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Innovation networks for social impact: An empirical study on multi-actor collaboration in projects for smart cities

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ABSTRACT

This study investigates the factors that drive an innovation network formation comprising companies, government, and society, and the ways these actors contribute and collaborate within a network to develop technologies that have a social impact. A conceptual framework has been developed by combining literature-based arguments and insights from two cases of smart city innovation. This study demonstrates that the innovation network is driven by the activities of searching, acting, and convincing actors of an opportunity to develop smart city solutions. The findings also show that innovation networks emerge not solely from a business goal, but also from a social goal and can still generate business opportunities for companies. Therefore, innovation for smart cities specifically requires a new form of configuration (public–private and citizens' participation), drivers (economic and social), and resources (technological and non-technological) in both its development and implementation. The analysis of the different configurations suggests more/less effective innovation.

1. Introduction

Innovation is a top priority for many business leaders, but the complexity involved in the innovation process, particularly in the high-tech industry, which requires an integration of different pieces of scientific knowledge, has encouraged companies to innovate through networks (Alberti & Pizzurno, 2017; Möller & Halinen, 2017). Scholarly attention to innovation networks, which is defined as loosely coupled systems of autonomous actors engaged in innovation (Dhanaraj & Parkhe, 2006), has increased with its practical relevance (see e.g. Dhanaraj & Parkhe, 2006; Möller & Halinen, 2017; Alberti & Pizzurno, 2017). A significant body of literature exists on networks, but these studies tend to focus more on inter-firm cooperation. However, if a new technology aims to address solutions for complex societal problems, such as climate change, urban population, or a pandemic, a company developing such a solution will certainly need to develop close relationships with several actors outside their traditional network of partners (for example, government and society).

There is little literature on how opportunities for innovation that have a social impact are formed and how they evolve when actors participate in different stages of the innovation. Hence, this study aims to enhance the theoretical understanding of innovation networks by analysing actors, resources, and activities, and by providing descriptions of the network dynamics during the innovation process. Thus, the **first research question** is: Which factors drive an innovation network formation comprising companies, government, and society? Studies within innovation networks suggest that innovation networks, in general, are innovation-driven and therefore emerge from an economic motivation (Möller & Halinen, 2017; Hurmelinna-Laukkanen and Nätti, 2018). However, it is relevant to examine if this is also the case when companies are embedded in a network containing non-business actors. These actors commonly aim to achieve a social goal. There is a lack of knowledge about innovation that has a social impact and empirical studies are few in numbers (Kumar & Christodoulopoulou, 2014).

This study focuses on two smart city projects. According to the European Commission (2018), the global smart cities market is expected to exceed USD 2 trillion by 2025. The term 'smart city' refers to the integration of public and private services using technological innovation, which typically involves ICT (information and communication technologies) (Zanella, Bui, Castellani, Vangelista, & Zorzi, 2014). Such technologies have a societal impact since they may facilitate remote monitoring and the management of traditional public services, such as transport and parking, public street lighting, education, and health, etc. Specifically, the social impact of smart city projects refers to certain social consequences of any public or private actions that change how citizens live, work, relate to one another, and generally cope as members

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of society (Burdge & Vanclay, 1996). Although ICT technologies, as stated above, may impact society positively, ICT itself does not automatically transform cities, and success factors are related to how different stakeholders interact and find solutions for complex societal problems (Hadjikhani, Leite, & Pahlberg, 2019). From a business point of view, incorporating digital technologies that meet the city's sustainable development may create business opportunities for companies, while contributing to social well-being. This means that companies need to understand the current problems experienced by a mayor, public official, society, or any potential users of the solution. The **second research question** is thus: How do business and socio-political actors contribute and collaborate within a network to develop technologies for a social impact? Here, social actors refer to 'NGOs and citizens', while political actors refer to 'mayors and public officials'.

Rather than focusing solely on the corporate level, the aim is to analyse the cases at the network level by incorporating the views of various network participants. The innovation investigated in this study includes both companies' technological development and the implementation of the smart city solution. However, such phases do not follow a series of sequential events, i.e., starting from idea generation to implementation. The main reason for this is that innovation in a city setting requires not only the needs of mobilising resources, but also the aligning of diverse interests of actors, for example, economic and social, at different stages (Hadjikhani et al., 2019). This suggests a more dynamic iterative aspect and therefore phases of development and implementation intersect. This process will be further illustrated through the companies' activities of searching, acting, and convincing actors of an opportunity to develop a smart city solution. These activities are important to explain network formation, configuration, and dynamics.

This study contributes to both business and marketing network literature in several ways. First, it brings a conceptual analysis of relationships between actors, resources, and activities at the network level. Second, the cases show that two types of innovation networks emerged: one, coordinated by a non-business actor, is driven by a social goal, while another is coordinated by a company driven by a business goal, but addressing a social purpose. In addition, we illustrate that innovation networks for social impact require new forms of collaboration that combine public–private and citizens' participation. Finally, the study offers insights into which configuration of the actors (business and non-business), resources (technological and non-technological), and drivers (economic and social) may result in more/less effective innovation.

The paper is structured as follows. First, a review of the relevant literature on innovation networks is undertaken and the theoretical basis regarding network formation and configuration is discussed. The method, research process, and the background to each case are then described. Following this, the case analysis and the key findings are presented. The paper concludes with a summary of the main contributions and suggests avenues for further research.

2. Theoretical background on innovation networks

Möller and Halinen (2017) highlight that the industrial network theory provides a wider view of actors and their contribution to innovation. Studies range from individuals, groups, and organisations to a network of partners. Research has also been conducted on the understanding of how public–private collaboration contributes to science and technology-driven commercial offerings. Examples include science parks, business accelerators, and other forms of entrepreneurial networks (Partanen, Chetty, & Rajala, 2014). Some other network researchers have highlighted the role of non-business actors in the final stage of the innovation, i.e. in the commercialisation. For instance, Aarikka-Stenroos, Jaakkola, Harrison, and Mäkitalo-Keinonen (2017), state that business partners beyond the traditional supply chain may facilitate the process of bringing innovation to the market and help to reduce the resistance of newness. In the same line of thinking, Leite and Bengtson (2018) stress that non-business actors are primarily important in projects with a social purpose because they can help companies to gain endorsement and build trust and a reputation.

Cooperation for innovation can also be found in strategic alliances (Bouncken, Fredrich, Kraus, & Ritala, 2020; Bouncken & Fredrich, 2016), teamwork (Jiménez-Jiménez & Sanz-Valle, 2011), and innovation including startups (Alberti & Pizzurno, 2017), but the role of government and society on companies' innovation processes has received less attention, at least in comparison to traditional business network literature. One exception is observed in social impact research that emphasises the multi-actor collaboration and social influence within, but not limited to, corporate philanthropy (see, for example, Dees & Anderson, 2003; Vasi, 2009), social value (Quélin, Kivleniece, & Lazzarini, 2017), and socio venture (Van de Ven, Sapienza, & Villanueva, 2007; Zahra, Gedajlovic, Neubaum, & Shulman, 2009). However, these studies do not bring a network perspective to their analysis, which is what this present study focuses on. Nevertheless, there is a need to expand an understanding of how and under which conditions non-business actors contribute to companies' innovation processes and the social impact of such innovations.

2.1. The formation of innovation networks

The traditional business network perspective explains the reasons for cooperation among business partners (Håkansson & Snehota, 1995). First, technical development will occur only if it is perceived to solve a problem or achieve a goal for users. Therefore, resources will only have a meaning in relation to actors. Second, because the resources required in any combination are controlled by different actors in the network, relationships should be developed. However, in a city setting users differ, i.e. the client is not a company and integrating resources means incorporating business resources into the needs of socio-political actors. Hence, the resource dimension is expected to be intrinsically interwoven with the actor dimension and at the intersection between actors and resources, the concept of a smart city solution emerges.

In a city environment, actors have a different perception of value. While the public managers' goal is to reduce costs, citizens expect a safer life or less time in congestion (Meijer & Bolívar, 2016). Thus, if an invention is perceived to be a type of breakthrough that creates a lot of value to citizens and governments, the network of companies that invented it will be rewarded more generously than those who are superior only at an incremental level. Opportunities that are cognitive distant (with potentially more reward) are those which require the company to act and explore knowledge beyond its intellectual domain (Gupta, Smith, & Shalley, 2006) and are therefore radical in character (explorative type). According to Nilssen (2019), smart city initiatives that encourage citizen involvement in the innovation process have a radical scope. In contrast, opportunities that are cognitive proximate are those very close to or within the company's current knowledge domain. Thus, adding a smart city solution to an existing urban system, for instance, belong to the incremental (exploitative) innovation type (Nonaka, 1994). Despite the attractiveness stated above concerning the rewards for those networks conducting incremental and/or radical innovation, companies face difficulties when exploiting an opportunity (March, 1991), interpreting and acting on novel opportunities (Gupta et al., 2006), and shaping the idea/invention to the market (Gupta et al., 2006).

It is important to distinguish idea/invention from innovation. Ideas represent the very initial stage of the development of an invention, i.e. a product or service, but this needs to be proved by either a full solution or prototype. The invention is the extension of the idea that is developed into either a prototype or an intermediate solution, while the innovation is confirmed to have been developed when the end-user experiences it. In this study, the terms 'idea' and 'invention' are used interchangeably, since the invention is an idea that has been further developed

(Ostendorf, Mouzas, & Chakrabarti, 2014). Aarikka-Stenroos and Sandberg (2012) argue that the invention does not influence company performance until it is introduced to the market. Gavetti (2012) explains that even if companies identify where a superior opportunity lies, they can be stuck and unable to act and seize an opportunity. Gavetti states that there is a lag period between identifying, creating, and seizing opportunities. In addition, companies also compete to gain legitimacy and brand awareness of their products and/or services. Thus, to identify an opportunity and then act by creating, for instance, a new technology does not translate directly into superior performance since companies still need to convince external audiences, i.e. customers need to be convinced of the potential benefits, e.g. cost savings, social value, etc. (Anderson, Narus, & Narayandas, 2008) of the new technology. Technologies applied to cities are still a novel concept and overcoming the resistance of end-users and/or intermediaries is crucial for a successful implementation. The potential buyers of smart city solutions are political authorities, but public opinion from NGOs and citizens may influence decision-makers. Thus, companies' interactions with such actors are important to understand what the needs of society are and then adjust the technology accordingly.

2.2. The configuration of innovation networks: a multi-actor collaboration

This study focuses on the role that actors and networks play in companies pursuing a business opportunity for the development of a smart city solution. In this context, the solution can be understood as the integration of products and services, including a unique interface between companies and users, and also interoperability among products and services (Zanella et al., 2014). Actors are important agents of innovation and activities are performed using their resources, which are embodied in the form of competences, knowledge, technological know-how, etc. (La Rocca & Snehota, 2014). Actors, therefore, assess available and potential resources to understand what type of resources they already have and how these can be combined (La Rocca & Snehota, 2014).

In a smart city context, the configuration of the network involves both business partners and socio-political actors. Companies, thus, contribute their technological expertise to solution development. Examples include technologies to improve public service in education, health, or urban mobility. Socio-political actors know about the city's situation and therefore, by exchanging information about the current needs of a city, they can contribute to idea generation, encourage citizen participation and the usage of the technology developed by companies. By exchanging knowledge with socio-political actors, companies may adjust the technology to meet societal needs. The activities for smart city development are closely linked to the process of exploring or exploiting an opportunity and the knowledge is developed through interactions. From a technological point of view, companies will strategically find ways to use the knowledge in a different environment. For instance, part of the solution developed in a city setting might be used in another setting; examples include solutions for consumers in private parking, private security, etc. (Leite, 2019). This may expand the company's knowledge and its strategy to explore novelty in different settings (Schumpeter, 1934).

It is important to mention that researchers studying the concept of opportunity, however, have focused on individuals acting as entrepreneurs or an opportunity facing a single company. This study neither focuses on people as entrepreneurs, nor single companies, but rather on actors within a network. In the network approach, an opportunity is based on the actors' ability to act, contribute, and interact with others to combine and recombine resources (La Rocca & Snehota, 2014). An interesting aspect related to smart cities is that a successful implementation and acceptance of new technology will require companies to possess the ability to align technologies to contribute positively to society, as well as to manage a complex network structure that includes business partners, governments, NGOs, and even citizens. Hence, innovation networks for social impact are expected to bring a new social dimension, i.e. the smart cities' consumers/citizens named here as socio-political actors who may contribute to the innovation process.

2.3. Innovation networks for social impact

The literature on innovation networks has grown substantially over the past decades and social impact has become an important variable of inter-organisational relationships (Siemieniako, Kubacki, & Mitręga, 2021). This increased attention coincides with the public pressure on companies to embrace the concept of sustainability in their business activities (Kumar & Christodoulopoulou, 2014). In a review of this literature, Siemieniako et al. (2021) found that the social impact is multidimensional and has been analysed at three different impact levels: at the micro level, i.e. within a single organisation; at the mezzo level within, for instance, inter-organisational relationships and networks; and at the macro level within a community or a society. For Hervieux and Voltan (2019), societal transformation that reveals social impact happens in networks containing organisations, groups, and individuals. However, research into the social impact on business is still limited in terms of the analysis of individual organisations and does not consider its relationships and the effect that other actors exert on businesses. However, it is through relationships and networks that the social impact occurs in practice (Barraket & Yousefpour, 2013). Therefore, to address this limitation, we examine the companies' innovation activities for social impact and its influence on the network formation, configuration, and dynamics.

In this study, the innovation network formation and configuration for smart city development are anchored in three main basic business factors: i) companies have a limited ability to identify opportunities (searching); ii) companies have limited resources to pursue opportunities (acting) alone and iii) companies have limited expertise to convince their own external audience about their invention (shaping) (Berends, Van Burg, & Van Raaij, 2011). Thus, collaboration becomes the cornerstone for the development of innovation (Håkansson & Snehota, 1995). This is also in line with marketing network literature, which highlights that innovation is expected to take place through exchange and that it becomes a product of a 'network' of actors (La Rocca & Snehota, 2014), but less explicitly through the activities of 'searching, acting and convincing'. Fig. 1 illustrates the analytical framework for these innovation network activities. *Searching and acting* relate to, but are not limited to, the process of identifying potential partners, assessing the innovation's market potential, and evaluating the extent to which the innovation meets user needs (Harrison & Waluszewski, 2008). To *convince*, companies not only need to create future demand and new markets (Fisher, Kotha, & Lahiri, 2016), but also focus on marketing activities. Therefore, *convincing and acting* are linked to demonstrations of the technologies, brand development, and promotional events (Partanen et al., 2014). In the case of smart city solutions, developing business relationships between business and socio-political actors thus

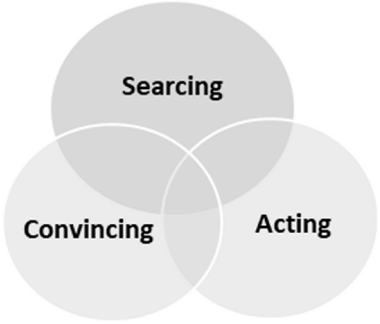

Fig. 1. The innovation network activities.

becomes a precondition to the activity of searching, acting, and convincing since the necessary resources are intertwined with those of other actors. Hence, these three activities become the basis of this study's argumentation and analysis.

3. Method

To understand the reasons for an innovation network formation containing business and social-political actors, as well as to examine how these actors contribute and collaborate in order to develop technologies for a social impact, two smart city projects were chosen. What makes smart city projects particularly useful is that sustainable urban development planning requires a holistic approach that integrates collaboration and coordination among different levels of government, along with companies and society. For this reason, a smart city case study is appropriate in a multi-actor setting, which is difficult to separate from its context (Yin, 2017), but necessary to understand the network formation, configuration, and dynamics. The choice for analysing two cases is in line with Eisenhardt and Graebner (2007) view that multiple cases allow the examination of the phenomenon in many dimensions. Hence, the actors' different viewpoints are considered to gain a comprehensive explanation of the context, but also with a focus on the business actors' engagement with the public sphere (e.g. public authorities, society, and NGOs). Additionally, a comparative case study has been used to identify unique patterns for each case and therefore improve the external validity of this study, while increasing the robustness of the outcomes. In this study, 'process' is captured in the activities of searching, acting, and convincing actors of an opportunity to create a smart city concept.

3.1. Data selection and data gathering

This study primarily relies on interviews and the analysis of secondary sources, such as company reports, and local and international media coverage about the projects. In-depth interviews (71 in total) were collected in two periods (2013–2014) and (2015–2018) with relevant key informants (see Table 1): Managers and decision-makers from the public and private organisations. Most of the interviews were conducted face-to-face, while a few interviews were conducted via phone or Skype. The interview duration was on average 30–180 min. The questions were divided into the following topics: 1) general questions about the overall collaboration; 2) specific inquiries about the idea, the idea's owner, and the development of the network, action plans, and the resources employed by each participant actor; and 3) an investigation into how the network activities helped and/or hindered the business actors when it came to addressing the social impact of the project. Factors such as digital service innovation, an emerging economy context, and the project's social impact were considered for case selection.

Table 1
List of respondents.

Organisation	Respondents by professional position	Interviews	Location
Ericsson	Managers, head of marketing,	19	Sweden,
Huawei	engineers, consultants, and analysts.	5	Brazil
Telefonica/ Vivo	Engineers, head of innovation department, project managers, business developers.	16	Brazil
Telefonica Foundation	Head of CSR initiatives, communication managers and public relation mangers	5	Brazil
ISPM	Head of innovation	3	Brazil
Dataprom	Engagement management, head of marketing, director of innovation	6	Brazil
URBS	Public officials in department of finance, project managers, president.	11	Brazil
ICI	Project managers	4	Brazil
City Hall	Secretary of tourism	1	Brazil
IPUCC	Head of city urban planning	1	Brazil
	Total number of interviews	**71**	

3.2. Data analysis

The analytical process comprised three steps of data analysis with a code procedure, following Gioia's methodology (Gioia, Corley, & Hamilton, 2013). Data were transcribed and coded using N-Vivo. The transcripts of the interviews were compared to the secondary sources, which helped to triangulate information and to enhance data validity (Eisenhardt & Graebner, 2007). In the first step, the data were analysed separately for each case and first-order open codes were then developed based on the informants' words. This resulted in case narratives and a historical timeline for each case with an emphasis on analysing the activities implemented, respondents' motivations, and expectations developed before and during the project. Initially, the focus was on understanding the collaboration process guided by the lens of the business relationship literature (Håkansson & Snehota, 1995), but as soon as the data were gathered, it was observed that the activities performed within the network appeared to be crucial to explaining not only the collaboration, but also the innovation process, the actor's contribution to the network, and the reasons for a network formation, configuration, evolution, and dynamics. Following this, second-order codes were generated with a more specific theoretical background in mind, such as business relationships (Håkansson & Snehota, 1995) in connection with innovation networks (e.g. Aarikka-Stenroos et al., 2017). Since the data analysis was an ongoing process, not all possible and relevant literature was identified in advance. However, this was revealed as part of the evolution of the cases by systematically combining data and theory (Eisenhardt & Graebner, 2007).

Subsequently, a third round of data analysis resulted in a more abstract level of coding in which searching, acting, and convincing constructs emerged as key phases of an opportunity for innovation within a network comprising business and socio-political actors. This third round showed that resource assembly has an impact on how activities were tailored to other actors within the network. Finally, the combined themes were put into the aggregate dimensions of building a data structure (see Fig. 2) by cycling between emergent concepts (for example, opportunity development and innovation activities) and themes (societal impact and citizen's engagement), and existing theory (Håkansson & Snehota, 1995). In this third and final step, we returned to the case narratives, and the second-order themes and aggregate dimensions were mapped to the case history timelines to establish a process representation (Pettigrew, 2011). Throughout the cross-case comparison (Yin, 2017), the activities of searching, acting, and convincing became relevant to explain an actor's role and contribution to the overall outcome as well as the evolution of the network over time. For instance, through the activities, it was possible to understand the reasons for which some actors stepped out and new actors stepped in during different phases of the smart city project. Thus, the collaboration aspect and the activities performed became the basis for addressing this study's aim and research questions.

4. Case description

4.1. Case 1 – Curitiba Smart City Project for Urban Mobility

The project was an initiative that came from non-business actors such as URBS (Urbanização de Curitiba) and ICI (Instituto de Comunicação e Informação). The project involved the implementation of 3G technology to the city's buses along with the development of an Operational Control Center (OCC) that could permit fleet monitoring and management in real time. URBS is a public organisation whose main task is the operation and supervision of the city's transport system, while

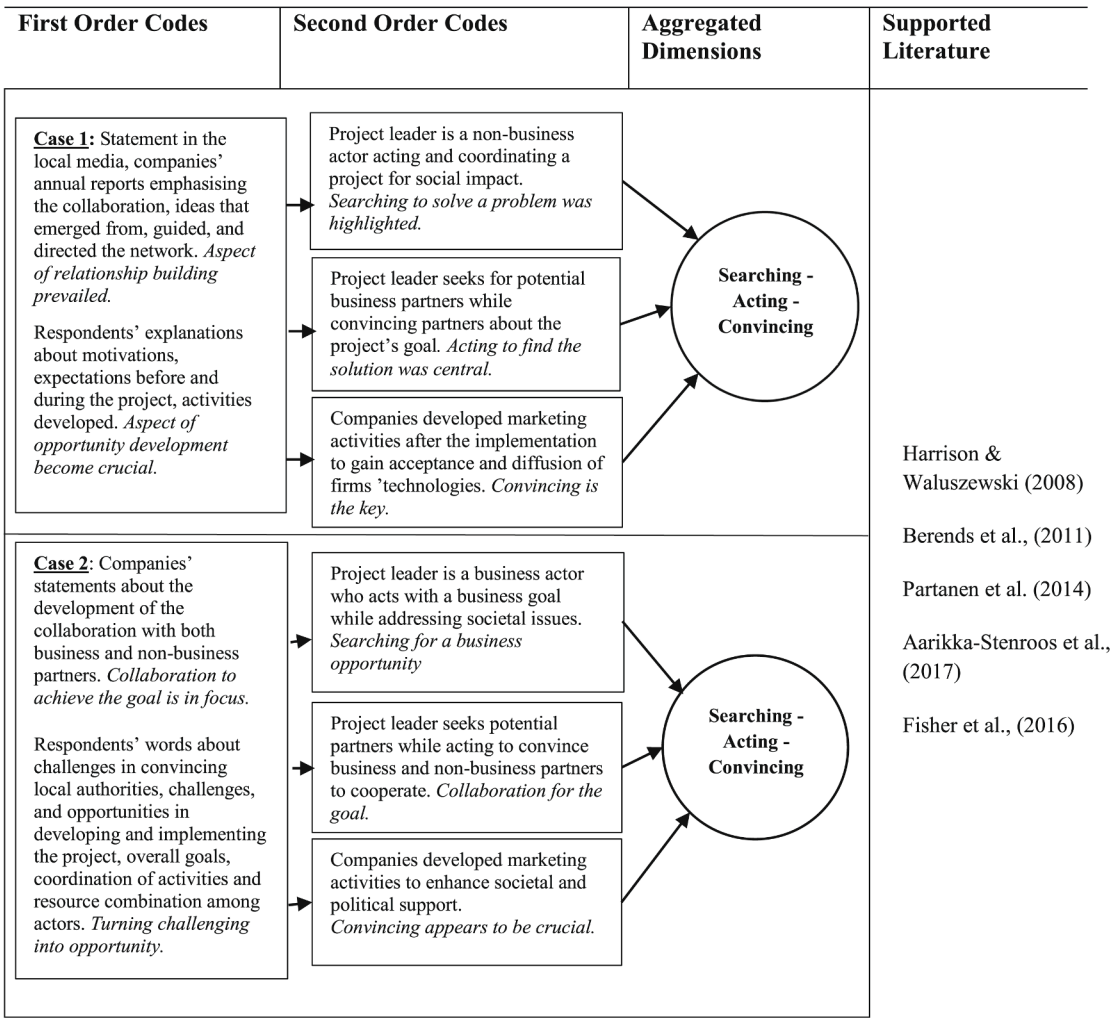

Fig. 2. Qualitative Data Structure.

ICI is a non-profit organisation that develops IT (information technologies) for public management. In Brazil, public transport agencies such as URBS provide and regulate public transport in metropolitan regions, but buses belong to private companies, the services of which the local government outsources. The transport companies, 23 in total, are represented by Setransp, a transport union with the mission of defending companies' interests. Other companies involved in the project were the Swedish Ericsson, which develops hardware and software for telecom services, the Brazilian Dataprom, which develops hardware/software for transport solutions, and the Spanish Telefonica/Vivo, a telecom operator that provides connectivity between devices.

In 2009, URBS was facing several communication problems that were affecting the city's transport system. At that time, all communication was done via radio, and ICI identified that wireless communication could be a route to improving the transport system. The first strategy was a partial adjustment of the electronic ticketing developed by Dataprom to allow the integration of a USB broadband modem inside Dataprom's equipment. In addition, a study for economic feasibility, ordered by URBS, was performed by LACTEC, a non-profit institute of scientific research and technology, whose advice was to build an OCC. In the meantime, URBS and ICI were searching for a telecom operator that could provide the connectivity for the OCC. To produce the solution, Dataprom acted by installing the card reader equipment at each bus station. The card reader was adapted to receive an embedded Telefonica/Vivo SIM card to allow connectivity. However, the OCC implemented at both URBS and Setransp did not function properly, and communication was lost several times. After several meetings mediated by ICI, the partners concluded that it was necessary to have the equipment to stabilise the system, and thus Ericsson's technology, originally developed for PCs, appeared to be the right equipment.

To create a solution for urban mobility, technicians from Dataprom, ICI, URBS, Ericsson, and Telefonica/Vivo worked together to integrate different pieces of technology. Once the coverage was adjusted and the system worked accurately, the solution allowed better fleet management by URBS and made it easier for passengers to plan their journey and save time. With an investment of USD 10 million by the municipality, the project was implemented in 2012, benefiting 3.2 million citizens in Curitiba by allowing real-time planning, while reducing CO2 emissions. In addition to the national recognition for the project's social impact, the UNFCCC (United Nations Framework for Climate Change Convention) also acknowledged this initiative as an innovative solution, giving international visibility to all actors involved.

4.2. *Case 2 – Aguas Smart City Project*

As a pilot project, Aguas was used by companies to test technologies with the potential to improve public services, while serving as a showcase to generate business opportunities for companies. Telefonica/Vivo, Ericsson, Huawei, and ISPM were the main actors from the business side. As mentioned above, Ericsson and Telefonica/Vivo worked together on the 'Curitiba smart city project'. Huawei is a Chinese multinational that develops and sells telecommunications equipment, while ISPM is a

Brazilian company specialising in the development of IoT platforms within 4G technologies. However, to deliver the entire solution, startups were involved, which developed apps and software for the IoT platform or served as suppliers of certain technologies to multinationals. From the socio-political side, the city mayor, public officials, and two NGOs named 'Vanzolini Foundation' and 'Telefonica-Vivo Foundation' participated in the project.

Through a collaboration agreement with the city mayor, Telefonica/Vivo, as a project leader, started by investing over USD 560,000 to convert the city's cable network infrastructure to a fibre-optic structure. In the meantime, the city hall performed a public consultation by asking citizens' opinions about overall societal needs. Areas identified included digital services in education, parking, street lighting, and health. With 3000 inhabitants, Aguas was chosen due to its high human development index, small size, and low level of investment required by companies. The estimated total investment in this project was around USD 4 to 5 million, including equipment, labour, and training. Within the project, Ericsson was responsible for the smart parking and smart street lighting solution, while Huawei was responsible for smart security with surveillance cameras installed in the city. Additionally, ISPM integrated all services into its IoT platform. The company developed digital application solutions in e-health; for example, an application to prevent dengue fever was developed. Dengue is a mosquito-borne virus common in tropical regions. In education, Telefonica/Vivo customised its digital technologies to a public library and classrooms, where students were provided with tablets. As part of the project, the Telefonica Foundation and the Vanzolini Foundation worked together to train schoolteachers to navigate in the new interactive platform.

The project was launched at the end of 2015 and received extensive media coverage, with mayors and ministers visiting the city. Seminars were also held in several other cities in Brazil to communicate the solutions and the benefits of having a smart city and therefore linking Aguas as a reference case. The project received international visibility as well among the entrepreneurial community, with it being recognised as an innovative project by the TM Catalyst Forum in 2015. Moreover, the project was presented in the 'Connected Smart Cities' in the same year, an event that brought together companies and the local government for a roundtable discussion on the future of smart cities within Brazil.

5. Case analysis

5.1. Drivers for innovation network formation

What are the reasons for an innovation network formation comprising companies, government, and society? The examination showed that many factors were driving these relationships. Motivations were varied and differed among actors. In case 1, the network emerged due to a social purpose to improve the city's urban mobility, and companies such as Ericsson and Telefonica/Vivo were interested in creating a new market opportunity in the urban mobility segment. However, the companies by themselves could not predict the result of the cooperation, or that the outcome would contribute to their innovation capability. Feedback from the bus drivers and ideas from ICI and URBS helped in the development process of the solution. The adjustment through Dataprom's system and connectivity, as well as the modem, was a co-creating process as an outcome of the actors' interactions. Thus, improving brand image and acquiring new capabilities became a central concern for the business actors. This is emphasised by the communication manager from Ericsson, who explained: *We did not know in advance what the overall outcome would be, but we knew that Curitiba has been recognized for its transportation system. Thus, we wanted to take part in this project and have our image associated to the city. Also, we could learn something new that could impact our knowledge base.*

When asked about how cooperation was beneficial to companies. Ericsson's CSR consultant stated: *The modem had been primarily developed to be used in computers; it was the first time that we applied it in buses, this creates new room for opportunities in transportation*. She explained that the adjustment of the solution helped them to gain a better understanding of the social desirability of the solution and to include this as part of the company's CSR report. For Telefonica/Vivo, participating in such a project would increase the company's relationship with the government and, of course, would facilitate the company's growth in the Brazilian market.

Dataprom's main reason for participating in such a project was to maintain its strong relationship with URBS. Such a strategy would give it access to some inside information that may facilitate future collaboration. Companies also emphasised that one of their main takeaways in this project was the experience of being coordinated by a public organisation; usually, it is the companies that set the action plans. For the societal actor ICI, the project would bring political visibility and opportunities to establish collaboration with the public administration in other cities in Brazil. Moreover, the mayor tried to link the project's success with his political campaign (see in the appendices). Hence, at a certain point, the individual motivations met the collective motivations, and this contributed to a successful implementation of the project.

In case 2, the innovation network emerged with a clear objective of creating new business opportunities, i.e. it had an economic motivation. The main point was to show this technology functioning in a real city context, and not only to help companies to sell the solution to several mayors, but also to enable them to expand in the Latin America region. The company's project manager explained that: *As a telecom company, it is important to leverage the development of the concept to allow the idea to be born, seize the opportunity, and create the market that we want for Telefonica/Vivo's core business*. Ericsson envisioned an opportunity for corporate market legitimacy, and this is confirmed by the words of the company's marketing manager. She explained that: *If a pilot project has a good story, it creates trust in the market and in the government's eyes*. Such a statement suggests the need for companies to receive social acceptance of their technologies and then translate this into new business opportunities. This implies that companies were acting to engage with the local government and then receive help to create a market for their solutions.

For Huawei, the main motivation was brand awareness. Huawei's solution manager stated: *Huawei is not yet well-known in the Brazilian market and we are searching to legitimize our technology*. In contrast, the main objective for ISPM was learning. For instance, the apps developed for health had been customised after receiving feedback from the city hall and the citizens who downloaded the app. Applications entitled 'Aguas without dengue' encouraged citizens to act as a health agent and help the public administration to prevent the proliferation of the dengue mosquito. Thus, by citizens sending photos of a potential outbreak, the location address is recognised via GPS before sending data. After that, the city hall acts by checking and using insecticide in the area reported. After the app implementation, the number of cases was reduced from 86 to zero cases in 2016. ISPM's innovation director explained that: *At ISPM, we wanted to learn more about the concept and create our know-how in cities, but we need not only to develop technologies, but we also need to understand 'the people'*. For him, this project helped the company to understand the user's needs and design strategies in order to encourage citizens' engagement with the company's technology.

For the Vanzolini Foundation, the main motivation was to be part of a project that could increase its brand visibility. The sustainable project manager stressed that: *Our participation in this project was a great opportunity to show the usage of technologies in education while fulfilling our organisational mission.* The political actors were interested in the image that such a project could bring to the city; the secretary of tourism contributed by both convincing other public officials about the potential benefits and by reducing all bureaucracies to speed up the project implementation (see in the appendices).

5.2. Innovation network configuration

The network configuration observed in both cases involved business and socio-political actors. Hence, an important question is to understand how the actors contribute and collaborate within a network to develop technologies for social impact. In case 1, the technological resources involved the devices, OCC, connectivity, and all tech solutions and expertise associated with the development of the technology. Concerning the non-technological aspect, the project was only possible first through an idea that came from the socio-political actors (i.e. URBS and ICI). Second, these actors had the contextual experience and understanding of which communication problem they had. Moreover, their contributions were on the organisational aspects of the network, such as searching for a solution to the urban mobility problem, setting up the network, recruiting network members, and creating a good flow of information, while trying to solve problems that arose during the project development. The socio-political actors were also aware of their technological limitations and for this reason, business actors were recruited. The network also allowed not only the participation of companies, but also feedback from bus drivers and advice from the NGOs in a process of co-creation. Furthermore, the innovation network activities were coordinated by a non-profit organisation, URBS, representing the local government. These activities included searching for new technologies, searching for business partners while convincing partners to cooperate, and acting cooperatively with other actors on the smart city concept, while seeking to adjust the partners' technology. URBS also convinced partners to customise the solution to meet the city's needs. Thus, the project configuration required not only the technological dimension, but also the social dimension for a successful implementation. Hence, the network configuration is a result of actors, their respective resources, and drivers (economic-social) and was achieved through the activities of searching, acting, and convincing. This suggests that innovation is socially constructed.

In case 2, Telefonica/Vivo recruited Ericsson, Huawei, and ISPM (see Fig. 4, section a), which contributed with their technological resources, such as cameras, IoT platform, devices, etc. Telefonica/Vivo also needed the support of the city hall to use the city as a showcase for its project. The network organising process, however, appeared to be complex since it involved several relational skills. These skills included, for example, acting as a leader, acting to create a good and open information flow within the network, and acting to reduce scepticism, while convincing others about the project idea. In addition, Telefonica/Vivo needed to have a flexible approach by creating an informal agreement among partners and explaining the responsibilities to be taken by each actor. Leadership skills can be observed through the words of the innovation manager at Telefonica/Vivo. He stated that: *We had our personnel dedicated to talk to several actors to explain the routines, to inform what would come next, etc.* Managers explained that cooperation required informing potential partners of the idea to develop trust, while at the same time gaining the support of such partners. Additionally, permission to use the city to develop the concept was necessary, while convincing the public authority that the project could add a positive image to the city in a way that would meet the city mayor's interests. Furthermore, Telefonica/Vivo needed to act with business partners to customise the technology after receiving feedback from city technicians and citizens. Citizens were also invited to rate apps and contribute by giving insights about what was good, what to improve, what was not working, etc. In the meantime, interactions with citizens were necessary to reduce scepticism and resistance, while encouraging citizen's engagement. The changes of actor bonds, resource ties, activity links, and ideas/inventions as well as a business logic with a social purpose shaped the network configuration and created the necessary conditions to show the social benefits. Hence, innovation is seen as a multi-stage process.

5.2.1. Innovation network dynamics

In both cases, the innovation networks for social impact were dynamic with changes happening at different phases of the project. In case 1, there was no clear separation between searching for and acting on an opportunity (see Fig. 3 and the arrows connecting sections a and b, since the actors moved back and forth between searching for both new possibilities and the most suitable partners, while acting to customise and adapt the existing technology. This is also observed in the implementation of the technologies when new problems appeared and made the actors focus on a new search, i.e. searching for other technology that could give stability to the system (e.g. Ericsson's modem). As such, this reinforces the idea that the phases of searching and acting are not completely detached from each other.

Specifically, Fig. 3 displays a network evolution through the innovation activities (see sections a, b, and c). The arrows connecting the boxes illustrate the interrelated aspects of the activities. As can be observed, the figure shows that the network was quite small at the beginning with a few participant actors, but the dynamics of the innovation process following the city's needs influenced the expansion of the network with an increase in new participants. Interestingly, Fig. 3 demonstrates that the configuration differs among the phases. In the searching phase, the configuration that matters is the sole presence of the social-political actors together with citizens, but for effective innovation, business actors became involved in a phase where more intensive action was required, i.e. in the momentum of crafting the idea from the socio-political actor into a technological solution developed by companies. At this phase, more actors participated and collaborated, and a blend of technological and experiential knowledge was necessary. In the convincing phase, a few actors became relevant, and this was a phase driven by companies interested in branding.

Resources leveraged in the network go beyond the aspect of technology to incorporating the ideas of non-business actors. It also involved their knowledge of the needs of the city, which was beyond the business market knowledge of companies. The figure clearly shows that the network increased in the acting phase, i.e. the development of the idea/invention, but that it decreased in the convincing phase. As the figure demonstrates, Dataprom was not part of the network in the final stage of the project (see section c). When Dataprom's marketing manager was asked the reasons for this, he explained that the company had been less proactive in such marketing activities. As the network analysed in this study is very diverse, different colours are used to distinguish actors in the network. Hence, the public sector is represented in green, while grey and black represent non-profit and business actors, respectively.

The companies, mainly the multinationals, used the project for marketing purposes to show how their technology affects society positively. This final stage of the project can be seen as the convincing phase (see Fig. 3, section c) once the project was implemented. Interestingly Ericsson and Telefonica/Vivo submitted a joint application and won the UNFCCC award competition. By receiving this award, both companies consolidated the concept of the first global reference case of buses connected through 3G technology. They also promoted the project in the media with national and international coverage. Furthermore, the two business partners joined forces to create a video. This video showed URBS's president, the city mayor, and citizens advocating in favour of the project with which the companies' technologies was associated. By articulating an optimistic vision of the use of the innovation for social impact, the city mayor and the public officials helped to support the diffusion of the companies' new technologies and increase the companies' reputation and legitimacy. On UNFCCC's website, URBS's president appears with the companies at the award ceremony. This helped to enhance the companies' brand awareness, market legitimacy, and market creation, which implies that the socio-political actors' endorsement was relevant to build trust and accelerate diffusion as well as the validation of the companies' technologies.

In case 2, the network dynamics and evolution are depicted in Fig. 4, which displays the activities of searching, acting, and convincing actors of an opportunity for innovation (see sections a, b, and c). The arrows connecting the boxes illustrate the interrelated aspects of the activities

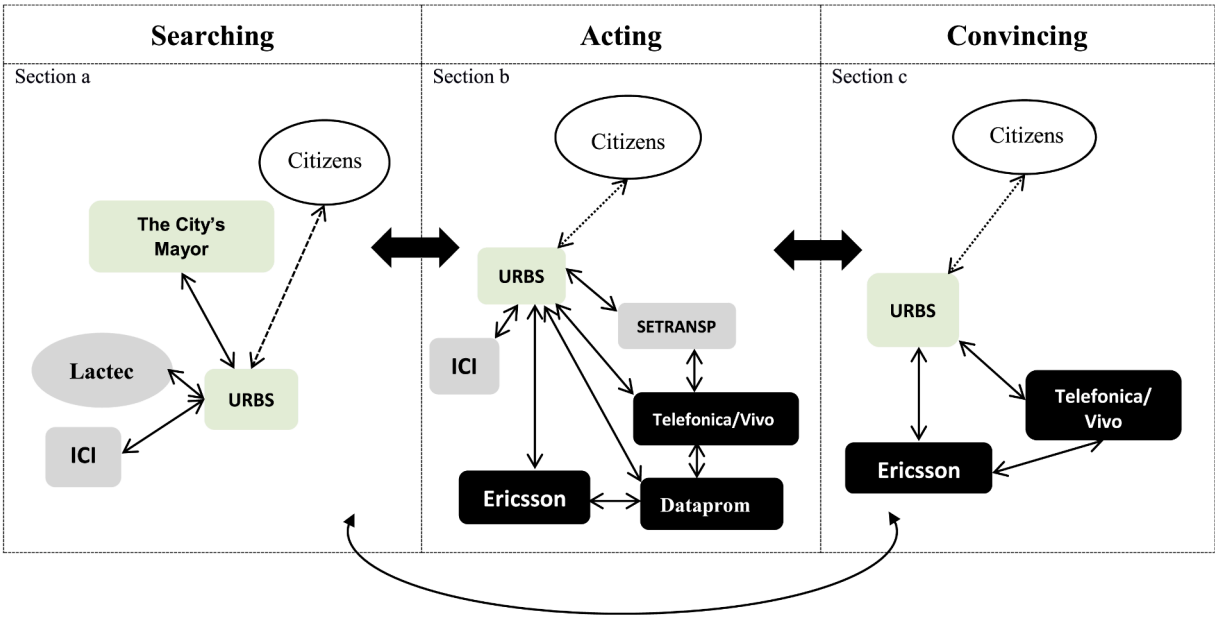

Fig. 3. The network view in the process of searching, acting and convincing of an opportunity – Case 1.

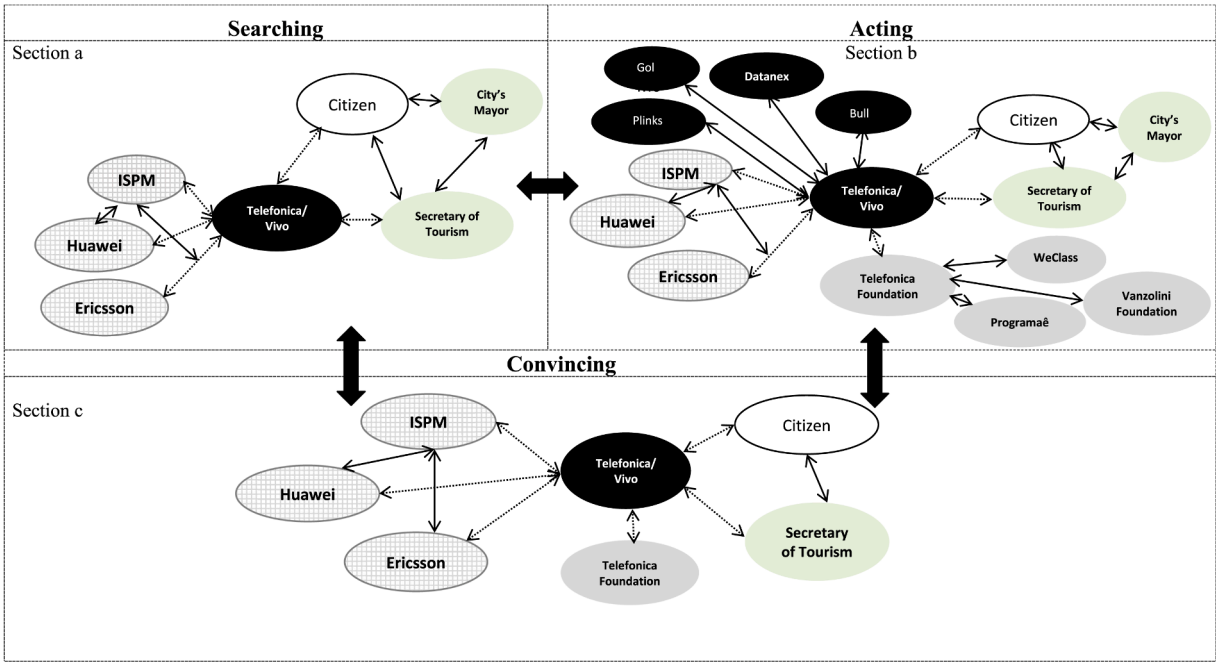

Fig. 4. The network view in the process of searching, acting and convincing of an opportunity – Case 2.

since the case shows that the innovation process was very dynamic and socially constructed with actors moving back and forth between the activities. These network activities exemplify the reasons for an innovation network formation and show how business and socio-political actors contribute and collaborate in order to develop technologies for a social impact.

Initially, the network was quite small with a few participant actors, but the dynamics of the innovation process to meet the city's demands influenced the expansion of the network with an increased number of participants. While Telefonica/Vivo was acting with its major business partners, i.e. Ericsson, Huawei, and ISPM, the company recognised that the partners only had part of the solution, and the new activity of searching for new resources emerged. In such a phase, small companies contributed with their technology (see section b). By integrating all pieces of knowledge from different business actors, the whole solution was created and it was possible to show the social benefits.

An important observation illustrated in Fig. 4 is that the configuration differs among phases. In the searching phase, the configuration that matters is the major multinational companies together with the city mayor, citizens, and secretary of tourism. But after the public consultation and interests for educational improvements, Telefonica/Vivo Foundation and the Vanzolini Foundation were also involved (see section b). For an effective and successful project development, together with the NGOs, many other business actors became involved in a phase where more intensive action was required, i.e. in the momentum of trying to meet the city's needs with the companies' technologies.

Furthermore, the technological solution developed as a result of ideas from citizens, information from the secretary of tourism as well as collaboration and a knowledge exchange with the city's technicians. Understanding the cities' overall context was not only necessary, but also beyond the business market knowledge of companies. In the convincing phase, few actors were relevant, and this was a phase driven by some companies interested in branding.

In Fig. 4, there is no arrow connecting Ericsson and Huawei. The main reason for this is that the companies are direct competitors, and according to Huawei's solution manager, there was limited dialogue between them. For both Ericsson and Huawei, the decision to participate was based on teaming up with Telefonica/Vivo, which was an important partner. Moreover, motivation was also linked to the importance of the project for the companies' strategic market creation and expansion in smart city solutions. Therefore, the process of searching, acting, and convincing among them was mediated by Telefonica/Vivo. Hence, the network increased with new participants in the acting phase, i.e. when the idea was developed (invention), but it then decreased in the convincing phase with the strong presence of foreign multinationals.

At the final stage, convincing activities were also related to promoting and communicating the project to the market. According to the innovation manager at Telefonica/Vivo, small companies lacked financial resources in the final stage of the project, i.e. in the launch phase, and this explains their absence in the marketing campaign (see section c). An interesting observation is that after the project launch, each business actor tried to promote the technology individually and tried to differentiate themselves by communicating and positioning their brands individually. As the network analysed in this study is diverse, different colours are used to distinguish the actors in the network. Hence, the public sector is represented in green; grey and black represent non-profit and business actors respectively; and Telefonica/Vivo's major business partners are represented in striped grey.

When comparing the two cases, the main differences observed were both the network evolution and goal. In case 1, the network started from a cognitive distant (exploration) invention for market creation, while in case 2 the network started from a cognitive proximate (exploitation) invention for market expansion. In case 1, the outcome of the innovation activity was the first case of 3G technology in buses, which created a new market for companies within the transportation industry. In case 2, the project itself is also a cognitive distant invention, but directed towards market creation in respect of the smart city concept and expansion regarding the companies' technology. Furthermore, in case 1 the innovation network was unintentional and driven by a social goal, while in case 2 the innovation network was intentional and driven by business goals, but with a social purpose.

5.3. The societal impact of the innovation networks

The impact of the projects is assessed in terms of their scope and the transformative effects in the city development. The scope of the social impact can be at micro, mezzo, and macro levels (Becker, 2001; Siemieniako et al., 2021). These two cases are at the mezzo level with their origins at the inter-organisational relationships within the innovation network. Hence, the outcome of the network activities was translated into the positive impact of the project in case 1, both to society and business. For society, the new solution improved the city's public transport system. For users of public transport, the new service helps users to better plan their bus travel, while increasing customer satisfaction and security for staff and passengers. For URBS, more efficient fleet management resulted in a better public service, reduced CO2 emissions, and contributed positively to the city's global image. For business, the positive social impact contributed to the companies' brand image, while expanding their technological domain in a new market. Moreover, network activities together with the need to meet social demands led companies to a customisation process. This contributed to learning how to align their existing technology with social desirability and sustainability aspects. The project also impacted ICI, as the NGO changed its mission from being an institute of IT for the public administration to an institute of intelligent cities. This implies an expansion of the NGO's scope of activities.

In case 2, the network activities illustrate a positive social impact of the project on education, health, and security. For society, digital tools in education improved communication among students, teachers, and parents at public schools. In health, the reduction of cases of dengue mosquito transmission was noticeable. The smart lighting solutions reduced electricity costs for the municipality, while surveillance cameras enhanced the security of the public areas. For the business actors, especially, for Telefonica/Vivo, one crucial aspect was to link potential profit goals to a social impact. Thus, this network emerged intentionally for profit gains and non-business actors were relevant to both idea generation, knowledge exchange, and support. For example, the secretary of tourism gave talks about his experience in the development of Aguas' smart city and the use of the companies' technology in several seminars. This reveals that the socio-political actors helped to validate the project. This project became a reference case and helped the companies win bidding processes in other cities in Brazil.

From a network perspective, the cases demonstrate that opportunities are formed as an outcome of the three innovation network activities. Hence, **searching** for an opportunity to develop a smart city project also requires searching for a societal problem to solve; recruiting partners to compose the solution, while customising the solution for a specific city; and searching for ways to implement the solution, while acting to create the conditions to enable the project to develop. These conditions can be associated with the organising mechanisms of the activities, the leadership role and management competencies, such as allowing a flexible approach to align different demands and goals. In both cases, the actors (URBS and ICI in case 1 and Telefonica/Vivo in case 2) were able to set up an open-source knowledge base, in which companies, government, and society collaborate and contribute in order to develop the solution. In this searching process for both cases, there was an open boundary with partners stepping in and out when necessary. This suggests that innovation networks for social impact should be open to new partners that fit the overall visions. Openness should also be translated into more participation from the public.

Acting was observed in the process of finding a solution by looking at problems within the community, i.e. in both Curitiba and Aguas, to create a meaningful impact. Adjusting the solution to meet the city's needs is part of the network activity in addition to acting to communicate the benefits to society, acting to create a market for smart city technologies, acting cooperatively to strengthen the means of implementation, acting to anticipate potential problems, acting to reduce scepticism, and acting to develop meaningful relationships that may support and enhance the project's successful development, while enhancing reputation and credibility.

Convincing was present in every phase of the innovation. It was necessary to convince others about the idea and therefore encourage them to collaborate, convincing others to talk positively about the project after the implementation phase, such as the public officials, and the local and international media. It was also necessary to convince international organisations that the project was innovative and to convince citizens to use the technology as well as the public officials. Furthermore, convincing the market that the solution was reliable had a social impact and could be replicated in other cities. In a broad sense, the development of more smart cities suggests a multi-actor activity that includes companies' participation, citizenship, and government involvement.

In summary, when these combined activities are analysed, it explains the network formation, evolution, and configuration as well as the social benefits. The cases show that innovation network for social impact requires a new form of collaboration (with public–private and citizens' participation), a different combination of resources (technological and non-technological), and drivers (economic and social). Hence, Figs. 3

and 4 show the configuration of the (above) matter at a particular stage of the innovation. The cross-case comparison, thus, suggests which configuration may result in more and/or less effective innovation. The acting phase (see both Figs. 3 and 4, section b) indicates a more intensive process of innovation with all configurations being put in place. Furthermore, it suggests that more actors, more resources, and the alignment of economic and social drivers are required. On the other hand, the searching phase (section a) and convincing phase (section c) illustrate that fewer technological resources are necessary, but other intangible skills seem to be more prevalent. For example, leadership and a clear communication of ideas, relationship development with the most important actors, marketing strategies, and/or even tacit knowledge concerning the city context or the network context that somehow influenced the activities.

6. Discussion and conclusion

The conceptual discussion followed by insights from the cases led the proposition of a conceptual framework to illustrate network formation, configuration, and dynamics. Such a framework is depicted in Fig. 5. By observing a nonlinear path, the process of innovation can be characterised by the three activities of searching, acting, and convincing actors of an opportunity to develop a smart city project.

The activities of *searching and acting* in a city setting, thus, refer to the process of designing, developing, and facilitating synergies between social structure and information technologies. I.e. this stage of exploring new technology requires not only the integration of different sets of technological and scientific knowledge, but also the integration of the social dimension. For instance, digital technologies may enable citizens, political officials, NGOs, etc. to monitor, understand, and help the development of a smart city (Meijer & Bolívar, 2016). Therefore, these activities require companies to find a balance between the exploration and exploitation of the knowledge developed. It is also relevant to find a balance when the technological dimension is relevant and when the social dimension should prevail in different phases of the project. An interesting aspect is that, in both types of innovation (radical or incremental), the a*ctivities of convincing* are necessary to minimise resistance from customers, citizens, and any potential users of the smart city solutions. Thus, convincing is not only linked to product advertising and brand development, but it is also related to motivating actors to collaborate and to engage in both the development and implementation phase.

These activities represent three conceptual stages of innovation. They do not occur separately; rather, actors must coordinate back and forth between them as they seek to innovate. Innovation aiming at a social impact thus involves bridges between these activities (see Fig. 5), which means mobilising resources, customising the technology, and accommodating the interests of actors at different stages. Findings from the cases suggest that the development and implementation of a solution is not a linear process. Rather, finding and enacting a solution is often a complex and dynamic process that may require actors to revisit earlier stages, perhaps multiple times, before a proper solution is identified, developed, and implemented. Hence, the model suggested is nonlinear, dynamic, and process based.

The findings show that innovation networks can emerge from a social goal (case 1) or an economic goal (case 2). The innovation, however, is a socially constructed process of co-creation between business and socio-political actors. Therefore, the novelty is that the smart city development and innovation is not limited to traditional business-to-business relationships, where researchers in business and marketing focus their analysis, but it can also emerge from socio-political actors such as governments, NGOs, and citizens. The results are in line with Aarikka-Stenroos et al., 2017), who claim that non-profit organisations and opinion leaders are important actors in the commercialisation of innovation. However, this study adds knowledge to their findings by showing the participation of other actors, for example, NGOs, politicians, public officials, and even citizens in the companies' innovation networks. This suggests that innovation networks for social impact entail a public–private-citizens collaboration type. Hence, in the context of smart city development, socio-political actors contribute to both the development phase – through idea generation, tacit knowledge, and providing feedback – and the commercialisation phase – by supporting diffusion, acceptance, and market creation – for companies' technologies. Another implication is that societal and/or political support may influence companies' decisions concerning resource allocation. Put differently, companies may focus their attention on incremental and/or radical innovation depending on the demands of the city. This implies that in cities in which the public authority demands a high level of adjustment or customisation of technology, companies will be encouraged to allocate resources to exploration, while in cities requiring a low level of adjustment or customisation, exploitation will be chosen instead.

6.1. Contributions

This study contributes to business and marketing network literature in various ways. First, the marketing view of cooperative innovation networks (Håkansson & Waluszewski, 2002; Möller & Halinen, 2017) is enriched by conducting a more fine-grained conceptual analysis of relationships between actors, resources, and activities at the network level. We argue that by understanding the network's formation and configuration, research has the potential to provide new perspectives on the entire industry rather than on the performance of an individual organisation. Second, this study suggests that the innovation networks for social impact relates to the activities of searching, acting, and convincing actors of an opportunity (see Figs. 3 and 4). These activities offer an example of self-organisation as a basis for the collective creation of opportunities, with important implications for technology

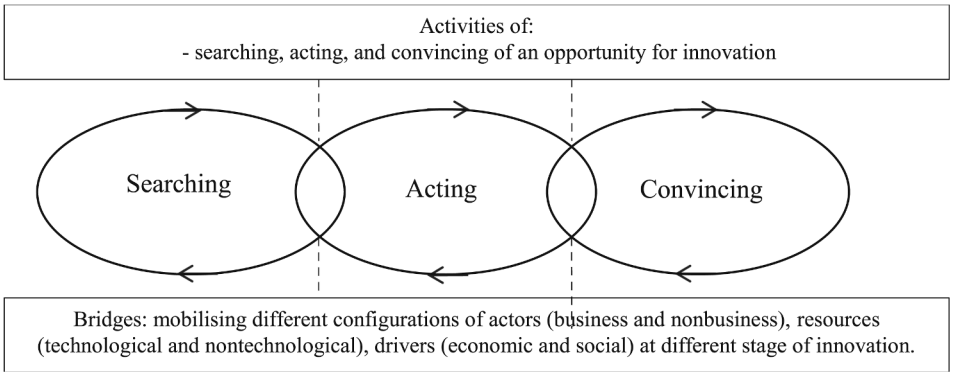

Fig. 5. A conceptual model of the innovation networks for social impact.

development and diffusion. The cases illustrate that these activities are socially constructed, which emerging technologies rely on, with supportive activities developed by a variety of co-creators within the network. Innovation networks emerge not solely with a business goal, as this study shows that they can have a social logic and still can generate business opportunities. Thus, innovation for smart city innovation specifically involves new forms of collaboration (public–private-citizens), drivers (economic and social), and resources (technological and non-technological) in both its development and implementation. Hence, the two cases of smart city development allow for insights to suggest which configuration may result in more/less effective innovation.

Although the findings are in line with Gavetti (2012), who states that there is a lag period between identifying, acting, and then convincing, these activities are interrelated. Within the projects, the study demonstrates that there is no such clear separation between these activities, but that actors move back and forth between them. One explanation for this is that in the cognitive distant invention type, companies cannot predict the outcome more easily and do not have the business and technical experience. For this reason, several activities are performed as the project advances in a process of learning by doing. Finally, this paper underscores that the innovation networks follow a nonlinear path in both the development and implementation phases. Still, it illustrates how collaboration between business and non-business actors can result in innovation for social impact.

6.2. Limitations and directions for future research

This study has some limitations that provide insights for future research directions. First, it is limited to the investigation of two cases within one industry and, therefore, the findings should be interpreted with caution. Moreover, the conclusion cannot be generalised, as they are based on cases from one industry. However, the framework proposed illustrates a dynamic model and provides insights into the link between network configurations and the type of innovation, therefore encouraging further research on the subject. Second, this paper focuses on the positive social impact of smart city projects, but depending on how a project is organised, it may also lead to negative social impact. In this perspective, how can companies mitigate negative social risks and increase social performance in future smart city projects?

Finally, the cases studied here show the importance of a project leader in coordinating activities between business and socio-political actors. A central position may provide companies with specific resource advantages, to access information more easily, and to gain knowledge from its surrounding counterparts (c.f. Burt, 2009). In such a case, how does centrality matter in innovation networks for social impact? Certainly, the effect of the centrality on the companies' business networks constitutes an interesting and promising future research area. In addition to this, smart city development demands close interaction with socio-political actors to adjust the technology accordingly with local needs. Despite an interest in understanding the interactions between business and socio-political actors (c.f. Hadjikhani et al., 2019), there is little research examining the impact of these actors on companies' resource allocation for exploration or exploitation. Moreover, how do companies manage relationships in a network that combines public–private collaboration and citizen involvement? Furthermore, in the second case, two MNEs (Ericsson and Huawei) were direct competitors. The analysis of their relationships within the project was outside the scope of this study. However, a project for developing a solution requires close interactions to facilitate the process of combining resources and information sharing (Håkansson & Snehota, 1995). One important question is: how do companies manage knowledge sharing when cooperation requires interaction with competitors? For example, informing others about where the company is focusing its opportunity efforts could provide information to skilled rivals about how to shape their own search efforts and consequently target the same markets. This implies that companies need to manage the willingness to share information, but must simultaneously be attentive to which type of information they should share. In such a context, how should managers best address this challenge? Should searching, acting, and convincing actors of an opportunity occur with a strategy of openness or with caution?

6.3. Implication for managers and policymakers

This study helps managers to better understand the complex innovation process connected to the smart city solution. Leading companies need to consider pursuing opportunities (e.g. technological adjustment and customisation) and deal with the understanding of how technologies should be adapted to generate acceptance and diffusion. An interesting observation from the cases is that innovation which has the potential to benefit society in areas of urban mobility, health, education, etc may receive strong support from external audiences such as the media, governments, NGOs, and citizens. Such support is essential to legitimise companies' technological know-how.

The findings also have political implications for regulating emerging technologies. From a global perspective, public policies may shift incentives from R&D funding towards more multi-sectorial innovation networks. Innovation for smart cities deploys not only a pooling solution for specific areas, but integrates all areas in which cities have requirements. Future studies addressing how companies work cooperatively with the government to gain support for the development of innovation networks could be insightful. How do these inter-organisational networks influence economic and social value creation and capture mechanisms? How can the process of searching, acting, and convincing actors of an opportunity attract governments' support in a way that benefits companies in such a digital service industry?

The social implication in this study is that innovation networks for social impact should be open to new partners that fit the overall visions and provide leverage for innovation. Moreover, openness should be translated into more participation from the public. The adoption of the traditional collaboration between public and private spheres might be misleading for smart cities' development since it does not allow citizens voluntary participation. For example, which type of governance mechanisms should be implemented to make cities inclusive and sustainable? More research investigating the dynamics of organising smart city projects from a governance and operational perspective is worthwhile.

In conclusion, while prior research recognises the importance of comprehending inter-organisational networks to facilitate innovation (e.g. Aarikka-Stenroos & Sandberg, 2012; Möller & Halinen, 2017), there is still a need to investigate how a heterogeneous network type, i.e. one with a diverse pool of actors (business and non-business) and drivers (economic and social) as well as resources (technological and non-technological), can result in effective innovation. It is hoped that this examination of innovation network formation, configuration, and dynamics has provided an important basis for future conceptual and empirical research in such a timely topic.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A Second-order themes and supporting quotes

Second-order themes & aggregate dimensions	
CASE 1 – Curitiba Urban Mobility	
Searching	• We were committed to solving the communication problem and searching for new ideas were happening daily. [Innovation Manager at URBS] • URBS had a strong belief in the project concept and was very engaged to improve the city's urban mobility [Project Manager at ICI]
Acting	• 'After the implementation of the whole technology inside the 1500 buses, we needed to check again and again to identify the problem, it was a stressful time' [Project Manager at ICI] • 'We ordered a study for economic feasibility to make sure that we were going in the right direction' [Project Manager at URBS] • 'We checked all companies' equipment to assure that they met all requirements necessary for a public purchase [Project Manager at URBS]
Convincing	• 'At Setransp, we are convinced that the solution was good to us. It allows Setransp to centralise all costs and communication with URBS before it was done separately through the 23 transport firms. Now with the consortium, the communication is better, and the costs have decreased. [Technical Advisory at Setransp] • 'The project allowed us to show how our technology can contribute to people's lives' [Communication Manager at Ericsson] • Beto Richa is the first mayor in Brazil to be invited to talk in the World Week of Urban Mobility in Seoul [Beto Rita, Political Campaign]
Searching & Acting	• While we were searching for a solution to bring stability to the system, we were also developing training for the personnel at both URBS and Setransp [Solution Manager at ICI]
Acting & Convincing	• 'We did not know in advance what would be the overall outcome, but we knew that Curitiba has been recognised by its transportation system and for being a very innovative city in Brazil, thus we want to take part in this project and had our image associated with the city. We started by installing the smart park and smart streetlight' [Communication Manager at Ericsson]
Convincing &Searching	• 'Dataprom was interested to meeting URBS needs but also in expanding its product portfolio, thus we began to search for partners that could develop the technology and a stable and trustworthy system with us' [Commercial Director at Dataprom • 'This project was and still is very important to Telefonica/Vivo. It created the right conditions to put the company in focus in respect to M2M (machine-to-machine) technologies which become a priority of the Telefonica Digital Hub, we are always searching for new business opportunities within M2M' [Sales Director at Vivo]
CASE 2 – Aguas Smart City	
Searching	• Huawei is not yet well-known in the Brazilian market, and we were searching to participate in this project to legitimize our technology. [Solution Manager at Huawei] • 'At ISPM, we were searching to acquire knowledge in the smart city concept. We wanted to create solid know-how in cities. After the project, a spin-off company entirely dedicated to a smart city solution was created [Innovation Director at ISPM]
Acting	• 'We acted by adjusting our solution in education to improve communication among students, teachers, and parents' [Sustainable Project Manager at Vanzolini Foundation]. • We need to coordinate activities between business partners but also with public officials [Relationship Manager at Telefonica/Vivo]
Convincing	• A pilot project serves as a lab for the development of future public–private collaboration, mainly in densely populated areas [Telefonica/Vivo President at Latin America Region] • I was interested in the societal contribution that the project could bring to us, first in terms of cost reduction and then improving the public service to the city's citizens. [Tourism Secretary, at Aguas] • 'It was necessary all the time to convince others, to convince partners and even the city's technicians working together with us in the implementation phase [Innovation Manager at Telefonica/Vivo] • Interviewer: You mentioned a lot about the importance of convincing different actors, how did you convince the public authority regarding the project? Interviewee: The communication is different, it is not showing what the technology can do, but what the technology can solve, the social benefit, and the political benefit [Government Relation Manager at Ericsson]
Searching& Acting	• 'We acted by proposing the collaboration to the city hall while searching for potential partners' [Innovation manager at Telefonica/Vivo] • We were searching for small companies that could supply pieces of the technologies that the multinationals did not have while acting to adjust the solutions to meet the city requirement' [Innovation Manager at Telefonica/Vivo]
Acting & Convincing	• I started by reducing all bureaucracies to help the project implementation while convincing the mayor and the other public officials about the project idea. [Tourism Secretary at Aguas city] • We were searching for information about citizens' overall perception of the project while convincing them by communicating the social benefits and of course acting to anticipate potential problems. We wanted to avoid any damage to the project's image [Public Relation Manager at Telefonica/Vivo]
Convincing&Searching	• 'As a telecom company, it is important to leverage the development of the concept to allow the idea to be born, develop and create the market that we want for Telefonica/Vivo's core business [Project Manager at Telefonica/Vivo].

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