a university or hospital with cross-disciplinary composition, whose members legitimize collaborations between academic researchers, government organizations, and industry and practitioner groups in order to implement projects for citizens (Harvey et al., 2014; Mørk et al., 2012). Some other researchers have suggested a need for the establishment of a separate boundary-spanning organization to build a collaborative environment for the development and implementation of a new technology or service (Van Geenhuizen, 2016). Acuto et al. (2019), for example, found that boundary-spanning organizations facilitate knowledge exchanges between local authorities within a city and between cities, which provides an information ecosystem underlying policy-making in cities. The literature has captured anecdotal, rather than systematically structured evidence about these organizational structures to interrogate boundary spanning mechanisms. More explicit elaboration is needed to explore how collaboration can be made more citizen-centric, less vulnerable to divergent actors' expectations, and more balanced in terms of equality and flexibility between actors. The value of enhanced understandings of boundary spanning is in identifying how citizens' new ideas can be solicited and supported in early visualizations of solutions and projects. What should also be considered is how actors interact so that proof of concept of these ideas is demonstrated. This also represents a notable omission in our understanding of boundary-spanning organizations' roles in the formation of new actors' coalitions, conflict resolution, and decision-making within and between governmental settings and external actors. Further exploration of these roles will also be invaluable when testing fine-tuned solutions and experimenting with different projects to scale up. An important feature of our study is that we operationalize boundary spanning at an activity level, based on specific activities undertaken by a boundary-spanning organization, to provide granular details of how boundary spanning works to build collaboration in the smart city context. We drew on Carlile's (2002, 2004) distinctions between transferring, translating, and transforming knowledge and the definitions of political, cultural, and technical activities in the smart city literature to show the roles of a boundary-spanning organization in creating collaboration in the smart city context.

3. Methodology

City authorities are highly complex settings, and a holistic view of organizational, institutional, social, cultural, technical, and political entanglements is indispensable to governing smart cities (Meijer and Bolívar, 2016; Sadowski and Bendor, 2019; Yigitcanlar et al., 2019). In order to elaborate the role of a boundary-spanning organization in conceiving a multidimensional view, we have adopted a holistic single case study methodology (Hafiz, 2008; Yin, 2003). A single-case design for this study offers a unique opportunity to produce concrete, context-dependent knowledge in depth and in its particular type of setting (e.g., process, mechanism, or practice) (Flyvbjerg, 2006; Small, 2009; Yin, 2013). Although case studies are seen to be less rigorous than quantitative, hypothetico-deductive methods, they are of outstanding merit in revealing and ruling out alternative explanations that cannot be attained by statistical procedures or other means of quantification (Towne and Shavelson, 2002; Strauss and Corbin, 1990). The key advantage of using a case study is to “close in” on real-life situations and test views directly in relation to phenomena as they unfold in practice (Campbell, 1975; Flyvbjerg, 2006). Doing interviews, making direct observations and talking with informants unearth more discoveries and ostensibly allow more room for the researchers' subjective and arbitrary judgment than statistics applied to large groups (Flyvbjerg, 2006). Indeed, the levels of freedom and flexibility case studies or other qualitative methods provide for researchers give them a great opportunity to cast off preconceived notions and theories in order to confirm or challenge a theory, develop new concepts, elaborate existing concepts, provide insights into issues and clarify complexity (Peshkin, 1993; Yin, 1994). The next subsections elaborate on a research site of this research, including information on Dublin's city authorities, the case study of Smart Dublin, case study selection, and data collection, data analysis, and study validity.

3.1. *Research site*

The population of Dublin is 1.43 million inhabitants in 2021, accounting for 28.5 % of the total population of Ireland, and set to be 1.8 million by 2036. While Dublin is considered a very large city in Europe (>1,000,000) (Kylili and Fokaides, 2015), falling in the same category with 41 European cities (Stratigea et al., 2017), it is a medium-sized city globally (>1,000,000 and <5,000,000) (Berrone and Ricart, 2020). Dublin city's governing area is administered by four LAs, covering an area of 920.66 km^2 (Central Statistics Office (CSO), 2016). These four LAs are made up of Dublin City Council, n.d. (DCC) at the center, Dún Laoghaire-Rathdown County Council and South Dublin County Council, to the south and west, and Fingal County Council to the north (see

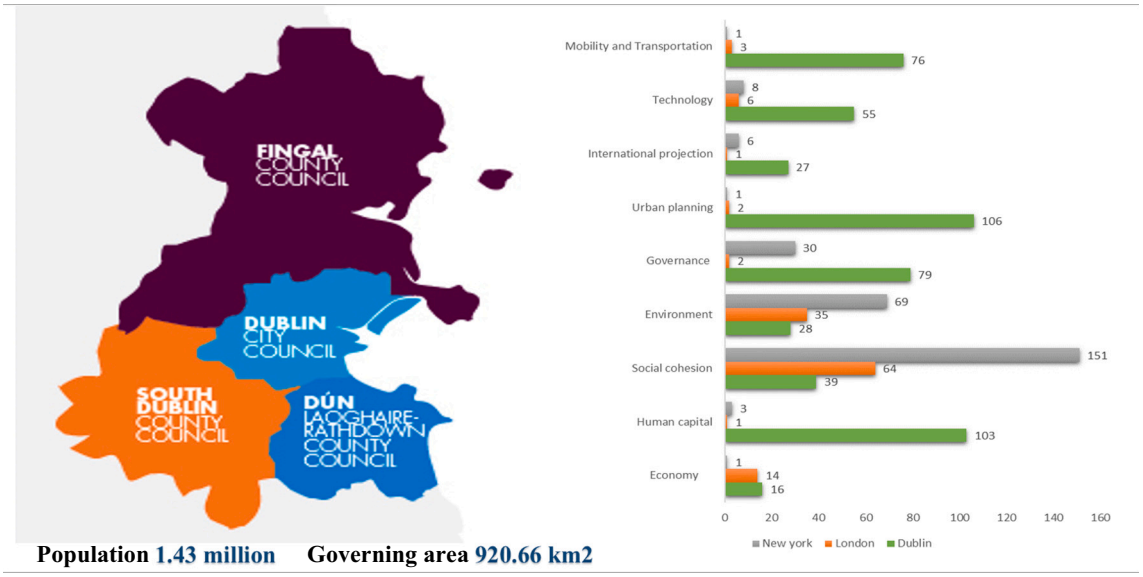

Fig. 1. Geographical boundaries of LAs and rankings of Dublin, London, and New York based on nine dimensions.

Fig. 1). Each LA has its own executive function alongside their corporate functions: corporate services, digital strategy, IT, and other technical departments such as traffic management. Dublin's economic activity accounts for 50 % of Ireland's gross value added and the city is ranked as Europe's third most attractive city for foreign direct investment of smart city enterprises, hosting the world's top technology companies (Dublin Chamber of Commerce, n.d.). Anthopoulos (2017) stated that cities can be classified for the types of services they offer in addition to their population and density, their impact (local and global cities), and their development stage (new and existing cities). Dublin, as a local and existing city, was ranked as 33rd smartest city among 174 cities in the world in 2019, where London and New York ranked in first and second positions respectively. Dublin performed well in offering services in the area of the economy, ranking 16th, whereas it failed in the areas of human capital and urban planning, ranking 103rd and 106th (Berrone and Ricart, 2020) (see Fig. 1).

In terms of generalizability, it is worth noting that like the US model, Irish cities follow the council-manager form. The CEO of the council is a professional manager, with permanent staff, responsible for implementing policy. Unlike the US model, an Irish CEO is not appointed by the council; he or she is appointed by the central government (Maccani et al., 2020). Dublin in Ireland is an historically, politically, economically, and culturally contingent place and as such, the services and products it produces with other actors are created in more fragmented and piecemeal ways due to critical barriers, as discussed earlier (Cardullo and Kitchin, 2019). Dublin has been experiencing some critical issues that have impeded collaboration in its smart city project (see Table 1) (Cardullo and Kitchin, 2019; Coletta et al., 2019; Kitchin, 2015).

Table 1
Dublin's smart city critical issues.

A piecemeal approach to innovation and a lack of shared agenda and master plans associated with mission and goals.
An absence of joined-up thinking within and between local authority technical activities.
The passive role of the IT departments of local authorities in implementing ICT infrastructure and initiatives.
Weak governance structures and an absence of directed leadership.
An entrepreneurial focus in governance approaches, which prioritizes business innovation and deprioritizes citizen-centric initiatives.
A staid cultural mindset with respect to procurement, experimentation, and operations.
Political and regulatory barriers for project implementation.

Before the establishment of a mediating organization called Smart Dublin in 2016, each local authority's technical departments worked independently of each other, which made it very unlikely that information, knowledge, and technical expertise would be shared across local authority boundaries. This was the case not only across local authorities, but also within them. Best practices within a local authority were often effectively siloed, meaning that very little knowledge sharing could occur between internal technical functions. As a result of the fragmented internal structures and weak leadership, discrete smart city initiatives developed in a piecemeal fashion and could not meet project goals (Cardullo and Kitchin, 2019; Mu et al., 2022). In addition, the LAs had separately invested in, procured, and operated a large number of smart city technologies, such as open data portals and systems, through partnerships with various SMEs, IT companies, and start-ups. Once these relationships began to develop, LAs focused on cultivating external actors with disparate approaches, often leading to disjointed and inefficient models (Coletta et al., 2019). As a result of this tendency, citizens were less empowered to participate in opportunities to express their preferences regarding smart city policies, initiatives, and infrastructure components and services (Kitchin, 2016).

To resolve these issues, Smart Dublin was initiated by the four LAs as a mechanism through which new and experimental forms of collaboration could be developed. The intervention was intended to create new technical and social capacities whereby the city could provide better services, promote innovative solutions, and improve economic activity. As such, Smart Dublin intended to play a more proactive role as a decision maker for the city in providing a better degree of alignment between technology development and social needs. Smart Dublin's efforts were aimed at acquiring external expertise and aligning it with the city administration and policies, so as to identify urban problems and effectively trial new technologies and projects.

3.1.1. *Smart Dublin*

Smart Dublin, the organization for the management and development of the city's smart initiatives, markets its activities under the banner “Open, Engaged, and Connected”, which valorizes collaborative frameworks, open innovation, and transparent governance (DCC, n.d.). Smart Dublin has a hybrid structure that links the four LAs with external actors and various stakeholders. Its goals are to promote economic development through open data, open government, and open innovation, which require connected networks, infrastructure, and city-related

initiatives. Smart Dublin embodies these objectives by engaging with entrepreneurs, multinationals, indigenous startups, and citizens to collectively trial new technologies and projects (Coletta et al., 2019). Its organizational structure consists of four chief executives (one from each local authority), a regional steering committee, an advisory network, the Smart Dublin regional group, and local working groups. The steering committee includes two members of staff from each LA, one with a technical background and the other being service- or enterprise-focused, and a representative of Maynooth University. The steering committee is chaired by one of the LA CEOs. The advisory network comprises 40 stakeholders from industry, government, civil society, and academia. Smart Dublin has run various programs that provide innovative solutions to urban challenges such as mobility, environment, energy, waste, and emergency management. Table B1 in Appendix B provides a summary of some projects and programs Smart Dublin is leading with the LAs.

3.1.2. Case study selection

The choice of the Smart Dublin case is consistent with Stake's (2013) selection criterion: relevance (to the phenomenon of interest), diversity (in context), and accessibility (to the researchers). First, these issues may not be Dublin-specific, but in reality, may be relevant to all smart cities, since other cities are similarly characterized by complex systems of actors and stakeholders, technologies, and institutions through which new knowledge, innovation, and policies are created (Angelidou, 2014; Townsend, 2013; Yigitcanlar et al., 2019). These issues reflect genuine tensions in urban governance, as cities seek to transform themselves to benefit from the features of digital technology. Second, the primary criterion for selecting Smart Dublin as a case study is its potential to provide a rich and contextualized foundation for understanding the boundary-spanning activities deployed by an organization, which, as we shall see, achieved at least partial success in transforming the practice and culture of governance in the city. Also, the case supports a theoretically relevant organizational context for studying collective actions and behaviors that reveal the roles of a boundary-spanning organization in a multidisciplinary and multisectoral context. Third, access to the case data and organizations is made easier by a long-term relationship between Smart Dublin and the authors, stemming from collaboration on earlier research projects.

3.2. Data collection

Semi-structured interviews were identified as the primary data collection method for this study and twenty-five interviews were conducted. Alongside the interviews, secondary data, such as reports, internal documents, presentations, and websites, were also collected. Thirteen of the twenty-five interviewees worked in Smart Dublin and their perspectives were solicited several times to maximize the richness and complexity of the data. Respondents were asked to describe a variety of everyday activities, including how they communicated and shared information with other actors. They were also asked about their engagement in various projects, the challenges encountered, and any remediating strategies they deployed to negotiate these challenges. To facilitate this process, a list of topics from the smart city and boundary-spanning literature was created and used to gather the participants' perspectives (see Appendix A). Data collection stopped when theoretical saturation was reached. Two authors of this paper interacted with a number of key Smart Dublin employees (technical and non-technical professionals) for over a year between March 2019 and October 2020, which meant the research was kept up to date on their roles in new projects. We also interviewed their peers working in the space who were aware of project-related activities and challenges that involved Smart Dublin. They included six digital strategy managers or IT managers from the LAs, four CEOs or managers from IT companies, and two professors from research institutes and universities. Table 2 provides a summary of the participants by job title, type of organization, and average of interview duration.

3.3. Data analysis

Understanding the roles and activities undertaken by a boundary-spanning organization to secure collaboration requires the development of a taxonomy to organize them. We followed the taxonomy development method of Nickerson et al. (2013), describing the use of the iterative process that proceeds from the examination of empirical data towards the development of theoretical interpretations. As we had a significant amount of data from twenty-five transcribed interviews alongside specific knowledge of the boundary spanning domain, an empirical-to-conceptual approach was suggested following several steps for analyzing the data through established coding techniques. First, to avoid the situation of naïve empiricism (Aldenderfer and Blashfield, 1984), we identified a meta-characteristic based on the purpose of the taxonomy by looking into the perspectives of various participants working in and with Smart Dublin. At the same time, we identified a set of dimensions (cultural, political, and technical boundaries) that we wished to classify through the review of the literature. Drawing on the relevant body of boundary spanning theory together with prior findings discussed across both boundary spanning and smart city literatures as a resource, this approach provides a deep insight into the emergence of the results. Next, we acknowledged the common characteristics of subdimensions to ensure the internal consistency of the meta-characteristic. This led to a set of subdimensions from various activities undertaken by Smart Dublin and the different experiences of those with whom the organization interacted.

Once the set of characteristics of subdimensions had been identified, we grouped them into initial dimensions of the taxonomy so that each dimension included characteristics that were mutually exclusive and collectively exhaustive (Nickerson et al., 2013). According to Bailey (1984), p.32) this grouping involves creating “conceptual labels”; the results of our taxonomy development process led to the identification of ten first- and second-order categories that were aggregated across four overarching dimensions, representing in total our conceptual framework

Table 2
Participants by job title, expertise, experience, type of organization, and average of interview duration.

Job title	Expertise	Experience	Type of organization	Average of interview duration
13 Technical and non-Technical Professionals	Information Systems, Program & Project Management, Software Development, Computing, Citizen & Community Engagement, Innovation, Communication.	From 2 to 12 years	Smart Dublin	80 min
6 Digital Strategy Managers or IT Managers	Information Systems, Information Technology, Statistics, Digital Program/ Strategy Development, Information Services Research & Development, Electronic Engineering.	From 5 to 24 years	DCC, Dún Laoghaire and Fingal County Councils	70 min
4 CEOs or IT Managers of IT Companies	ICT Design & Implementation, Software Development	Above 20 years	IT companies	60 min
2 Professors	Planning & Environmental Policy, Electronic Engineering.	Above 10 years	Research Institutes and Universities	60 min

(see Fig. C1 in Appendix C). Finally, we iteratively used both subjective and objective ending conditions as markers to ensure uniqueness and avoid redundancy among characteristics of subdimensions. This iterative process was carried out by the first and second co-authors and then results were jointly discussed and revised.

3.4. Validity of THE study

To ensure the case study's trustworthiness, considerations must be given to construct validity, internal validity, and external validity (Tellis, 1997; Yin, 2013). Construct and internal validity are improved through data and investigator triangulation (Golafshani, 2003; Johnson, 1997; Yin, 2009). This study availed of a range of data sources in order to identify correct operational measures for organizational boundary spanning (see Section 3.2). Moreover, validation efforts were conducted with the involvement of several investigators (e.g., the chair and program manager of Smart Dublin) as well as peer researchers' interpretation of the data at different times and locations. The concern over internal validity extends to the broader problem of researcher inferences in determining cause-and-effect relationships (Yin, 2013). Even though we made use of the heterogeneous perspective of several IT and academic participants (see Table 2), we maintained the premise that the procedure and outcomes are not the product of a heteronomous approach but the considered "best try" of a situated, autonomous team (Blair, 2015). External validity relates to the generalizability of the outcomes from an individual case in which more discoveries stem from intense observations than statistics applied to large groups (Eisenhardt, 1989; Miles and Huberman, 1984; Yin, 1994). From Tsang and Williams' (2012) standpoint of generalizability (cross-population, temporal, contextual), concerns about limited external validity were traded off against the opportunity to gain deep insight into a poorly documented phenomenon about a mediating organization (see Sections 3.1.1 and 3.2) during various smart project implementation stages (see Appendix B) in the specificities of the Irish context (see Section 3.1).

4. Findings

A conceptual framework (see Fig. 2) representing a taxonomy of the four activities of boundary-spanning organizations – social, technical, cultural, and political work – was developed from the iterative data analysis processes. The framework shows the differences in the actors that were involved in each activity. The political roles of boundary spanning involve aligning the interests of various actors, including internal non-technical and technical departments, IT companies, universities, and citizens, to decide how their goals can be jointly attained within and across their organizations. The cultural roles include the integration of interpretations and cognitions of some actors, namely the technical departments, IT companies, and universities. The technical role of boundary spanning can be observed when boundary-spanning organizations familiarize themselves with an emerging technology and its implementation, employing a variety of artifacts to promote knowledge flow throughout the entire network. The social role of boundary spanning indicates the different methods of engaging with citizens and communities.

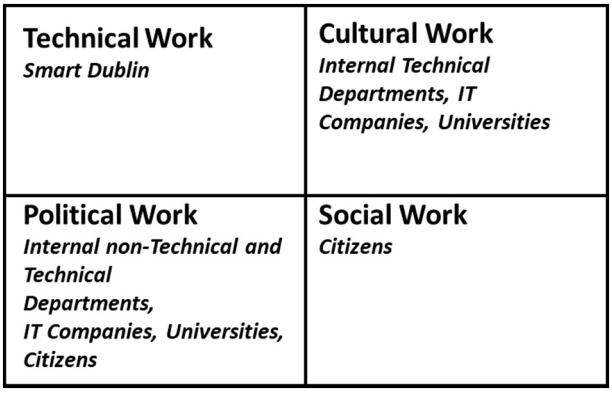

Fig. 2. Taxonomy of the activities carried out by a boundary-spanning organization.
Note: the text in italics in the boxes above refers to the entities involved in each activity.

As the level of familiarity and understanding across actors varies, the boundary-spanning organization synthesizes the fluctuating manifestations of transferring, translating, and transforming processes. In the following subsections, we elaborate on the four roles that inductively emerged from the activities carried out by Smart Dublin. It is worth noting here that each of the following categories have interdependent overlaps, and work carried out by Smart Dublin in these categories may occur at the same time and in the same space. These categories are not fixed, separate entities that contribute to boundary-spanning activity but rather are reciprocal activities that each feed into and act upon the other. The distinction made through this categorization is done so to facilitate understanding and track movement across the categories only.

4.1. Political work

A boundary-spanning organization's political role encompasses integrating the knowledge of local authorities with new policies and standards and adopting confrontational behaviors to synchronize divergent interests between all kinds of actors. The data analysis uncovered two specific political work activities: challenging/interpreting regulations and reconfiguring the balance control (see Fig. C1 in Appendix C).

4.1.1. Challenging/interpreting regulations

This activity involved raising local authorities' awareness about regulatory requirements and the importance of updating policies and procedures to facilitate the development of smart projects. For example, the digital strategy departments of the local authorities and IT companies had encountered several challenges with regard to their Electric Vehicle (EV) charging project and their 5G project (see Table B1 in Appendix B). These included how electric cars should be priced and licensed and how powering and metering issues should be addressed in relation to smart devices installed on city infrastructure.

> *"In bye-laws, we found Local Authorities did not distinguish between electric cars or internal combustion engines, firstly. Secondly, there is no transparency in terms of the pricing and the licensing, which I think is really bad…".*
>
> *(Smart Dublin)*

In such cases, Smart Dublin negotiated issues with local authorities and informed them of the need to replace legacy policies and practices to ensure compliance with EU and national regulatory obligations and best practice guidelines. Examples of changes made include ensuring that IT companies have appropriate and fair access to city infrastructure and data, and ensuring that environmental sustainability and regulatory standards are emphasized in project initiation plans to avoid increased costs related to retroactive implementation. As part of this process, Smart Dublin attended multiple meetings with IT companies to focus their attention on legal issues (e.g., data protection liability, due diligence practices, and intellectual ownership of data and city assets) and human rights principles enshrined in legislation (e.g., privacy and security of citizens). For example, Smart Dublin stated:

> *"…So that conversation needs to happen, hopefully we will work it out… through the strategic policy committee, the environmental committee, and the local councilors… there is always a memorandum of understanding (MOU) with details of the project and a project scoping document and then the Data Protection Impact Assessment (DPIA)".*

(Smart Dublin)

4.1.2. Reconfiguring the balance control

The most important activity undertaken by Smart Dublin was lessening the dominance of the local authorities through confrontational behaviors as a directive strategy approach. Their role included balancing everyday decisions and directing project activities in a way that did not explicitly or implicitly favor the local authorities, while facilitating meaningful citizen participation. For example, when the internal technical departments of a local authority became insistent on persisting with the application of their formal policy parameters, Smart Dublin itself initiated a project with a university to install Internet of Things (IoT) sensors and collect practical data for further measures.

> *"The guys (citizens) expressed a concern on air quality, they expressed a concern to DCC…The councilors can't until they have real data to prove there remains or isn't a concern. So, we are using the Horizon 2020 project with UCD to install new sensors and to validate the concerns, which we do in a lot of cases".*
>
> *(Smart Dublin)*

Similar behaviors took place to restrain the narrative dominance of national and/or international IT companies. Smart Dublin overwhelmingly participated in most of these types of actions, for example to increase the likelihood that LAs would gain added value from services by designing compatible business models that reflected their priorities and goals.

> *"The local authority essentially holds the balance of control in where these assets can go; they have to determine, we need to explain to them (IT companies) that small cells are deployed and evenly distributed across the city so that we don't enhance the digital divides…".*
>
> *(Smart Dublin)*

At a conceptual level, these two activities are acknowledged in different contexts, such as software development or IS contexts (Birkinshaw et al., 2017; O'Mahony and Bechky, 2008; Pawlowski and Robey, 2004). We could not find prior studies in the smart city literature that comprehensively elaborated on such activities. There are, of course, some debates about the role of living labs in managing the decision-making power of large actors (Guldemond and Van Geenhuizen, 2012; Van Geenhuizen, 2016) or facilitating the production of knowledge for policy (Acuto et al., 2019), for example, around data assemblages (Kitchin, 2014). Using Carlile's (2002, 2004) point of view, reconfiguring the balance control emphasizes balancing different interests between political entities, including technical and non-technical departments, and IT firms, through establishing new practices embarking on priorities, such as the influence of citizens, environmental issues, or social inclusion and equality. It is also followed by translating knowledge to engender a shared language among stakeholders, so as to negotiate and challenge obsolete routines and prior false assumptions.

4.2. Cultural work

The cultural role of the boundary-spanning organization involved creating an agile environment for actors to become acquainted with each other's knowledge and expertise and consequently elaborate jointly on new proposals and development of smart city projects. In such cases, we observed that Smart Dublin proactively engaged with the internal technical departments of some LAs to exchange information and develop relationships of reciprocity. Smart Dublin developed a conflict-solving capacity to guide actors, including the four local authorities, IT companies, and universities, towards a common understanding of each party's concerns and priorities. Based on our analysis, we identified three activities in the cultural sphere: ecosystem creation, expectation alignment, and business process innovation (see Fig. C1 in Appendix C).

4.2.1. Ecosystem creation

Smart Dublin added value by making new relationships, maintaining existing connections, and evaluating external actors based on their cognitive and historical performances in specific fields. Smart Dublin built an interactive ecosystem promoting communication between the internal technical functions of different LAs and connected them to external worldviews and vice versa.

> *"…We asked them to connect us with internal stakeholders within the city councils so there are planners, architects, and engineers 25 years working in the city council who are going to be able to use this platform to streamline their effort".*
>
> *(IT Company Manager)*

The data showed that different strategies were applied to create such linkages. Smart Dublin organized physical events where all the central actors (LAs, IT companies, and universities) were assembled. They also adopted a stimulative approach by, for example, expending social media branding resources on specific projects to promote the benefits gained by IT companies that were already involved so as to motivate other IT companies to become part of the network.

> *"Look what we can do through Smart Dublin, we organize networking events, hackathons, pitch days, we bring the companies together, when there are international events …One of the developers got involved, then the others saw that logo up there and said 'why are they up there?'".*
>
> *(Smart Dublin)*

Besides organizing such events, Smart Dublin also acted as a catalyst by conducting market soundings to attract national/international IT service providers and local start-ups. For example, they conducted an evaluation process to systematically select external organizations, verifying the compatibility between the actors' composition and the contributions they claimed to have the capacity to make.

> *"I have the questions in here that I am pretty sure that I asked them (IT companies). Would you like to be part of it? What would you like to get out of it? Could you commit time or money etc.?".*
>
> *(Smart Dublin)*

Smart Dublin also maintained connections through regular meetings with universities, well-known and multinational IT companies, such as Facebook, Google, and Airbnb, and small to medium IT enterprises. These activities allowed them to expand the broader network to those that had funds and resources, so that these assets could be leveraged when brokering relationships with those that had innovative ideas and solutions. Efforts to connect actors have led to fruitful projects and data analytics platforms, resulting in changes in the development of city architectures, the implementation of new infrastructure, new perspectives on tourism patterns, and the exploration of innovative opportunities with citizens on planning proposals and designing aspects (for example, see the 3D Docklands Planning Model in Appendix B).

> *"Because I work in that kind of general space, the guys in Hibernia came to me and asked me, did I know anybody who does this kind of scooter parking? Which I do know because I do work in this space. So, I act as 'you guys should have a chat because you have the scooter parking solution and you guys need it'…".*
>
> *(Smart Dublin)*

4.2.2. Expectation alignment

The second aspect of cultural work is Smart Dublin's effort to minimize asymmetric knowledge, fostering mutual understanding among technical departments of local authorities and IT companies. On multiple occasions, since actors had varying mindsets and goals for smart projects, Smart Dublin spent considerable time and effort identifying potential sources of conflict and playing a persuasive role in reconciling differences through translating across boundaries. This role was one of

Smart Dublin's main activities, individually meeting IT companies on behalf of LAs' technical departments or meeting business owners/managers to resolve their misinterpretations of how a new technology would operate in their context and how technology use would benefit their everyday business functions. For example, Smart Dublin held several informal and formal meetings about adopting 5G between a building manager and an IT manager to stimulate conversations about using the building as a testbed for trialing 5G connectivity and data sharing activities. In this incident, the business manager was incorrectly persuaded by the insistence of the IT professionals that certain functionalities existed within 5G. To confront the issue, Smart Dublin envisioned the possible benefits for both groups and created a convergent outcome. They emphasized benefits for the business such as enhancing its reputation as the first smart building in Dublin equipped with 5G, and for IT companies, the opportunity to conduct a free trial culminating in the collection of empirical evidence on how 5G could travel through certain blackspots. In the same project, the role of Smart Dublin was to interpret some technological concepts such as connectivity, while also sell the benefits of open innovation to internal technical departments (e.g., the traffic department).

> *"We realized what an IT firm were saying was false promises and false expectations. It is because their head is very technical, so they just think 'I want to get this into this building', so they make promises based on that… So, if I wasn't there, what the IT guys would be also saying to the traffic department would bamboozle them".*
>
> *(Smart Dublin)*

The lack of coordination and limited expertise within the four local authorities resulted in a fluctuating pace of understanding of each other's functions, operations, and strategies. It was noticeable that Smart Dublin tended to situate the task of developing smart projects and digital strategies among the digital strategy departments of the local authorities.

> *"When you are all doing it, can we all sit down at the table and talk about a coordinated approach? How do we go with tendering it? What goes into a tender? Instead of having four different systems in place…".*
>
> *(Smart Dublin)*

4.2.3. Business process innovation

The third activity was the creation of an innovative approach to project valuation and portfolio management. This work involved Smart Dublin playing an entrepreneurial role in fully engaging with the internal technical functions of DCC, aligning them with citizens' key issues and ideas, as well as with ongoing projects, and encouraging them to express innovative ideas and solutions. Such efforts also sought to involve internal technical departments in developing solutions with external partners in the commercial phases. Indeed, Smart Dublin encouraged employees and managers to adapt to changing requirements and actively take part in the feasibility process of solutions, making DCC's functions and operations more efficient, accessible, and responsive. These efforts required a certain amount of translation of information through internal publications, workshops, or social media channels.

> *"Recently we organized an internal engagement event to demonstrate what we are doing to develop some projects that smart city teams are working on for DCC, but also giving staff an opportunity to develop their ideas, so these staff ideas that we got through staff engagement even…".*
>
> *(Smart Dublin)*

At a conceptual level, these three activities involve translating knowledge across different boundaries by a mediating organization and some transformation when shifting mindsets towards innovation (Carlile, 2002, 2004). This is a primary role played by mediating organizations to build relationships with external actors and settle conflicts among them (Acuto et al., 2019; Aldrich and Herker, 1977; Levina and Vaast, 2005, 2008; Paraponaris et al., 2015; Ranga and Etzkowitz, 2013; Tushman, 1977). Examples are technology transfer centers acting as intermediaries to enable industry-university links (Comacchio et al., 2012) or knowledge brokers in conflict resolution between open-source members (Fleming and Waguespack, 2007). Regarding business process innovation, the literature reflects innovation intermediaries, e.g., knowledge intensive service firms (KIBS) (Howells et al., 2004), engaging in cognitive activities to bring, for example, citizens and the university into closer alignment (Harvey et al., 2014).

4.3. Technical work

The technical role of a boundary-spanning organization could be seen in activities that required multiple technical specialties and skills in the various phases of developing smart projects and provided appropriate communication channels to facilitate information and knowledge flows within local authorities' organizations and across external actors. Based on our analysis, two roles emerged out of the technical work: acquiring technical expertise and information management (see Fig. C1 in Appendix C).

4.3.1. Acquiring technical expertise

This involved a technical scout from Smart Dublin explaining a given technology and its implementation in order to coordinate the work of technologists and non-technical actors. Surprisingly, we noted that employees working for Smart Dublin had a sophisticated level of insight into IoT installation, deployment network models (e.g., neutral hosting for 5G adoption), new business models, operations of city smart assets (metering & billing), data analysis, system design, and so on. They acquired these complementary technological competencies through close relationships with universities and actively participated in international/national networks such as conferences, seminars, and workshops.

> *"I was required to develop a level of technical expertise that allowed me to have conversations with the technologists…".*
>
> *(Smart Dublin)*

4.3.2. Information management

This is a supplementary role to ensure the accomplishment of social, cultural, and political activities. Smart Dublin established the architecture to coordinate information and knowledge within and between actors' organizations. These activities were split across a variety of boundary objects,[1] informal/formal meetings, and technical workshops to harmonize knowledge. The boundary objects included presentations, knowledge management systems, shared Google Drive folders, social media (e.g., Facebook), Intranet pages, use cases, newsletters, and emails. The different actors were partially or fully engaged in preparing the material and content, such as reports, technical specifications, or market evaluation documents. They had regular meetings to exchange information with different internal technical departments, IoT teams, research institutes, and large/medium/small-sized IT companies (such as Google).

> *"Intranet (Dubnet), we just post like announcements there for the internal management…We have internal newsletters and we are publishing articles there…I have a meeting at the Docklands IoT network, they are all fairly important people".*

[1] Boundary objects refer to a broad range of artifacts that are socially recognized and legible templates, established by boundary spanners to construct shared meanings across diverse communities in order to facilitate cross-boundary coordination practices (Kellogg et al., 2006). For example, boundary spanners employ technological artifacts (e.g., websites) (Levina and Vaast, 2005), physical objects (e.g., manuals or guides) (Roberts and Beamish, 2017), or shared systems (Ferraris et al., 2019) to enable the distribution and application of domain-specific knowledge among actors.

(Smart Dublin)

For example, an internal knowledge management system was developed, and Google Drive was used to keep everyone abreast of project developments and also to control accessibility for internal/external actors.

> *"Now, it is Trello as project and portfolio management system. So, you will see that Dún Laoghaire have projects, Fingal have projects, our calendar which cuts across all the boards, all the SBIRs, these are South Dublin…".*
>
> *(Smart Dublin)*

To integrate the use of these objects into the activity of transferring and translating knowledge (Carlile, 2002, 2004), Smart Dublin used discretionary behaviors that varied based on their experience with the actors, as well as the actors' expertise.

4.4. Social work

The social role involved interacting with citizens and communities to facilitate their participation with central actors and include them in the smart city ecosystem underpinning policy-making for the city. Using a range of pre-existing networks as well as novel stakeholder engagement approaches, a broad cohort of citizens was canvassed for their opinions and ideas for project development. Based on our analysis, Smart Dublin undertook social roles in three areas: social inclusion, mutual learning, and engagement methodology (see Fig. C1 in Appendix C).

4.4.1. Social inclusion

This activity involved Smart Dublin facilitating and ensuring the participation of citizens in developing digital strategies and innovation processes. These participants varied in terms of their age, educational attainment, technical knowledge, and physical health profiles. Various community groups, including non-profit organizations, schools, local history groups, and shopping and leisure center users were also approached to identify city problems and solutions.

> *"In Fingal, we knew who to go to, and we did the workshop design and all that kind of stuff. We got an older action group, we got an environmental group, we got the elected members, we got the chamber, we got a youth group… We did the people with disabilities…".*
>
> *(Smart Dublin)*

4.4.2. Mutual learning

The second activity of social work was Smart Dublin's efforts to increase the awareness of citizens about potential smart projects and their impact on the quality of their lives. In this sphere, citizens were invited to participate and share their points of view and solutions for improving current and future city services. Citizens were educated about a given technology and its utilization and familiarized with city policies and services rolled out by their local authorities. For example, Smart Dublin taught elderly people what data meant in a specific field and how systems and applications were fed with data. Consequently, they qualitatively and quantitatively integrated citizens' ideas and solutions into meaningful information and knowledge to be shared with central actors.

> *"It was really nice to be able to reach out to people and community centers and just get the feedback and then kind of inform them about what smart city is about, and then because of that project we were able to link up with councilors …We really show that the technology and the new solutions can improve the life of people or improve communities…".*
>
> *(Smart Dublin)*

4.4.3. Engagement methodology

The last activity was Smart Dublin's most important role in building trust and authentically cultivating citizen participation. Smart Dublin actualized the implementation of the social inclusion and mutual learning roles through several engagement methodology activities: children's competitions, a simulation of how the city might operate within the Smart framework, critical thinking and voting workshops, outdoor arts-based activities, and surveys. First, they approached citizens through their personal contacts or the LAs' public participation networks (PPNs). In addition, Smart Dublin had face-to-face communication and virtual contact with citizens and communities through social media such as Facebook and Twitter. Second, citizens were assigned to hypothetical roles as technologists or decision makers to provide their feedback on the technical, political, and economic feasibility of various projects (e.g., design features of applications or allocation of project budgets). Third, Smart Dublin focused people's minds on smart city operations and services using different types of technologies (e.g., augmented reality/virtual reality applications or iPads).

> *"We had a coloring competition for children where they could draw Fingal in the year 2100 and we were surveying parents while the kids were drawing…We are trying to use digital strategies such as augmented reality/virtual reality applications that help citizens understand the impact of developments in real time and using just their phones or iPads…".*
>
> *(Smart Dublin)*

At a conceptual level, using Carlile's (2002, 2004) language, these three activities involve translating and transformation knowledge across different groups of citizens (Carlile, 2002, 2004). We found a limited number of studies that particularly explore the role of mediating structures in involving and selecting user-groups in collaborative learning or co-creation activities for implementing ICT infrastructure (Van Geenhuizen, 2016; Bergvall-Kåreborn et al., 2009).

4.5. Integrating social, technical, cultural, and political work

Our findings indicate that a combination of Smart Dublin's political, cultural, and technical activities established smart collaborative mechanisms, including internal and external collaboration and citizen participation (see Fig. C2 in Appendix C). Building on the boundary-spanning taxonomy, we elaborate upon the applicability of these activities that can be used in tandem and also sequentially to resolve the city's critical issues (see Section 3.1), as well as issues related to smart collaboration (see Section 2.1).

4.5.1. Internal collaboration

Internal collaboration cannot be effective if the internal technical departments of municipal governments have no common motivation and understanding of each other's priorities. This can negatively impact the development of new initiatives (Alawadhi et al., 2012; Alhusban, 2015a, 2015b; Mills et al., 2021). Smart Dublin's provision of resources, such as manpower and expertise, demonstrated the cultural aspect of their functionality to achieve synergy between the technical departments of the four LAs. For digital strategy development, the inclusion of all digital strategy departments was sought, and these contacts were kept abreast of best practices taking place in other LAs. Smart Dublin also acted in a quasi-technological advisory and functional role to compensate for the lack of IT skills and expertise within internal IT departments in order to facilitate the process of project implementation.

> *"What we are starting to see now is, where it makes sense, the four local authorities are coming together to jointly work on a project… It is that*

kind of raising awareness and knowledge transfer across the four local authorities".

(IT Manager of a LA)

Through the political work of Smart Dublin, corporate functions and higher-level IT managers of the LAs were apprised of updated institutional regulations, legacy policies were integrated with emerging EU and national standards, and data protection and open data principles were embedded in the early stages of project planning.

"To be honest, Smart Dublin has been very proactive to change the whole narrative at government level and it has changed the whole narrative at policy level…".

(Digital Manager of a LA)

It appears that Smart Dublin's entrepreneurial role could improve coordination among internal IT professionals to locate a bottom-up governance approach. Researchers' critiques of top-down city planning show how cities failed to understand "close-grained diversity" – all the little plans from citizens and local technical staff within a city that alone can generate the diversity necessary for successful bottom-up city planning (Barrutia et al., 2022; Myeong et al., 2020; Townsend, 2013). In such cases, the IT departments of the LAs became aware of ongoing projects and their implementation processes, and they were engaged in innovation processes, creating solutions in an attempt to include citizens' ideas.

"*They do consultations with our internal staff to make contact with the community, and they share citizens' key issues and then ask how come you line up with companies that come to us in terms of developing projects? …*".

(IT Manager of a LA)

The level of internal collaboration varied from one LA to another, and the Smart Dublin mechanism did not seem to create an equilibrium between all LAs in terms of frequency of communication and sharing knowledge and resources. With DCC employees working in Smart Dublin, the relationship between Smart Dublin and DCC is more intense and deeper than between Smart Dublin and other LAs. This has meant that the DCC has contributed more towards developing projects and city services.

"…So, this collaboration could be really a lot better served if we had a Smart Dublin team in there… we would maybe see, and it is probably just for the close proximity with Smart Dublin and DCC, that they get a lot from the collaboration because they are sitting in the same room…".

(Digital Strategy Manager of a LA)

4.5.2. External collaboration

Researchers have revealed that collaborative capacity to manage information exchange and communication, legislation and policies, and misinterpretations across jurisdictional, organizational, and academic boundaries is key to the achievement of smart city objectives (Alhusban, 2015a, 2015b; Barrutia et al., 2022; Ruhlandt, 2018; Pardo et al., 2010). Smart Dublin is currently assembling a broad spectrum of subject matter experts to overcome regulatory, ethical, and legal issues. Smart Dublin faces challenges associated with the heterogeneous ideologies and interests of actors in real-world smart city implementations. As a neutral and trusted party in the negotiations whose brief was to resolve conflicts caused by the misinterpretations of the lead actors, the cultural work of Smart Dublin achieved resolution where previously intransigent parties might not have continued the dialogue. The political work of Smart Dublin involved being the driver of activities for navigating and managing the cohesion of diverse agendas into desired outcomes in the public interest. The political work foregrounded regulatory, best practice ethical standards and the governance principles of transparency and accountability (e.g., data protection and environmental laws) during project planning and implementation with IT companies.

"… They (Smart Dublin) will definitely be in the design, what are we trying to achieve, what is the value map amongst those stakeholders? What is the data and how will it flow? Then something gets created to operationalize that…Smart Dublin is doing the impact assessment for the data too".

(IT Manager of a LA)

Like most cities at an early stage of the smart city implementation, where technological endowment can be seen as a resource for the development of a smart city (Angelidou, 2014; Anthopoulos, 2017; Browne, 2020; Myeong et al., 2020), Dublin had adopted hard infrastructure oriented strategies. Furthermore, Dublin has a history with global IT firms where "Dublinked", an open data repository, was the outcome of having attracted IBM's global smart city research team to Dublin in exchange for access to city data (Coletta et al., 2019). Cities require an effective governance approach that allows local knowledge to become visible from stakeholders in relation to specific political, institutional, societal, economic, and cultural conditions (Meijer, 2016; Ruhlandt, 2018). Appendix B demonstrates several pilot projects that Smart Dublin is undertaking, designed to explore the challenges and opportunities associated with city infrastructure and smart assets. Beyond its great experience working with multisectoral actors, Smart Dublin encouraged local technical capacity by allowing local IT companies, rather than global IT firms, to have an equal chance, bringing proposals from the bottom up into the political arena.

"…We are trying to achieve world class connectivity, we don't want our roads to be dug up, and we don't want to put shit on our assets. And we want to have amazing services and opportunities with our local IT companies and start-ups…".

(IT Manager of a LA)

While research institutes and universities found a forum for the practical application and testing of their theoretical expertise, fulfilling their community engagement remit, external collaboration, however, does not seem to have been able to set up a formal communication mechanism with some respondents from that sector.

"I do not know what is happening in Smart Dublin, I have no way of finding out if I don't ask what is happening in Smart Dublin. There are no formal monthly meetings that I am aware of that are open, or minutes, there is no annual conference, and there is no platform…".

(Professor)

4.5.3. Citizen participation

Our findings indicate that some progress has been made in the area of citizen participation at the design stage, in contrast with the previous use of citizen input to rubber stamp preordained choice in terms of technology design. In the context of e-government, city governments involve citizens through transparency websites, open data platforms or e-participation platforms (Bolivar, 2018), or social media (Falco and Kleinhans, 2018). Previously, Dublin city adopted an online tool for citizens to report the location of issues (e.g., potholes, graffiti, broken streetlights, illegal dumping) to be included in the next city work programs (Cardullo and Kitchin, 2019). To make tight links with citizens, Smart Dublin relied on existing social fabric – the casual face-to-face

encounters with various communities or through PPN members – to cast off the restrictions of oversight decision-making including only ICT users. For example, when WiFi4EU (see Appendix B) was in the earliest stage of development, Smart Dublin was conducting a public consultation process to select appropriate targets and to identify where this infrastructure might be usefully located.

> *"Now it has been all face to face and social media so this is face-to-face engagement. They link up with public participation network for like WiFi4EU"*.
>
> *(Digital Strategy Manager of a LA)*

Unheard Voices is a Small Business Innovation Research (SBIR) project (see Appendix B) being led by Fingal County Council and Smart Dublin, and the purpose of the Unheard Voices SBIR is to explore the potential of digital technologies in improving citizen engagement and enrolling local citizens and communities in the decision-making activities of local government. In particular, the project is concerned with identifying and engaging "the voices of those who had traditionally been silent", encouraging the participation of these under-represented groups and, in the process, addressing issues of inclusivity and inequality. The social work of Smart Dublin achieved synergy between a local authority and citizens that could be seen, for example, in the participatory-focused funding application for an SBIR project and in the development of the overall digital strategies.

> *"The planning and design phase included a representative sample of the communities that would be in the solution…The data that people are inputting through to the phase two application called Unheard Voices is completely owned by the council"*.
>
> *(IT and Digital Strategy Manager of a LA)*

Some researchers consolidate the various features of enabling citizen participation in efficient, transparent, and accountable smart projects and city services (Albino et al., 2015; Dimelli, 2016; Meijer, 2016), whereas some others describe a stronger citizen-centric focus as key ambitions of smart governance (Bolivar and Meijer, 2016; Engelbert et al., 2019) by collaborating across internal technical and non-technical departments and with communities to make services truly citizen-centric (Barrutia et al., 2022; Bătăgan, 2011). The social inclusion, mutual learning, and engagement methodology of Smart Dublin represent a new systematic way of involving citizens with smart city initiatives. Smart Dublin used community development activities, in which information collected from citizens is utilized as input to build capacity at all stages of project initiation and implementation.

> *"Citizens are part of the design of the project,…of every aspect of the projects that they have a voice in and that is not shaped from a technical executive perspective"*.
>
> (IT and Digital Strategy Manager of a LA)

5. Discussion

The findings of this study explain how boundary spanning takes place within a multi-organization structure and specifically helps to build collaborative mechanisms in a smart city context. Drawing on the findings and their contributions to the existing literature of boundary spanning and the real-world barriers to an effective inter-organizational collaborative governance approach and joined-up working with citizens, the next subsections summarize the theoretical and practical implications for both researchers and practitioners.

5.1. Theoretical implications

The theoretical contributions of this research provide empirical evidence through the boundary spanning lens to understand boundaries, the multiple roles and activities of a boundary-spanning organization, and the consequences of such roles in building an effective collaboration and governance approach.

First, the emerging taxonomy of boundary-spanning activities (see Table D1 in Appendix D) presented in this research is the one of few empirical studies focusing on a boundary-spanning organizational setting in a multi-actor environment (Acuto et al., 2019; Marrone, 2010). Our findings offer a supportive architecture of a boundary-spanning organization and the mechanisms adopted by them to illustrate boundary-spanning activities occurring not only within an organization but also between a set of diverse actors' organizations (Buick et al., 2019). Therefore, the case of Smart Dublin identifies generative boundaries to span multiple levels of government entities, IT companies, universities, and citizens, that are characterized by different cultures, knowledge bases, disciplines, or perspectives (Buick et al., 2019).

Second, our findings delineate how a boundary-spanning organization traverses different boundaries to transfer, translate, and transform knowledge through the performance of political, cultural, technical, and social roles. The major objective of boundary spanners is to create cross-boundary practices where all actors can utilize, learn from, and synthesize knowledge when their work routines are identified and represented to others (Carlile, 2004; Carlile and Rebentisch, 2003; Schein, 2017). Carlile (2002, 2004) and Kellogg et al. (2006) suggest that boundary spanners manage the flow of information by engaging in cross-boundary coordination practices. Tippmann et al. (2017) explicate that the consequences of these activities are the creation of new knowledge and practices such as the replacement of work processes, the creation of innovative products and services, and the rejuvenation of management and business practices. In doing this, Smart Dublin creates a new milieu of boundary-spanning work among local authorities and IT companies, where the technical and cultural work activities transfer existing information to each other and both groups develop a common understanding of each other's existing knowledge to resolve issues and conflicts. Also, the technical and political work activities help modify the body of knowledge, expertise, and technical skills of these actors so that they can reframe existing knowledge and generate new knowledge. Beyond these changes, the combination of social, technical, cultural, and political roles of the boundary-spanning organization includes efforts that have made a significant shift from traditional autocratic management and business practices into a more citizen-centric form of governance.

Third, the internal/external and citizen collaborative mechanisms conceptualized in this study contribute to building bottom-up governance components, including administrative cultures, policies, and decision-making processes (Meijer and Bolívar, 2016). These mechanisms initiate the garnering of "raw" contributions from citizens (social role), feed LAs' internal technical staff with citizens' priorities for smart city development (cultural role), and endeavor to send signals to the LAs about their legacy regulations and the processes inherent in smart city operations (political role). These roles create capacity for the enhancement of internal and external collaboration and integration through increasing the efficiency of formal regulations, policies, and protocols, and establishing innovate effective management styles for executing project activities. Alongside the improvements in hard skills and business processes brought about by the use of a boundary-spanning organization, the LAs also experienced a cultural shift in terms of their

capacity and models for interacting with citizens. This new knowledge can be used to enhance and center the ethical and human-rights-based dimensions inherent in any smart city project; instead of being the default afterthought of project design, engagement with the public becomes a palpable opportunity to mainstream effective participatory governance practices within business models. IT companies also benefited from this process by using stakeholder input to move closer to the goal of achieving universal design of services and products that will appeal to a broader market, even after the substantive project is finished.

5.2. Practical implications

Smart Dublin's roles can offer practical solutions to resolve universal barriers (discussed earlier in the Literature) through internal and external collaboration and citizen participation (Coletta et al., 2019; Broccardo et al., 2019; Emerson et al., 2012; Nam and Pardo, 2014). Smart Dublin has overseen some flattening of the hierarchical structure of collaborative governance after its inception (Coletta et al., 2019; Kitchin and McArdle, 2016; Perng, 2017). This has been achieved by emphasizing the use of various internal, external, and citizen participation activities as communication channels between the various actors and by refining knowledge exchange practices. Internal and external collaboration, for example, provides a basis for understanding legal, regulatory, and ethical imperatives, resolving conflicts, balancing power relations, and acquiring the IT skills necessary for project implementation. However, internal and external collaboration do not seem to be firmly established between the actors in Dublin's smart city. This may be because of the lack of a formalized communication approach between Smart Dublin and some of the local authorities and universities. This result is consistent with previous findings that formal features are necessary for collaboration (Coletta et al., 2019; Broccardo et al., 2019; Ruhlandt, 2018) and highlights where collaboration should expand to involve more of these actors in the future.

Previously, researchers have argued for a top-down version of citizen participation, in that citizens should be consulted for feedback using social media or online tools after a project's detailed objectives have been decided (Cardullo and Kitchin, 2019) and key planning and decision-making processes have concluded (De Waal, 2014; Seltzer and Mahmoudi, 2013). Therefore, abundant efforts have been expended to engage with citizens through new technologies, such as the use of open data sources, citizen sensors, and serious games, to enhance collaboration between the city's government and citizens (Batty et al., 2012; Federici et al., 2015; Pereira et al., 2017). However, researchers have noted that citizens do not become the main co-creators or dominant decision makers in smart cities' initiatives, and co-creation primarily occurs in the form of short-term hackathons or living lab projects, mostly restricted to an unbalanced selection of citizen targets (Engelbert et al., 2019; Martin et al., 2018). According to Arnstein's (1969) ladder of citizen participation, demonstrating citizen power on the top rung entails delegating decision-making authority to citizens and giving them opportunities to engage meaningfully at each stage of innovation and project implementation. In relation to Dublin's smart city initiatives, Cardullo and Kitchin (2019) claimed that an example of citizen participation where co-creation was present was difficult to identify, but this was not the case in the Smart Dublin arena, as ownership and creation are actively induced by the social, technical, cultural, and political boundary-spanning activities. Beyond these citizen engagement efforts, the collaborative framework introduced in this study offers solutions for intensity and quality of collaboration, contributing to public value creation (Barrutia et al., 2022). We hold that the social inclusion, mutual learning, and engagement methodology roles of Smart Dublin enhance the frequency and fluidity of relationships with citizens, thereby enabling citizen participation in innovative decision-making processes for smart projects and city services. Furthermore, these roles substantially realize the participatory formats with citizens envisaged by European Commission in order to implement citizen-led initiatives (Engelbert et al., 2019; Mora et al., 2019). In parallel with this process, cultural, political, and technical-based activities improve the functionalities of internal IT and non-IT departments and give rise to new public services administration based on citizen-led impetus.

From social capital- and human capital-based approaches in building smart cities (Kummitha and Crutzen, 2017; Tan and Taeihagh, 2020; Myeong et al., 2020), these developments in city governance mechanisms are an example of how a visible democratic governance approach thrives on intangible, skills-based developmental efforts among citizens and government staff. Given that investments in human and social capital fuel the success of smart city projects and services through a more citizen-centric governance approach in medium- or large-sized cities (Caragliu and Del Bo, 2019; Caragliu et al., 2011; Myeong et al., 2020; Ruhlandt, 2018), the results of this study shed a light on essential governance practices for those cities with a similar set of city-level specificities and characteristics to Dublin.

The practical contributions of this study provide an insight into the significance of the establishment of boundary-spanning organizations. The study contributes to the understanding of technical actors' perceptions of the value of boundary-spanning activities: the majority of respondents spoke of their interaction with Smart Dublin in positive terms and were open to further engagement in this type of work. City governments must improve the performance of these organizations by investing them with more executive power and hiring more employees with IS/IT backgrounds with a longer vocational employment. However, the influencing and trust-building practices carried out by Smart Dublin remain somewhat nebulous due to the lack of records of process flows and evaluative systems. Relying on individuals' characteristics and relationships rather than on recording strategies represents a risk to longer-term sustainability, in that staff turnover could lead to the loss of expertise and local knowledge that has contributed to Smart Dublin's successes.

6. Conclusions, limitations, and future research

This study examined the experiences of a boundary-spanning organization set up as part of a city's drive to offer smart services to its residents. Mediating bodies of this kind are often used in establishing smart cities because these projects involve a range of actors, but previous research in this domain has not examined their specific practices and impact. Using rich qualitative data, this study has developed a taxonomy of such practices and explained how the different types of activities – technical, social, cultural, and political – have provided the web of connections needed to develop the smart city. As more cities begin to use advanced IT to achieve their goals more effectively, this study's findings will be useful to those involved in such initiatives, whether at organizational, individual, or task level. More importantly, the integration of boundary-spanning activities demonstrates how the governance style of Dublin's smart city initiatives has transformed to be more bottom-up and citizen-centric.

As with any research study, this one has several limitations and offers multiple potential avenues for future research. As a cross-sectional design, there may be a lower level of robustness in our conclusions, compared to a longitudinal design that is better able to demonstrate the

consequences of the boundary-spanning organization in the smart city context. Another limitation is that boundary-spanning activities developed in this research were found in an existing city with soft infrastructure-oriented strategy. We encourage others to pick up on our findings in other smart cities with either technology- or human-driven approaches.

As this study focused on the boundary-spanning organization in a multidisciplinary context, the demonstration of the four roles and the collaborative framework these roles build should be employed in assessing and evaluating the success of smart project implementation. In the IS context, several researchers have investigated intra- and inter-group activities within an organization and social interactions with external actors during IS project development and implementation (Sawyer et al., 2010; Fisk et al., 2010). Future research could incorporate the suggested boundary spanning-enabled collaborative mechanisms outlined in this study to explain the impact of the strategies, behaviors, and processes undertaken by a boundary-spanning organization on the effectiveness of smart services and projects. Also, since collaboration can elicit the transformation of organizational norms (Birkinshaw et al., 2017; Schotter et al., 2017), perhaps the occurrence of boundary spanning roles in organizational settings could be used to evaluate the performance of other actors' organizations. Several IS researchers have investigated the importance of IT governance implementation, consisting of structure, process, and relational mechanisms within an organization that enable both IT and business functions to execute their responsibility in support of IT-business alignment (De Haes and Van Grembergen, 2005, 2009; Boonstra et al., 2018). Maccani et al. (2020) have identified IT governance structural mechanisms through which triadic alignment can be shaped between IT, smart city, and non-technical functions in city authorities' organizations. We encourage future researchers to focus on the effectiveness of IT governance between IT functions and other departments within local authorities' organizations in the light of the flattening governance structure described in our research. Specifically, future research should focus on how the alignment between IT, smart city, and business functions can be improved through the boundary-spanning organization's roles that can enable internal and external collaborative mechanisms between the IT companies and internal technical functions of local authorities.

Another future research stream could arise from the levels of executive power of boundary-spanning organizations (Acuto et al., 2019; Coletta et al., 2019). A future research question is whether a lack of enforcement powers facilitates the success of a boundary-spanning organization in terms of its negotiating and influencing activities within the soft power sphere; perhaps the siloed nature of the types of organizations and industries targeted by boundary spanners mean that they are more easily permeated through the informal strategies and networking activities in which boundary spanners currently engage?

Data availability

The data that has been used is confidential.

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Appendix A

The impact of boundary-spanning activities on smart collaboration
Provisional interview questions[2]:

1- Can you describe your organization and its role within a smart city context?
2- What is your role within your organization?
3- What activities does your organization specifically carry out to develop, plan, and deliver smart projects?
4- How do you measure smart project success?
5- Can you describe the range of stakeholders you collaborate with?
6- Can you describe the types of information and knowledge that you receive and/or share with these stakeholders? What kinds of processes support such sharing, i.e., face-to-face, digital, documents, steering groups, meetings, and so on?
7- To what extent is the knowledge and information acquired understandable and interpretable?
8- What strategies do you use to ensure a common understanding between stakeholders? E.g., how information is edited, summarized, reworded, reformatted, and so on.
9- Are the relationships created by Smart Dublin temporary or are some sustainable in the long term? If so, please describe.
10- In your experience, how has the role of smart Dublin improved the levels of collaboration in Dublin?
11- What more could be done to improve smart collaboration and what are the particular challenges and opportunities to such improvement? For example:
- How might collaboration be more sustainable and produce more sustainable solutions?
- How might internal technical expertise play a more meaningful role in collaborative process?
- In your experience to what degree does organizational culture and/or politics impact collaboration?
12- What impact if any has regulatory frameworks such as GDPR had on the capacity of stakeholders to collaborate?

[2] **Note:** The interview guide provided an outline of the topics and open-ended questions to be covered in the interviews via email, including examples of boundary spanning and its applicability in different contexts. The above questions were designed based on previous studies (Ancona and Caldwell, 1992; Pawlowski and Robey, 2004; Sawyer et al., 2010) to elicit rich descriptions from the informants about their experiences and work practices related to boundary spanning in a smart city context.

Appendix B

Table B1
Projects and programs led by Smart Dublin and the LAs.

Projects	Lead authorities	Description	Impact
Small Business Innovation Research (SBIR)	Dublin City Council, Fingal County Council, Dun Laoghaire-Rathdown County Council – all supported by Smart Dublin	Small Business Innovation Research (SBIR) program, in partnership with Science Foundation Ireland (SFI). SBIR programs operate in the pre-commercial procurement space, allowing public bodies to stimulate innovation in the small business sector within formal procurement parameters. The SBIR programs operate by addressing challenges identified by local government that impact citizens which will, in turn, lead to reduced congestion, cleaner air, lower noise pollution, and safer roads. It has been proposed that these solutions will enhance the capacity of citizens to connect with the city and, therefore, play a more active role in improving advocacy mechanisms and collaborative decision-making. To date, this project has enabled 42 SMEs to leverage funding support totaling €1.5 million. In 2018, Fingal County Council launched the "Unheard Voices" challenge, under Enterprise Ireland's SBIR program. The challenge aimed to engage young people, migrant groups and others with new technological solutions. It includes two phases: Phase 1: a series of participatory workshops were held with community members across Fingal to understand the local context and identify the design needs of the end-users. Phase 2: a beta version of an app was made available, and users could submit feedback and suggestions as the app was further developed. The **Fingal Voices** app was officially launched in May 2020. Citizens can vote, rate, and comment on specific consultations and questionnaires, submit ideas and suggest improvements, and access local and community news and events information.	This project has removed the gap between communities and decision makers. The implemented app empowers citizens to engage in joined-up decision-making with Fingal County Council and encourages citizens to share their views and opinions about the future of their city.
Unheard Voices	Fingal County Council, in partnership with Enterprise Ireland and Smart Dublin.		
Local Authority EV Charging Strategy for the Dublin Region	Dublin City Council, Fingal County Council, Dun Laoghaire-Rathdown County Council – supported by Smart Dublin and CARO	This project is intended to facilitate Dublin's four local authorities in exploring the challenges and opportunities associated with the provision of electric vehicle (EV) charging infrastructure. It is the intention of the local authorities to implement a network of public charging stations in residential areas which will compliment services currently being supplied by the ESB (Electricity Supply Board) and by private operators. The strategy will be published in June 2022.	This project helps policy-makers who strive to achieve a just transition, where citizens from across society have opportunities to avail of the benefits of low-carbon life.
WiFi4EU	Dublin City Council, Fingal County Council and Smart Dublin	WiFi4EU is an initiative of the European Union which promotes free access to Wi-Fi connectivity for citizens in public spaces such as parks, squares, public buildings, libraries, health centers, museums, and community and Council facilities. Fingal installed 47 Wi-Fi access points in 18 different locations whilst Dublin City installed 145 access points in 33 different locations in the city.	The project aims at giving communities better internet access, improving digital literacy, and complementing other public services provided in the locations selected, such as parks, libraries, community centers, and youth services.
5G Network	Smart Dublin	The project is designed to trial Dense Air's neutral-host, small-cell 5G network in the Docklands area of Dublin. As mobile data consumption increases, Mobile Network Operators (MNOs) are faced with the prospect of increasing the densification of their infrastructure in preparation for the transition to 5G standards. This trial led to the below developments providing guidance to guide Local Authorities on the rollout of 5G. 1) The emergence of the Neutral Host model as an attractive future deployment model for local authorities across Ireland. 2) Developing streamlined interpretation and issuing of section 254 licenses for delivery of new mobile sites or equipment installs such as small cells.	The first phase is completed, and small cell units have been installed across the Docklands area, which provide connectivity both indoors and outdoors. The success of this project was recognized in 2019 with a win at the World Small Cell Awards. Dense Air are now replicating this work in some cities in Portugal, Belgium, Australia and elsewhere. The extension of this project will improve Dublin's economy, lower mobile network costs for both providers and consumers, and provide more equitable access to the internet.

(*continued on next page*)

Table B1 (*continued*)

Projects	Lead authorities	Description	Impact
		3) Establishing a centralized point of contact for connectivity requests in each local authority. 4) Investing pivots to small cells and a new revenue opportunity emerges for local authorities. 5) Ensuring that the interests of citizens and communities are put at the center of the implementation process by minimizing digital divide and social exclusion risks. 6) Open access to local authority assets on equal terms to all operators where appropriate to support densification plans.	
MaaS (Mobility as a Service)	Smart Dublin	This project is a collaboration between Smart Dublin and Urban Foresight, funded by the Department of Public Expenditure and Reform through its Public Sector Innovation Fund. The Maas project is considered customer-centric services that integrate all travel modes (public & private) and facilitate journey planning plus payment facilities. A public-led MaaS model has been proposed to better reflect societal goals and protect citizens' data. This model will be implemented without a trial.	Once this project is implemented, it will provide users tailored, accurate, seamless, and timely information to inform their mobility choice.
Bigbelly Bins	Smart Dublin	This project is a two-year feasibility study being undertaken by Smart Dublin in order to explore the potential of Bigbelly smart bins delivering service and environmental benefits for the city and the project was designed to investigate the following three categories: service optimization, developing an advertising-based revenue stream, and Smart City functionality. Bigbelly bins have been deployed in Dublin's Docklands through a novel innovative service model contract (compared to Bigbelly bins deployed in other parts of the city) to investigate five main work streams: Optimizing waste management; local advertising; Deployment of Internet of Things (IoT) & WiFi solutions; supporting telecoms and 5G; as well as further R&D as identified. To date, around 110 smart bins have been installed across the Dublin Docklands area over a 30-month period.	The project outcomes show an 85 % reduction in collection frequencies in the Docklands and in the overall cost of the bins through revenue received from local advertising on the bins. Each bin is equipped with one WiFi connection (powered by a solar panel) and new sensors to capture information on air quality, noise, and footfall in the area. Also, there is the potential to use the bins in order to investigate an approach that could host small cells and support 5G to help deliver better connectivity in mobile coverage “black spots”.
Flooding Sensor	DCC and Smart Dublin	The purpose of the project is to support technical innovation by testing the potential of a network of low-cost, low-powered rainfall and water level sensors to operate effectively on Pervasive Nation's IoT testbed, using the LoRa-flavored LPWAN (low-power wide area network). So far, 25 rainfall sensors using LoRaWAN connectivity, 10 river level Sensors using Sigfox connectivity, and 56 sensors (river, rainfall, weather stations, etc.) using cellular connectivity, have been added.	This project is able to determine rainfall and river levels, which can help determine flood risk to homes, businesses, schools, and all other affected properties and persons around the vicinity.
3D Docklands Planning Model	DCC and Smart Dublin	This project, which sought to produce a detailed 3D model of the Docklands area of Dublin, is a collaboration between DCC (Dublin City Council) and the computer aided drafting company, D3D. The intention of the project was to explore the potential of such a model in assisting planners and developers in answering questions relating to structural and infrastructural issues. This led to changes in the design which should improve the real-life experience for citizens of and visitors to Dublin.	The model has already provided great value to the city in the planning process. It supported the initial design phase for the proposed Blood Stoney Bridge. LA planners were able to virtually walk along the bridge and experience what it would be like. The model was also used to bring the designs of a proposed White Water Rafting facility to life. The model received over 160,000 views, demonstrating the potential of using 3D modeling to communicate proposals and engage the public.

Appendix C

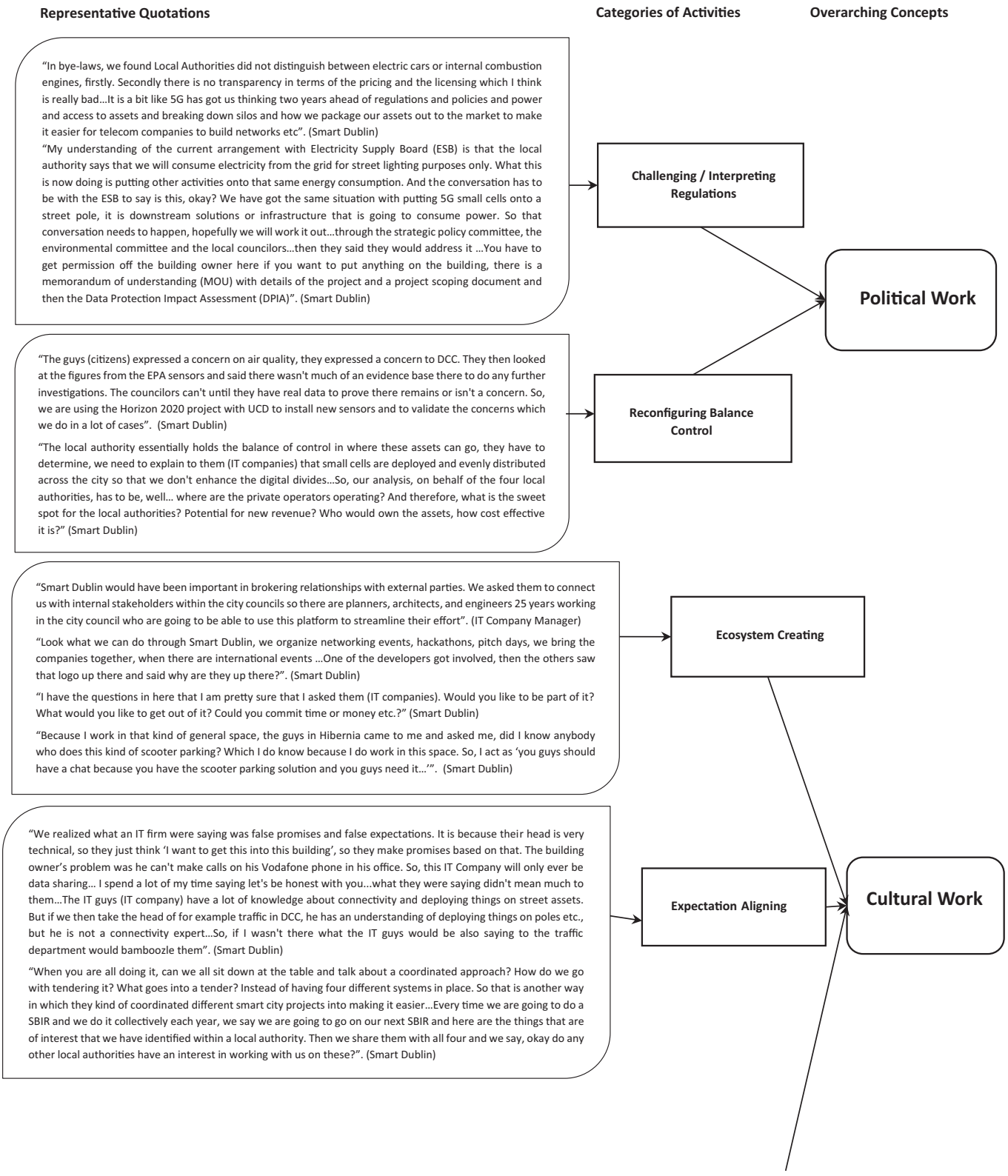

Fig. C1. Data structure.

Fig. C1. (*continued*).

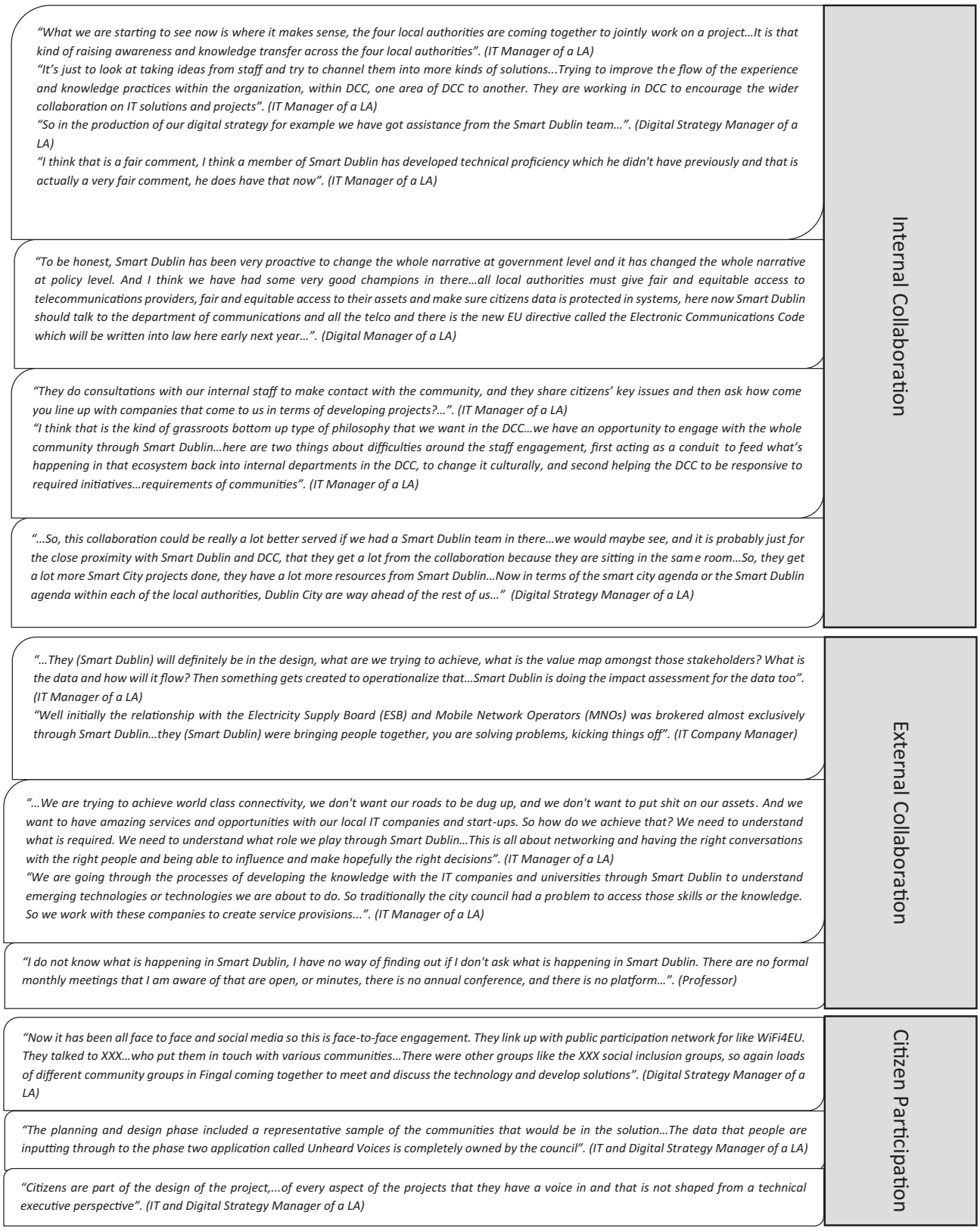

Fig. C2. The Quotations of Internal/External Collaboration and Citizen Participation.

Appendix D

Table D1
Boundary spanning roles and activities.

Boundary spanning roles	Activities
Political	• Negotiating regulatory requirements and the importance of updating policies and procedures with local authorities. • Negotiating appropriate and fair access to city infrastructure and data for IT companies. • Ensuring environmental sustainability and regulatory standards in different stages of project implementation. • Negotiating legal issues (e.g., data protection liability, due diligence practices, and intellectual ownership of data and city assets) and human rights principles enshrined in legislation (e.g., privacy and security of citizens) with IT companies and other stakeholders. • Lessening the dominance of the local authorities as well as IT companies through confrontational behaviors.
Cultural	• Using different approaches to make new relationships and maintain existing connections between internal IT functions, IT companies, and universities. • Evaluating external actors (e.g., IT companies) based on their cognitive and historical performances in specific fields. • Minimizing asymmetric knowledge and fostering mutual understanding among technical departments of local authorities and IT companies. • Identifying potential sources of conflict and playing a persuasive role in reconciling differences through some translating across boundaries. • Playing an entrepreneurial role to engage with the internal technical functions of local authorities in order to develop innovative ideas and solutions.
Technical	• Acquiring multiple technical specialties and skills in the various phases of developing smart projects. • Coordinating information and knowledge within and between actors' organizations through using boundary objects.
Social	• Ensuring the participation of citizens in developing digital strategies and innovation processes. • Increasing the awareness of citizens about potential smart projects and their impact on the quality of their lives. • Educating citizens about technologies and their utilizations, and familiarizing them with city policies and services. • Playing an entrepreneurial role to gather citizens' ideas and solutions, integrate findings into meaningful information and knowledge, and develop smart projects and digital strategies based on information gathered. • Building trust and authentically cultivating citizen participation. • Actualizing the implementation of the social inclusion and mutual learning roles through several engagement methodology activities.

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